ATOP Technologies, Inc.

Protocol Gateway
IEC60870-5-101 Master/Slave
IEC60870-5-104 Client/Server

Protocol and
eNode Designer configuration

eNode Configuration Manual

V1.4

August 3rd, 2023

This PDF Document contains internal hyperlinks for ease of navigation.
For example, click on any item listed in the Table of Contents to go to that page.

- **IEC 60870-5-101 Configuration Guide**
- **IEC 60870-5-104 Configuration Guide**
- **IEC 60870-5-101 Interoperability**
- **IEC 60870-5-104 Interoperability**

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2F, No. 146, Sec. 1, Dongxing Rd.,
Zhubei City, Hsinchu County,
302058, Taiwan, R.O.C.

Tel: +886-3-550-8137
Fax: +886-3-550-8131
https://www.atoponline.com

Important Announcement

Disclaimer

We have checked the contents of this manual for agreement with the hardware and the software described. Since deviations cannot be precluded entirely, we cannot guarantee full agreement. However, the data in this manual is reviewed regularly and any necessary corrections will be included in subsequent editions.
Suggestions for improvement are welcome.
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1 Introduction

Thank you for Buying ATOP's Protocol Gateway.

The product is bundled with the following three user manuals:

1) Hardware specific installation user manual, **not covered in this document.** It covers ATOP's hardware installation procedure, wiring, power connection etc.
2) Getting started with ATOP's Protocol Gateway user manual – configuration tool introduction, web configuration, software architecture introduction– **not covered in this document**. This manual covers the introduction, installation, network set-up maintenance and using of the configuration tool software, including the procedure to be followed for uploading new configurations to ATOP's device.
3) Protocol specific user manual **(This Manual). One protocol-specific manual will be provided for each protocol installed on the device.** This manual covers:
    a. Basic device network configuration
    b. Step-by-step protocol set-up for in eNode designer
    c. Description of the protocol-specific software features, the device profile and the implementation table of supported functionalities.

This manual is for **IEC-60870-5-101 and IEC-60870-5-104 client server** and describes how to use the **IEC-60870-5-101/104 eNode Designer Module** to configure ATOP's *IEC 60870-5-101/103 ADH Application* within the eNode Designer configuration tool.

1.1 Scope

This document is divided into 5 major sections:

- **Overview** with **General Description**; and a
- **IEC 60870-5-101 Configuration Guide**
- **IEC 60870-5-104 Configuration Guide**
- **IEC 60870-5-101 Interoperability**
- **IEC 60870-5-104 Interoperability**

1.2 Overview

1.2.1 Document Reference

[1] Document Title: Getting started with ATOP's Protocol Gateways
Revision: Version 1.00 or higher

[2] Document Title: IEC 60870-5-101 standard
Revision: Edition 2 – 02/2003

[3] Document Title: IEC 60870-5-104 standard
Revision: Edition 2 – 06/2006

1.2.2 List of Abbreviations

ASDU = Application Service Data Unit
ADH = Application Data Hub
IEC = International Electrical Commission
IED = Intelligent Electronic Device
PLC = Programmable Logic Controller

2 General Description

2.1 Adding the IEC 60870-5-101/104 ADH Application

An IEC 60870-5-101/104 ADH application can be set up as a *Client* or a *Server*. This choice will be presented when adding the application. Please note that ATOP Protocol gateways supports one Server application per protocol per device.

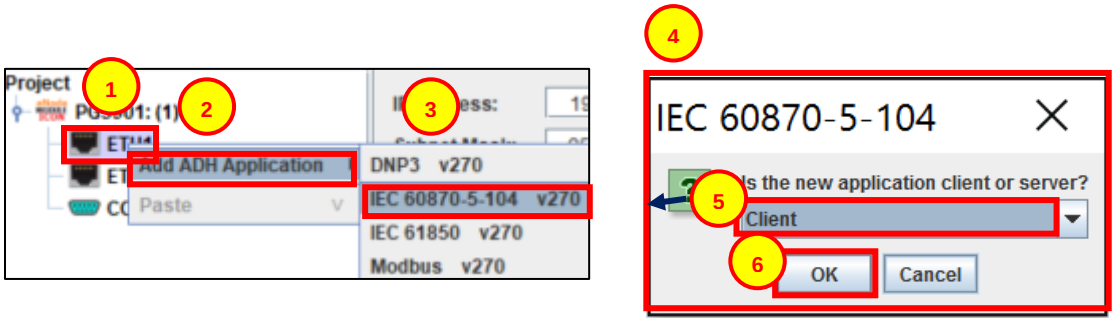

Figure 2-1 – Adding an IEC 60870-5-101/104 ADH Application.

1. Right click the intended port for the *IEC 60870-5-101/104* ADH application.
2. Left click **Add ADH Application**.
3. Left click **IEC 60870-5-101 or IEC 60870-5-104.** eNode Designer will automatically choose between IEC 60870-5-101 or IEC 60870-5-104 depending on what type of port the application is being added to.
4. This dialogue box will appear, asking whether the new application is to be configured as a *Client* or a *Server*.
5. Select either **Client** or **Server** from the drop down menu.
6. Left click **OK** to add the application.

There are differences when configuring the new ADH application depending on whether it is an IEC 60870-5-*101* or *104* and whether or not it is configured as a *Server* or a *Client*. See the following links for specific configuration information:

IEC 60870-5-*101* *Client* configuration

IEC 60870-5-*101* *Server* configuration

IEC 60870-5-*104* *Client* configuration

IEC 60870-5-*104* *Server* configuration

3 IEC 60870-5-101 Configuration Guide

3.1 IEC 60870-5-101 Client configuration

The following view is shown after an IEC 60870-5-101 Client Application is added. It is also accessible by left clicking the ADH Application in the *Project Tree*.

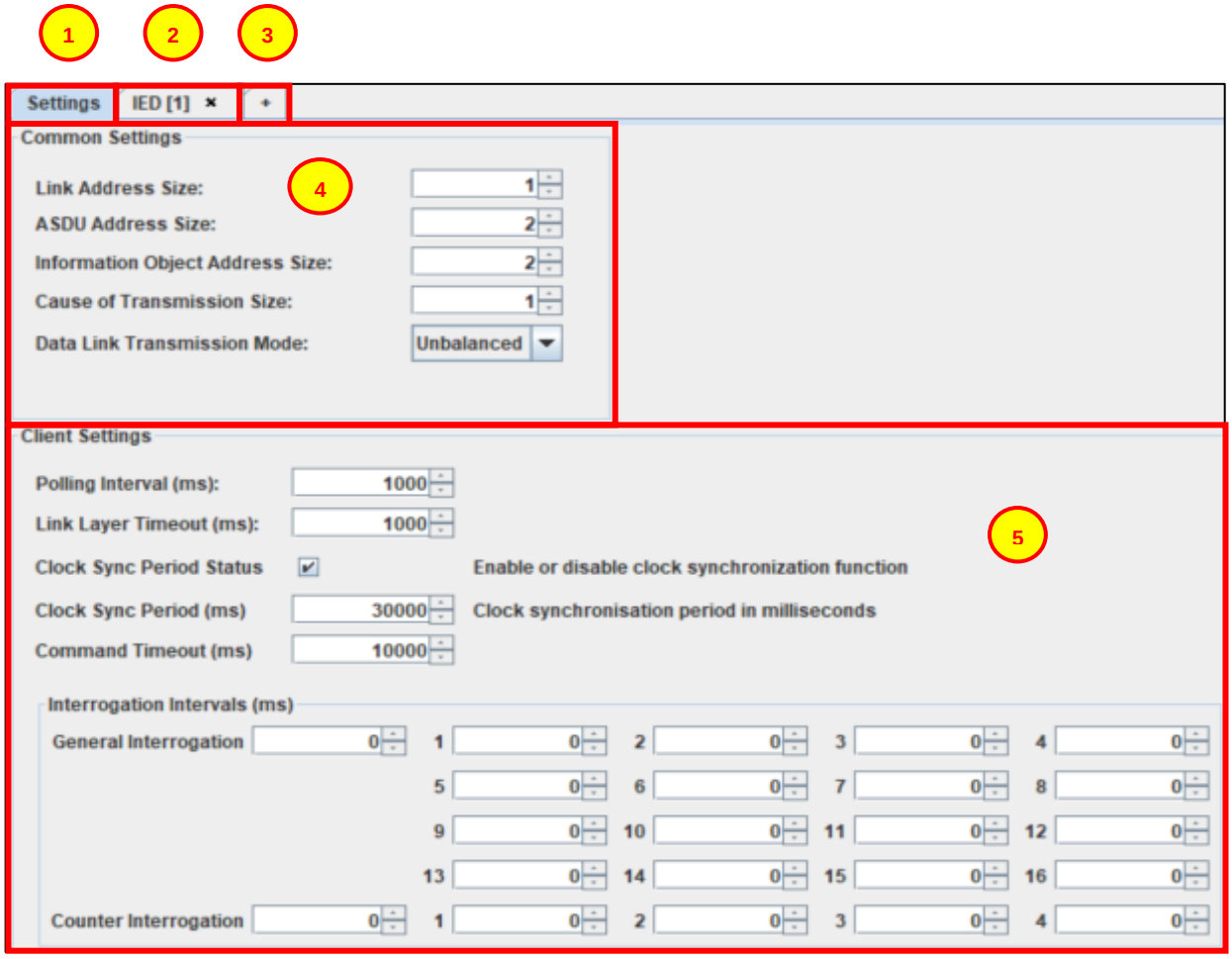

Figure 3-1 – Configuration Settings for the IEC 60870-5-101 Client.

1 The *Settings* tab, this is shown when clicking on an IEC 60870-5-101 ADH application in the *Project Tree*.

2 The Remote IED tab, this shows the *Address*, *Data* and *Commands* settings for the remotely connected IED(s). The settings in this tab are specific to the individual IED. For more information see: **IEC 60870-5-101 Client, Remote IED Tab Layout and Address Settings**. This tab can also be accessed by clicking the specific IED within the *Project Tree*.

3 The add IED option. This creates a new remote IED, which will be visible in the *Project Tree* and brings up a new IED settings tab for individual IED configuration.

4

The *Common settings*. These settings apply to the entire IEC 60870-5-101 ADH application and are shown regardless of whether the application is configured as a *Client* or a *Server*. For more information see: **IEC 60870-5-101 Common Settings**.

5 The *Client Settings*. These are specific to ADH applications configured as a client. For more information see **IEC 60870-5-101 Client Settings.**

3.1.1 IEC 60870-5-101 Client Settings

An IEC 60870-5-101 client requires the following settings for communication time outs and data polling intervals.

3.1.1.1 Polling Interval (ms)

Description	Requests for data are sent periodically in this interval (milliseconds).
Data Entry	Integer
Range	*1 to 65000* (*Default: 1000*)
Input Option	Mandatory

3.1.1.2 Link Layer Timeout (ms)

Description	The maximum time (in milliseconds) to wait for a response from a device when a 101 command is outstanding.
Data Entry	Integer
Range	*1000 to 65000* (*Default: 1000*)
Input Option	Mandatory

3.1.1.3 General Interrogation Interval (ms)

Description	The cyclic period (in milliseconds) between sending general interrogations (GI) messages. If set to 0, the interrogation messages will not be sent.
Data Entry	Integer
Range	*0 to 3600000* ms (*Default: 0)*
Input Option	Mandatory

3.1.1.4 Counter Interrogation Interval (ms)

Description	The cyclic period (in milliseconds) between sending counter interrogations messages. If set to 0, the interrogation messages will not be sent.
Data Entry	Integer
Range	*0 to 3600000 ms* (*Default: 0)*
Input Option	Mandatory

3.1.1.5 Clock Sync Period (ms)

Description	The cyclic period (in milliseconds) when clock synchronisation is performed with the connected servers.
Data Entry	Integer
Range	*30000 to* 3600000 *ms* (*Default: 30000)*
Input Option	Mandatory

3.1.1.6 Command Timeout (ms)

Description	The timeout period (in milliseconds) passing which an exception is returned
Data Entry	Integer
Range	*3000 to* 120000 *ms* (*Default: 10000)*
Input Option	Mandatory

3.1.2 IEC 60870-5-101 Client, Remote IED Tab Layout and Address Settings

The IED tab shows the address settings for remote IED(s) connect to the Client, as well as the Data Point and Command configuration of a connected IED. Configuration in this section is required as part of the Client's configuration.

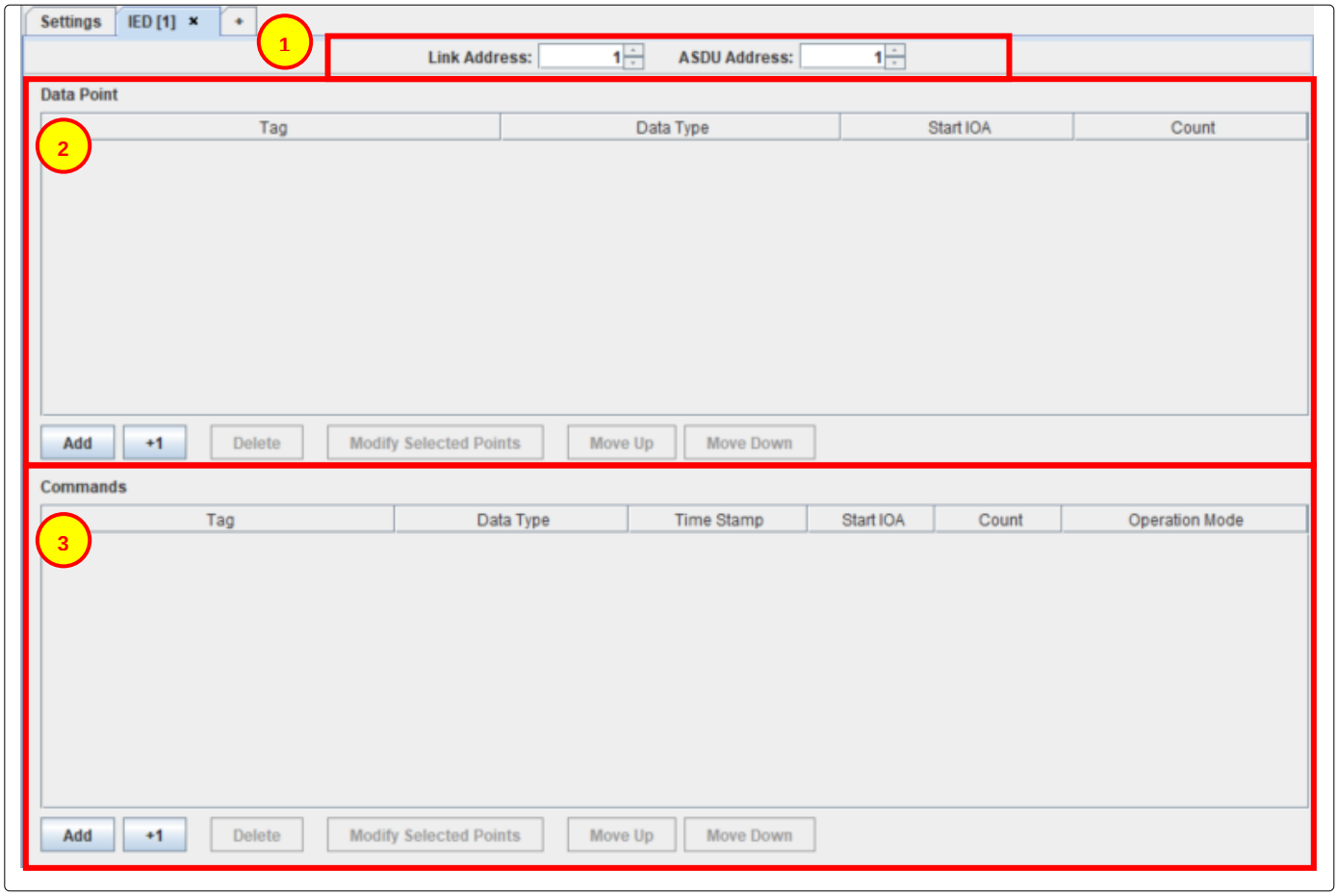

Figure 3-2 – Remote IED configuration settings for an IEC 60870-5-101 Client.

1 Address settings that can be defined using the up and down arrows or manually entered.

3.1.2.1 Link Address

Range: (Dependent on Link Address Size in Common Settings) See: **Link Address Size** (Default: 1)

3.1.2.2 ASDU Address

Range: (Dependent on ASDU Address Size in Common Settings) See: **ASDU Address Size** (Default: 1)

2 Data point list. For more information on adding and editing data points, See: **IEC 60870-5-101 Remote IED Data Point List**.

3 Commands list. For more information on adding and editing commands, See; **IEC 60870-5-101 Remote IED Commands List**

3.1.3 IEC 60870-5-101 Remote IED Data Point List

This section shows the data points for the connected IED. It allows addition, modification and deletion of data points as well as list sorting.

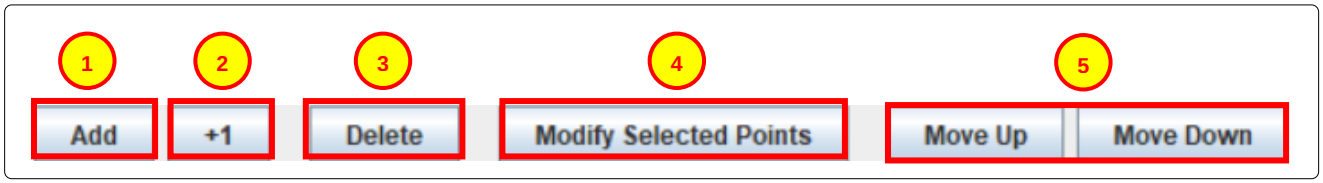

Figure 3-3 – Data Point configuration options for the IEC 60870-5-101 Client.

1. Left click **Add** to add one or more new data points. For more information on the *Add Data Point* tool see: **Adding Data Points.** Initially only this button will be available for the user. Once a data point has been created and/or selected by left clicking (data point will be highlighted) the other command buttons become usable.

2. Click the **+1** button– This will add a new data point with details copied from the selected data point, with an automatically increased Address. eNode Designer will make sure that a new unique tag name is generated for the point.

3. While one or more data points are selected, clicking **Delete** will remove it/them immediately unless they are mapped to a server, in which case, a dialogue box will ask for confirmation on the deletion of the point(s).

4. While one or more data points are selected, clicking **Modify Selected Points** will bring up the a dialogue box similar to the *Add Data Points* Dialogue box, however this box shows the original data point configuration as well as the new configuration for comparison.

5. **Move Up** and **Move Down** can be to shift selected data points within the list.

3.1.3.1 Adding Data Points

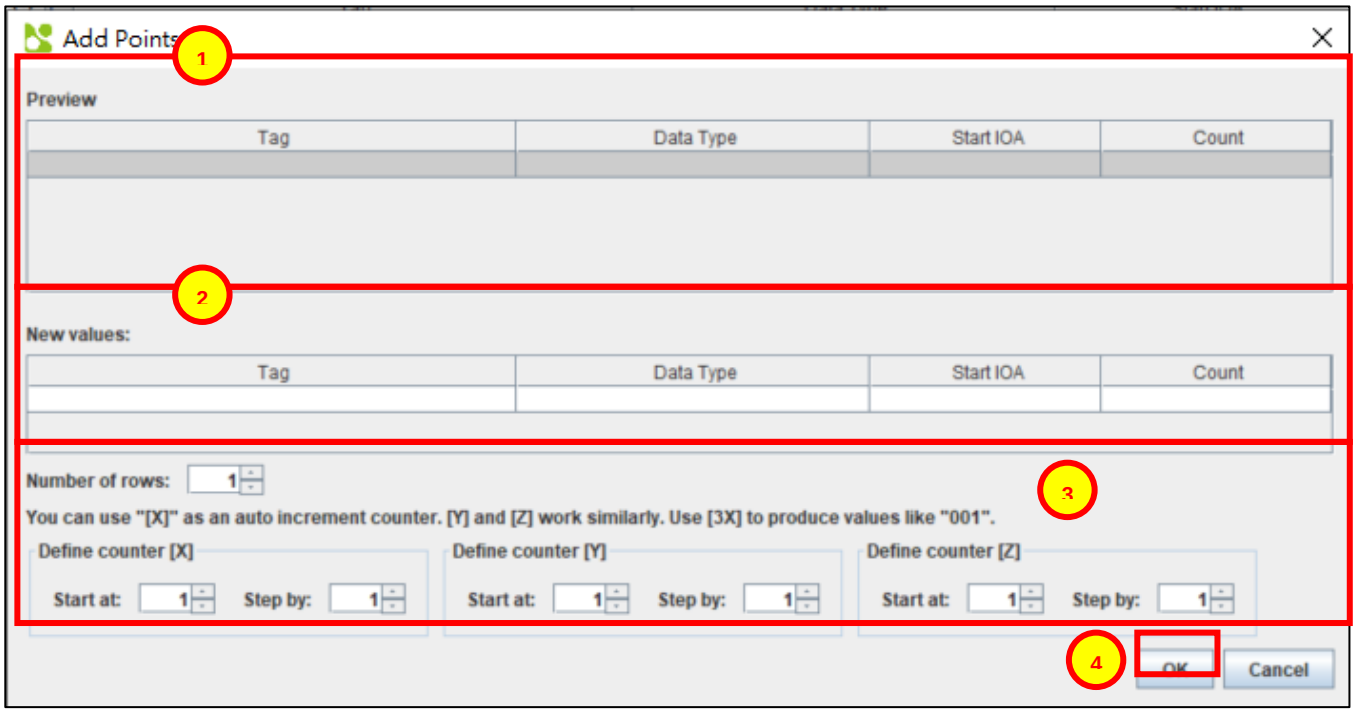

Figure 3-4 – Adding Data Points to an IEC 60870-5-101 Remote IED.

When adding data points, this dialogue box will be shown.

1. Data points will appear in this section as a preview before they are added to the IED.
2. Data point information is entered here. ***Tag***, ***Start IOA*** and ***Count*** are entered manually while ***Data type*** has drop down menus for selection. For specific information on these parameters, see **Data Point Parameters**.
3. This section can be utilised to make adding multiple similar data points easier. The values “[X]”, “[Y]” or “[Z]” can be entered in ***Tag*** as an auto increment counter. For more information on how to use the auto-increment feature see: **Using Auto-Increment.**
4. Once the required data points are shown in the preview section, click **OK** to add them to the IED.

3.1.4 IEC 60870-5-101 Remote IED Command List

This section shows the list of commands configured for the remote IED. It allows the addition, modification and deletion of commands as well as list sorting. This section is very similar to the *data points* section.

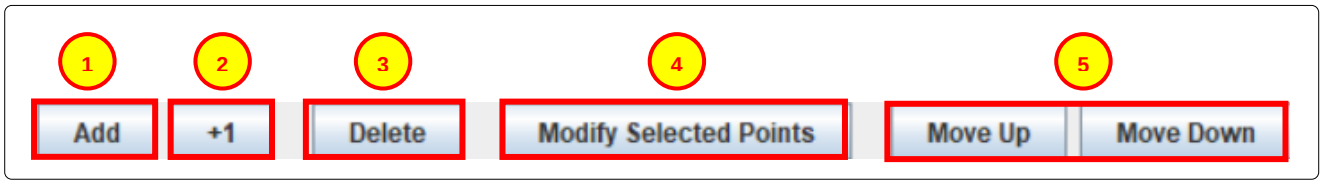

Figure 3-5 – Command configuration options for IEC 60870-5-101 Client.

1. Left click **Add** to add one or more commands. For more information on the Add command tool see: **Adding Commands**. Initially only this button will be available. Once a command has been created and/or selected by left clicking, command will be highlighted.

2. Click the **+1** button– This will add a new command with details copied from the selected command, with an automatically increased Address. eNode Designer will make sure that a new unique tag name is generated for the point.

3. While one or more data points are selected, clicking **Delete** will remove it/them immediately.

4. While one or more data points are selected, clicking **Modify Selected Points** will bring up the a dialogue box similar to the ***Add Data Points* Dialogue** box. This box shows the original data point configuration as well as the new configuration for comparison.

5. **Move Up** and **Move Down** buttons are used to shift selected data points within the list.

3.1.4.1 Adding Commands

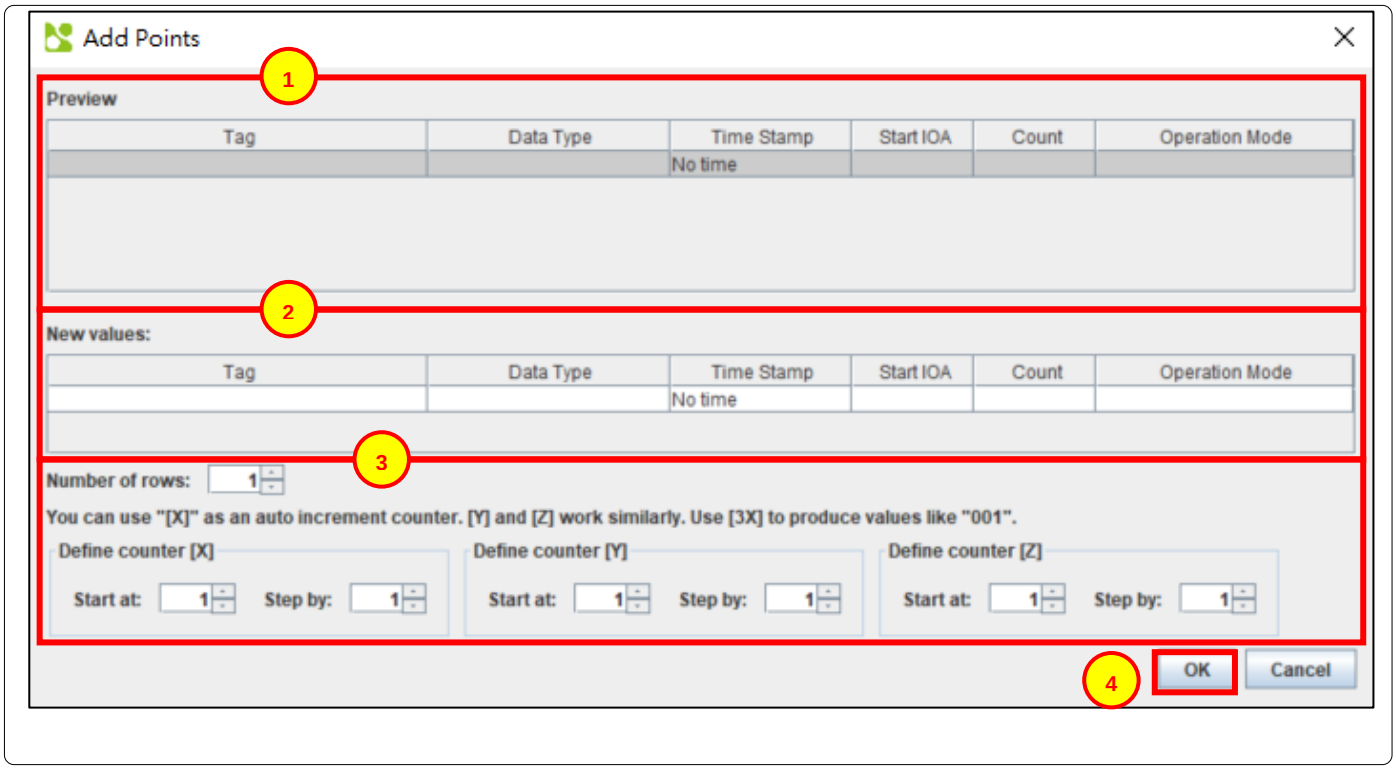

Figure 3-6 – Adding Commands to an IEC 60870-5-101 ADH Application Client Remote IED.

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Commands will appear in this section as a preview before they are added to the ADH application.

2 Command information is entered in this section. ***Tag, Start IOA*** and ***Count*** are entered manually while ***Data type, Time Stamp*** and ***Operate Mode*** have drop down menus for selection.

3 This section can be utilised to make adding multiple similar commands easier. The values "[X]", "[Y]" or "[Z]" can be entered in ***Tag*** as an auto increment counter. See: **Using Auto-Increment**.

4 Once the required commands are shown in the preview section, click **OK** to add them to the IED.

3.1.5 IEC 60870-5-101 Remote IED Data Point and Command Parameters

3.1.5.1 Tag

Description	A unique Tag value for each data point.
Data Entry	String
Min Length	*1*
Max Length	N/A
Input Option	Mandatory

3.1.5.2 Data Type

Description	IEC 60870-5 defined data type for each data point.
Data Entry	Drop Down Menu
Types	*Single Point Command, Double Point Command, Regulating Step Command, Set Point: Normalized Value, Set Point: Scaled Value, Set Point: Float, Bitstring32 Command*
Input Option	Mandatory

3.1.5.3 Time Stamp

Description	Time Stamp Format for each data point. The available time stamp types are dependent on the Data Type selected.
Data Entry	Drop Down Menu
Types	*No time, CP24Time2a, CP56Time2a*
Input Option	Mandatory

3.1.5.4 Start IOA

Description	A unique Information Object Address for each data point.
Data Entry	Integer
Range	Dependent on IOA Address Size in Common Settings. See: **Information Object Address Size**
Input Option	Mandatory

3.1.5.5 Count

Description	The request address
Data Entry	Integer
Types	0~65000

Input Option	Mandatory

3.1.5.6 Operation Mode

Commands only

Description	Assigns the command type to a command point.
Data Entry	Drop Down Menu
Types	*Direct Operate, Select Before Operate*
Input Option	Mandatory

3.2 IEC 60870-5-101 Server Configuration

The following view will be shown after an IEC 60870-5-101 *Server* is added to a local device. The view is also accessible by left clicking the ADH application in the *Project Tree*. The settings are used to setup this local IEC 60870-5-101 server. Please note that ATOP gateway supports one server/slave application per protocol per device

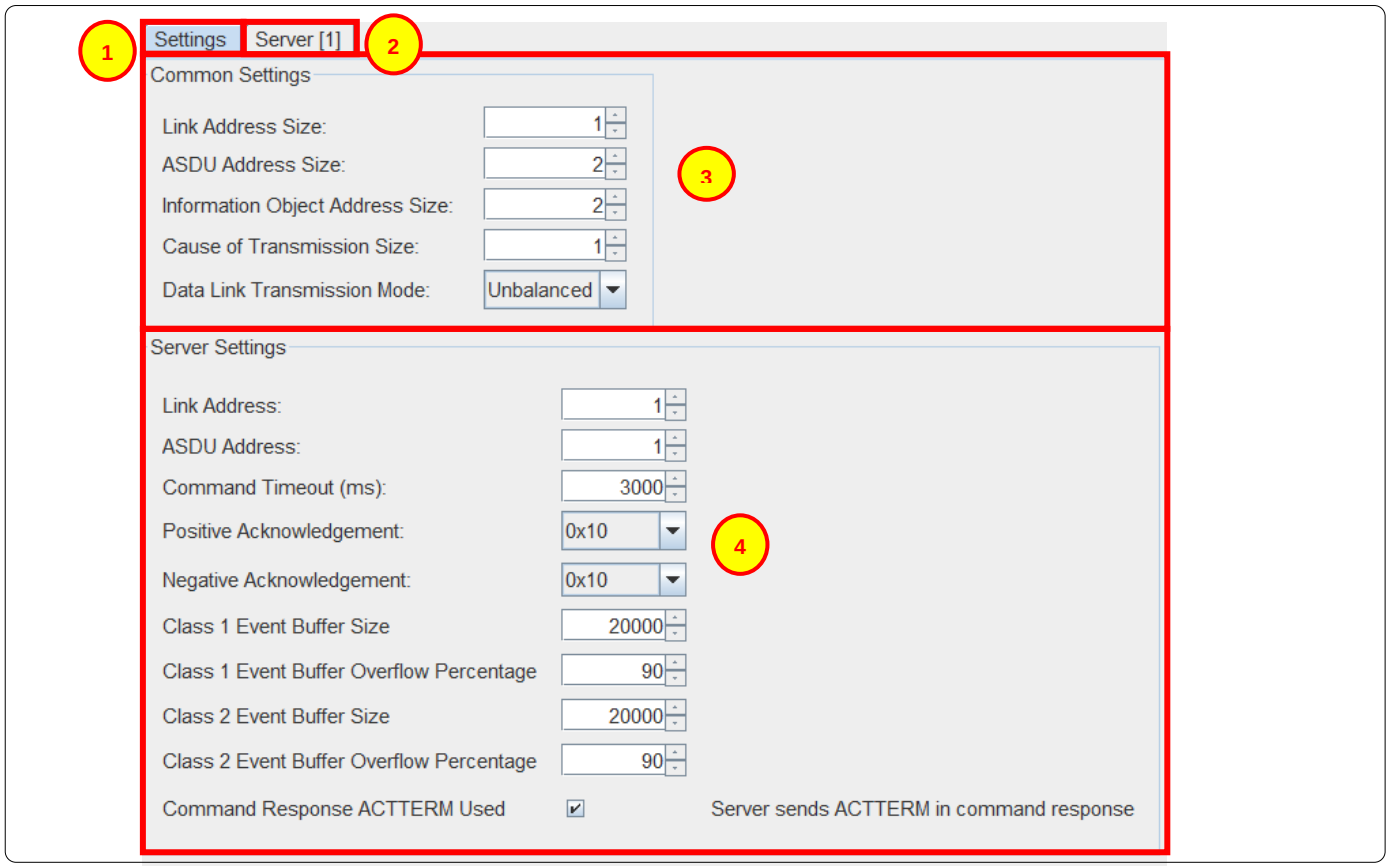

Figure 3-7 – Configuration settings for a local IEC 60870-5-101 Server.

1 The *Settings* tab, this is shown when left clicking on an IEC 60870-5-101 ADH application in the *Project Tree*.

2 The *Server* tab shows the *Address*, *Data,* and *Commands* settings for server ADH application. For more information see: **IEC 60870-5-101 Server Tab Layout and Address Settings**. Only one IEC 60870-5-101 server can be added as ADH application to an IED [1:1].

3 *Common settings* box includes the settings that apply to the entire IEC 60870-5-101 ADH application. They are shown regardless of whether the application is configured as a Client or a Server. For more information see: **IEC 60870-5-101 Common Settings**.

4 *Server Settings* box includes the parameters that are specific to ADH applications configured as a server. For more information see: **IEC 60870-5-101 Server Settings.**

3.2.1 IEC 60870-5-101 Server Settings

These settings define the acknowledgement response of the server and the period for short and long pulse commands.

3.2.1.1 Link Address

Description	The link address used by the server.
Data Entry	Integer
Range	*Dependant on Common Address Size in common settings.* See: **Common Address Size**
Input Option	Mandatory

3.2.1.2 ASDU Address

Description	The common address used by the server.
Data Entry	Integer
Types	*Dependant on Common Address Size in common settings.* See: **Common Address Size**
Input Option	Mandatory

3.2.1.3 Command Timeout (ms)

Description	The timeout period (in milliseconds) passing which an exception is returned
Data Entry	Integer
Range	*1000 to* 10000 *ms* (*Default: 3000)*
Input Option	Mandatory

3.2.1.4 Positive Acknowledgment

Description	This parameter defines the value for a positive ACK (acknowledge) to be transmitted by the server.
Data Entry	Drop Down Menu
Types	*0xE5 or 0x10 (Default 0x10)*
Input Option	Mandatory

3.2.1.5 Negative Acknowledgment

Description	This parameter defines the value for a negative ACK (negative acknowledge) to be transmitted by the server.
Data Entry	Drop Down Menu
Types	*0x10 or 0xA2 (Default: 0x10)*
Input Option	Mandatory

3.2.1.6 Class 1 Event Buffer Size

Description	This parameter defines the Class 1 Event Buffer Size
Data Entry	Integer
Range	*20000 to 65535 (default: 20000)*
Input Option	Mandatory

3.2.1.7 Class 1 Event Buffer Size over %

Description	This parameter defines the threshold in % to trigger Event Buffer Exception (Class 1)
Data Entry	Integer
Range	*25 to 100 (default: 90)*
Input Option	Mandatory

3.2.1.8 Class 2 Event Buffer Size

Description	This parameter defines the Class 2 Event Buffer Size
Data Entry	Integer
Range	*20000 to 65535 (default: 20000)*
Input Option	Mandatory

3.2.1.9 Class 2 Event Buffer Size over %

Description	This parameter defines the threshold in % to trigger Event Buffer Exception (Class 2)
Data Entry	Integer
Range	*25 to 100 (default: 90)*
Input Option	Mandatory

3.2.1.10 Command Response ACTTERM used

Description	This parameter defines whether ACTTERM is used or not
Data Entry	Checkbox
Types	*Checked or not (default: checked)*
Input Option	Mandatory

3.2.2 *IEC 60870-5-101 Server Tab Layout and Address Settings*

This tab is used to define all data points of the IEC 60870-5-101 server.

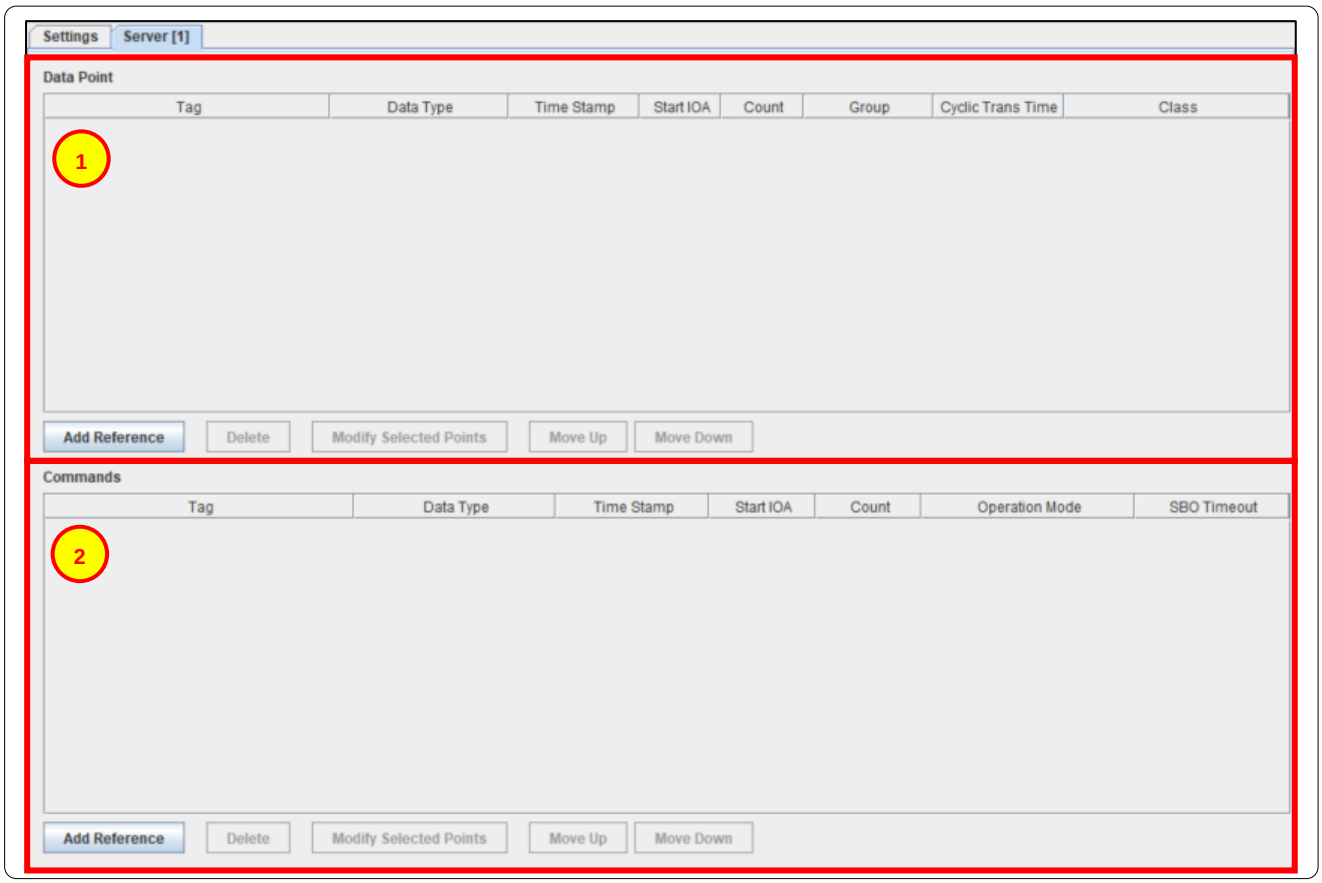

Figure 3-8 – IED configuration settings for IEC 60870-5-101 Server.

1 Data point list. For more information on adding and editing data points, see **IEC 60870-5-101 Server Data point and Command Reference List.**

2 Commands list. For more information on adding and editing commands, see **IEC 60870-5-101 Server Data point and Command Reference List.**

3.2.3 IEC 60870-5-101 Server Data Point and Command Reference List

This section shows the data point references for the server. It allows the addition, modification and deletion of data point references as well as data point sorting. This set of buttons is shown under the *Data* section and under the *Commands* section. They both function exactly the same.

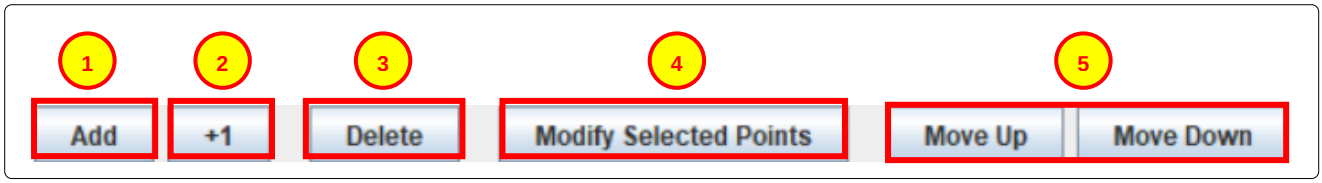

Figure 3 9 – Data Point Reference configuration options for an IEC 60780-5-101 Server.

1. Left click **Add** to add one or more new data point references. For more information on the Add data point reference tool see **Adding Data Point and Command References.** Initially only this button will be available to be clicked. Only once a data point reference has been created and/or selected by left clicking (data point reference will be highlighted).

2. Click the **+1** button– This will add a new command with details copied from the selected command, with an automatically increased Address. eNode Designer will make sure that a new unique tag name is generated for the point.

3. While one or more data point references are selected, pressing **Delete** will show a dialogue box asking for confirmation on the deletion of that reference.

4. While one or more data point references are selected, pressing **Modify Selected Points** will bring up the a dialogue box similar to the *Add* Data point references Dialogue box, however this box shows the original data point reference configuration as well as the new configuration for comparison.

5. **Move Up** and **Move Down** are used to shift selected data point references within the list.

3.2.3.1 Adding Data Point and Command References

Only data points that exist in a different ADH applications can be used for the IEC 60870-5-101 server. Data points in the ADH are normally generated by a client application such as for example a Modbus master or even by an IEC 60870-5-101 client as shown in this example. There are also client/server ADH applications available such as the IEC 61131 Soft PLC (programmable logic controller). Adding data points is also called “point mapping”.

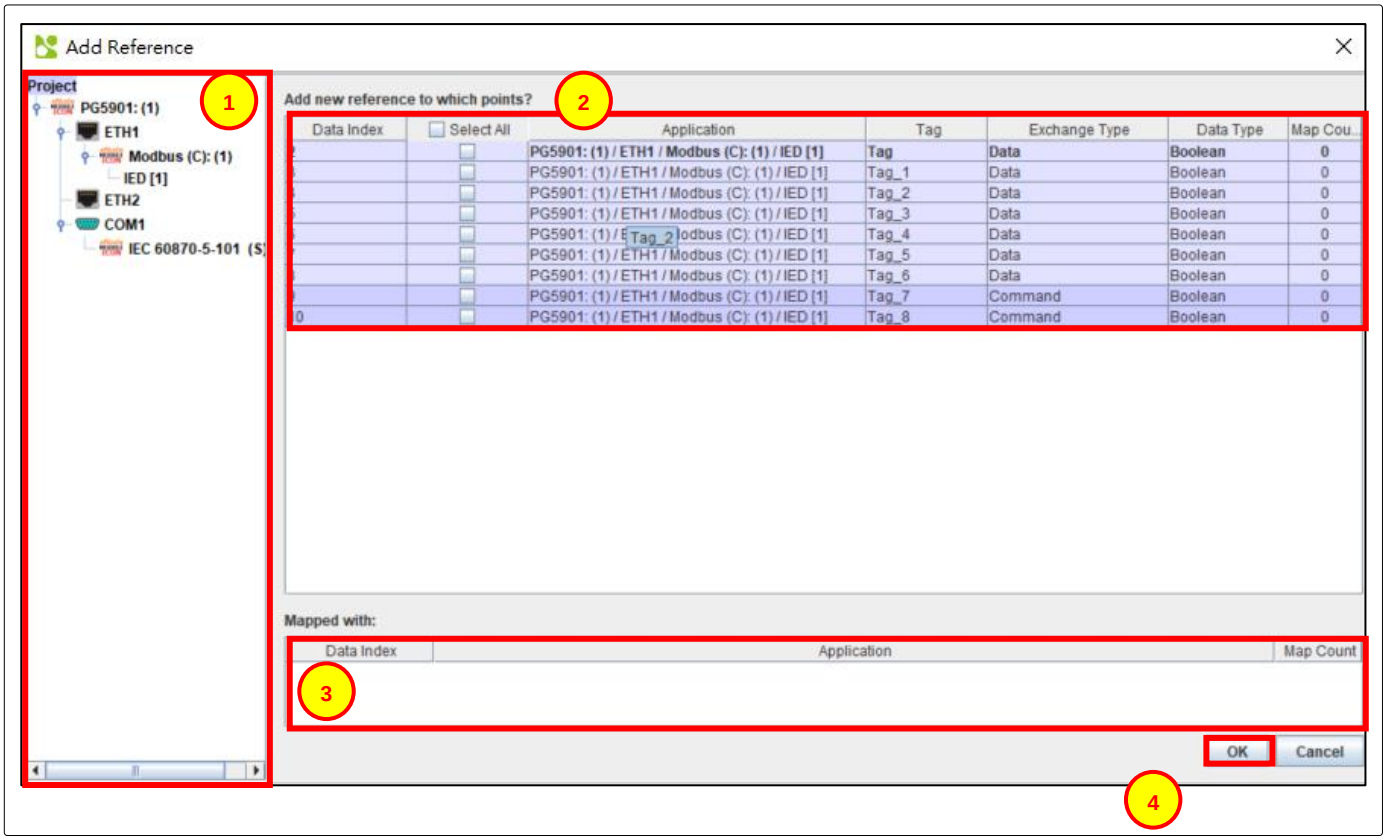

Figure 3-9 – Adding Data Point and Command References to an IEC 60780-5-101 Server.

1. *Project Tree* : can be used to search specific locations for data points in other ADH applications. Left clicking **Project** on the top shows every data point or command found within the entire project. Left clicking individual ADH applications or IEDs narrows that list down to local data points and commands.

2. Available data points and commands are here to be selected. Data points and commands show up slightly differently. Data points are highlighted in a light blue color. They are shown on the top of the list and have the exchange type “data”. Commands are highlighted a dark blue color. They are shown on the bottom of the list and have the exchange type “command”. To map a point, left click the box on that point’s row under the *Map* column. It will be included in the list for mapping and mapped when **OK** is clicked.

3. This section shows details on a points mapping if it has already been mapped to an application. This will only show points that have been previously selected.

4. When the required data points for reference are selected. Press **OK** to add them. eNode Designer will automatically check and verify that mapped data types match up.

3.3 IEC 60870-5-101 Common Settings

3.3.1.1 Link Address Size

Description	The number of bytes used to describe the Link Address in the ASDU.
Data Entry	Integer
Range	0 to 2 (Default 1)
Input Option	Mandatory

3.3.1.2 ASDU Address Size

Description	The ASDU Address is as known as Common Address. The size of the ASDU address is determined by a fixed system (network-specific) parameter, in this case one or two octets. The ASDU Address is the station address, which may be structured to permit the addressing of the whole station or just a particular station sector.
Data Entry	Integer
Range	*1 to 2* (Default *2*)
Input Option	Mandatory

3.3.1.3 Information Object Address Size

Description	This parameter sets the number of bytes used to describe the Information Object Address in the ASDU.
Data Entry	Integer
Range	*1 to 3* (Default *2*)
Input Option	Mandatory

3.3.1.4 Cause of Transmission Size

Description	This parameter sets the number of bytes used to describe the Cause of Transmission in the ASDU.
Data Entry	Integer
Range	*1 to 2* (Default *1*)
Input Option	Mandatory

3.3.1.5 Data Link Transmission Mode

Description	This parameter defines the operation of client and server. In balanced mode the ASDUs are connected in point-to-point configuration in full duplex mode. In unbalanced, a client is connected in point-to-multi-point system in half-duplex mode. ATOP PG59xx series only support unbalanced mode.

Data Entry	Drop Down Menu
Types	*Unbalanced (only)*
Input Option	Mandatory

4 IEC 60870-5-104 Configuration Guide

4.1 IEC 60870-5-104 Client configuration

The following view is shown after an IEC 60870-5-104 client is added. It is also accessible for further configuration by left clicking the desired ADH application in the *Project Tree*.

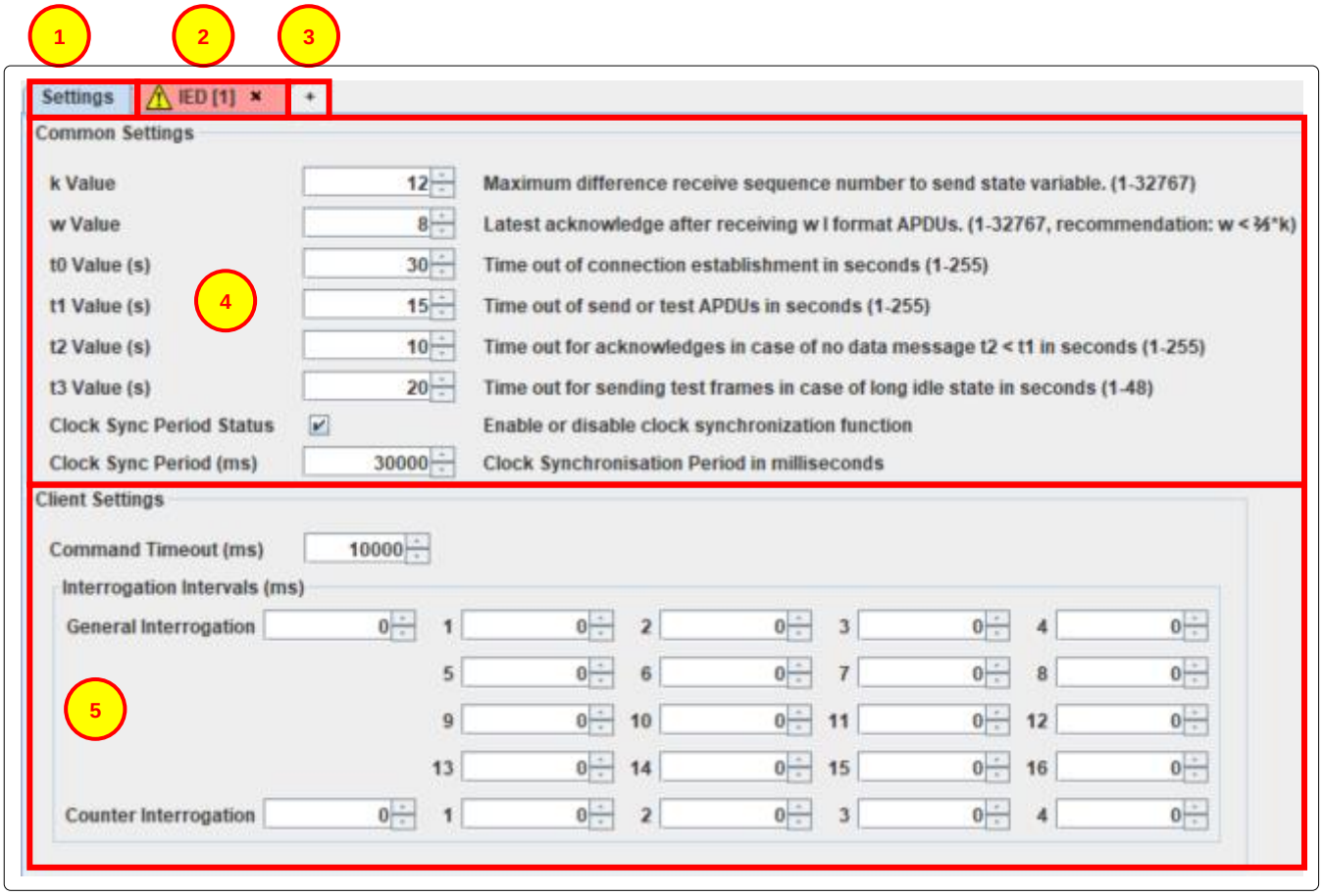

Figure 4-1 – Configuration Settings for the IEC 60870-5-104 Client.

1 The *Settings* tab is shown when left clicking on an IEC 60870-5-104 ADH application in the *Project Tree*.

2 The Remote IED tab shows the *Address*, *Data* and *Commands* settings for the remotely connected IED(s) on the ADH application. The settings in this tab are specific to the individual IED. For more information see: **IEC 60870-5-104 Client, Remote IED Tab Layout and Address Settings**. This tab can also be accessed by clicking the specific IED within the *Project Tree*.

3 The add IED option creates a new IED, which will be visible in the *Project Tree* and brings up a new IED settings tab for individual IED configuration.

4 The *Common settings* apply to the entire IEC 60870-5-104 ADH application and are shown regardless of whether the application is configured as a Client or a Server. For more information see: **IEC 60870-5-104 Common Settings**.

5 The *Client Settings*. These are specific to ADH applications configured as a client. For more information see **IEC 60870-5-104 Client Settings.**

4.1.1 IEC 60870-5-104 Client Settings

The configuration of all client settings is mandatory.

4.1.1.1 General Interrogation (ms)

Description	The General Interrogation (GI) interval.
Data Entry	Integer
Range	*0 to 3600000* (*Default: 0*)
Input Option	Mandatory

4.1.1.2 Interrogation for Group X (ms)

Description	The interrogation intervals for group 1, 2, 3, … 16.
Data Entry	Integer
Range	*0 to 3600000* (*Default: 0*)
Input Option	Mandatory

4.1.1.3 Request Counter General for Group X (ms)

Description	The interrogation intervals for “Counter Group 1” … “Counter Group 4”
Data Entry	Integer
Range	*0 to 3600000* (*Default: 0*)
Input Option	Mandatory

4.1.1.4 Command Timeout (ms)

Description	The timeout to wait for a command to complete before it is considered an error.
Data Entry	Integer
Range	*3000 to 120000* (*Default: 10000*)
Input Option	Mandatory

4.1.1.5 Interrogation Intervals (ms)

Description	Sets the intervals at which the interrogation commands will be sent. See the figure below for details of how to set the intervals for each type. If the value is zero, the interrogation commands will not send in intervals.
Data Entry	Integer
Range	*0 to 3600000*
Input Option	Mandatory

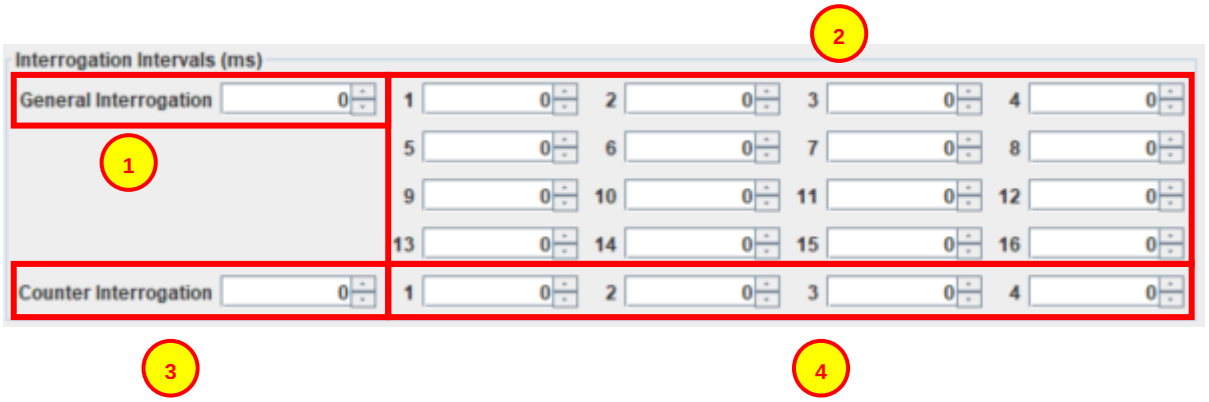

Figure 4-2 - Client Interrogation Intervals

All intervals are in milliseconds.

1. The General Interrogation (GI) interval.
2. The interrogation intervals for group 1, 2, 3, … 16. The label on the left of the spinner is the group number; the changeable value is the interrogation interval for that group.
3. The Counter General Interrogation (GI) interval.
4. The interrogation intervals for "*Counter Group 1*" … "*Counter Group 4*". The label on the left of the spinner is the counter group number; the changeable value is the interrogation interval for that counter group.

4.1.2 IEC 60870-5-104 Client, Remote IED Tab Layout and Address Settings

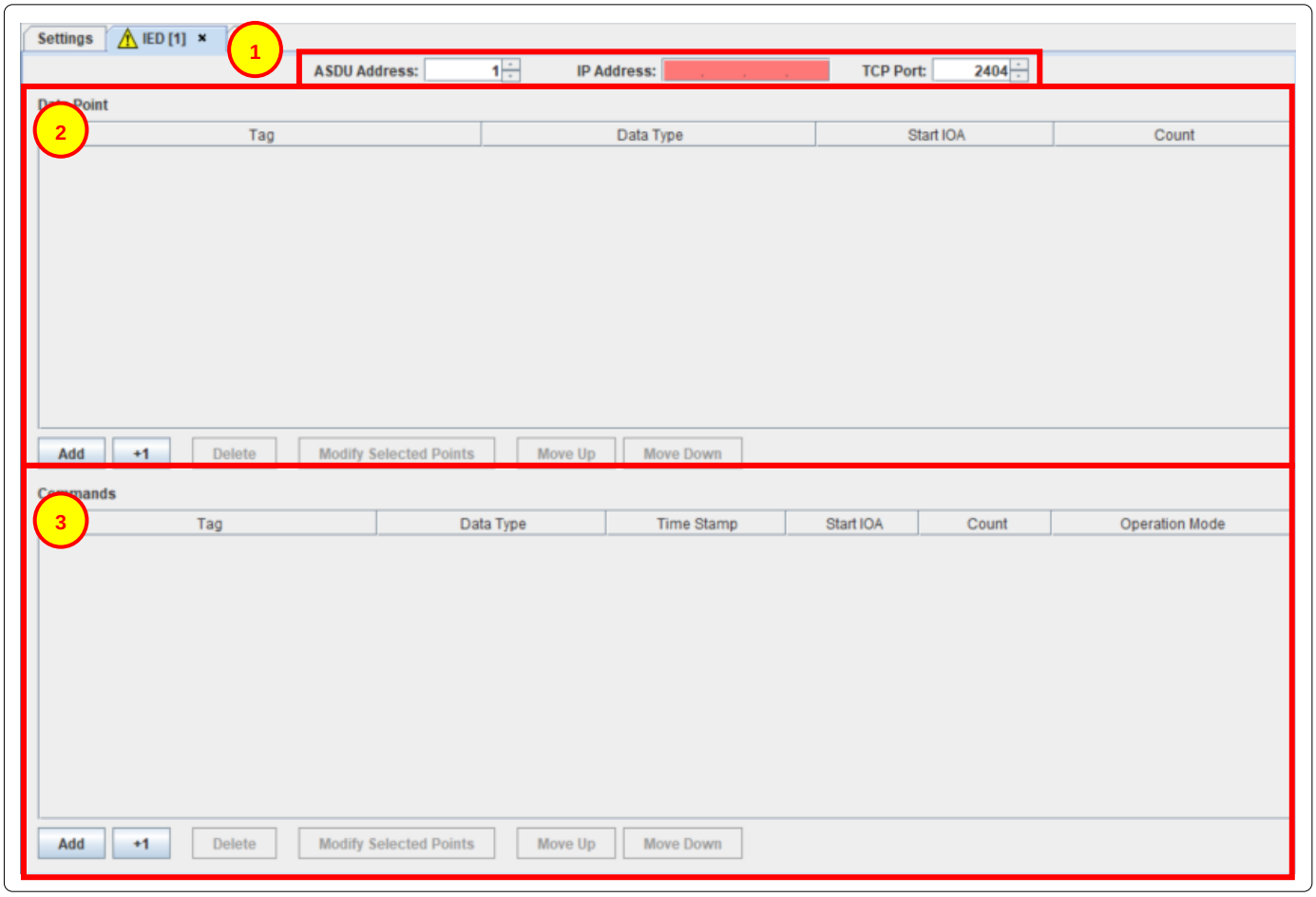

Figure 4-3 – IED configuration settings for an IEC 60870-5-104 Client.

1 Address settings, these can be defined using the up and down arrows or manually entered.

4.1.2.1 ASDU Address

Description: The common address is associated with all objects in an ASDU.

Range: 1 to 65534 (default: 1) – Mandatory

4.1.2.2 IP Address

Description: The IP Address of the remote server IED

Range: Valid IPv4 Addresses: 0.0.0.0 – 255.255.255.255 (default: 192.168.1.1) – Mandatory

4.1.2.3 TCP Port

Description: The TCP Port used by the server IED.

Range: 1 to 65535. Default: 2404

2 Data point list. For more information on adding and editing data points, see **IEC 60870-5-104 Remote IED Data point list.**

3 Commands list. For more information on adding and editing commands, see **IEC 60870-5-104 Remote IED Commands List.**

4.1.3 IEC 60870-5-104 Remote IED Data point list

This section shows the data points for the IED. It allows addition, modification and deletion of data points as well as data sorting.

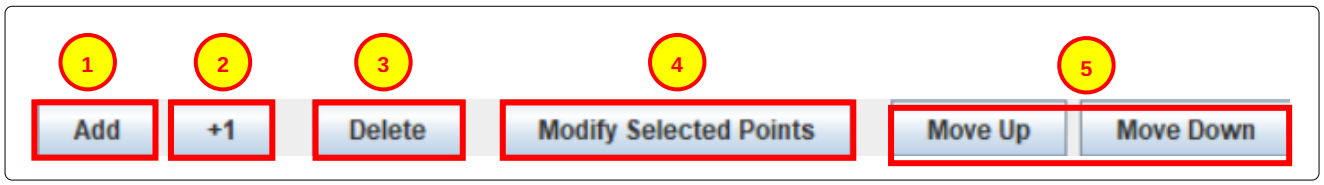

Figure 4-4 – Remote IED Data Point configuration options for an IEC 60870-5-104 Client.

1 Left click **Add** to add one or more new data points. For more information on the Add data point tool, see: **Adding Data Points**. Initially only this button will be available. Only once a data point has been created and/or selected by left clicking (data point will be highlighted) the other buttons will be available.

2 Click the **+1** button– This will add a new data point with details copied from the selected data point, with an automatically increased Address. eNode Designer will make sure that a new unique tag name is generated for the point.

3 When one or more data points are selected, pressing **Delete** will remove it/them immediately unless it/they are mapped to a server. In such case, a dialogue box will ask for confirmation on the deletion of the point(s).

4 When one or more data points are selected, pressing **Modify Selected Points** will bring up the a dialogue box similar to the *Add Data Points* Dialogue box. This box will show the original data point configuration as well as the new configuration for comparison.

5 **Move Up** and **Move Down** can be used to shift selected data points within the list.

4.1.3.1 Adding Data Points

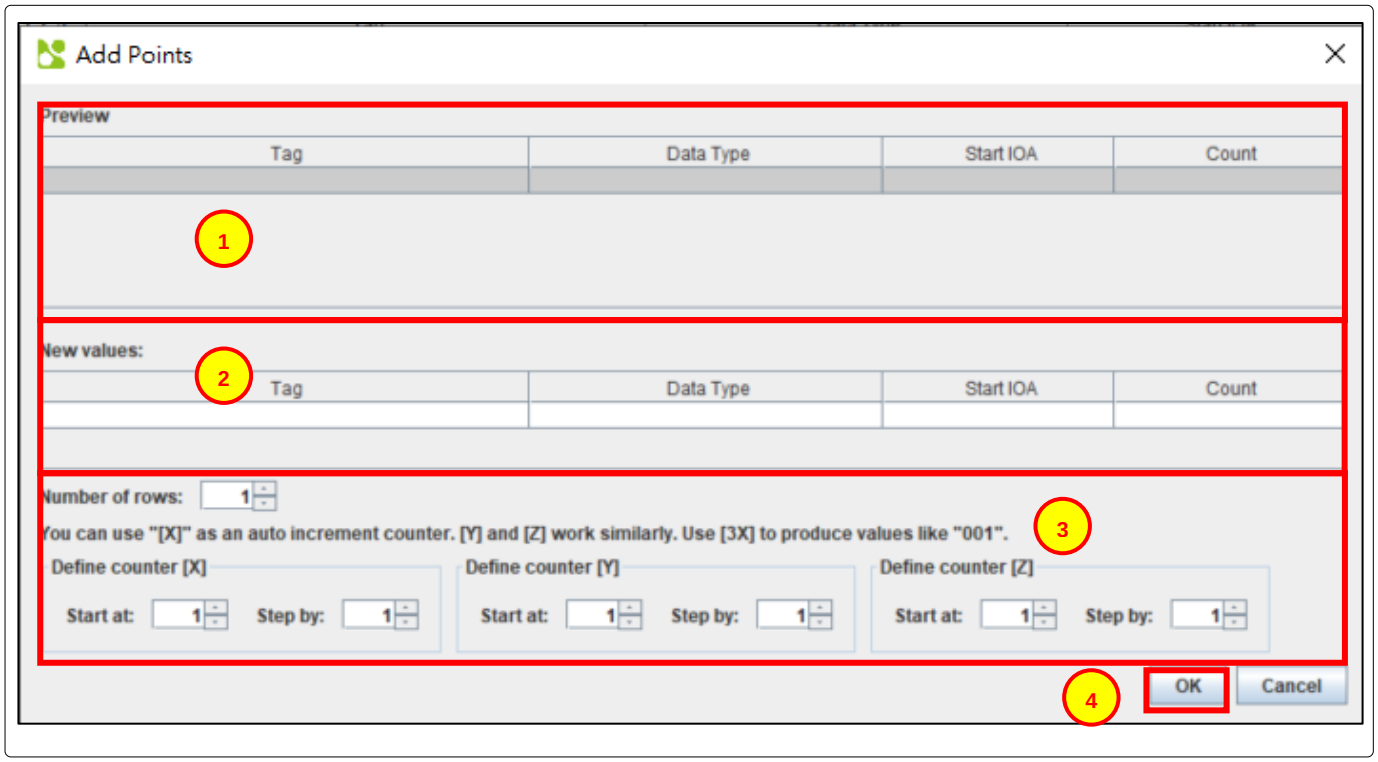

Figure 4-5 – Adding Data Points to an IEC 60870-5-104 Client.

When adding data points, this dialogue box will be shown.

1. Data points will appear in this section as a preview before they are added to the IED.
2. Data point information is entered here. *Tag, Description* and *IOA* should be entered manually while *Data type, Time Stamp* and *COT* have drop down menus for selection.
3. This section can be utilised to make adding multiple similar data points easier. The values “[X]”, “[Y]” or “[Z]” can be entered in *Tag, Description* or *IOA* as an auto increment counter. For more information on how to use the auto-increment feature, see: **Using Auto-Increment**.
4. Once the required data points are shown in the preview section, press **OK** to add them to the IED.

4.1.4 IEC 60870-5-104 Remote IED Commands List

This section shows the commands for the IED. It allows addition, modification and deletion of commands as well as command sorting. This section is very similar to the D*ata Points* section.

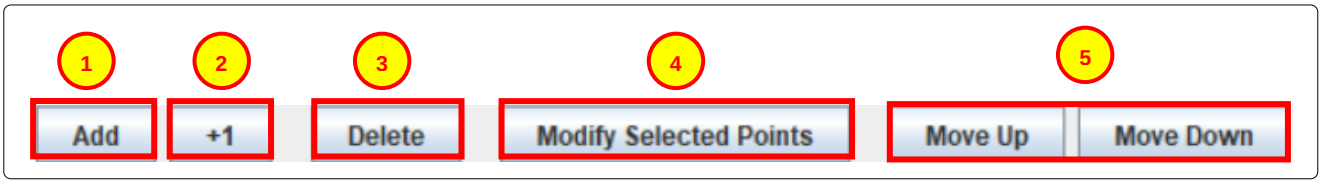

Figure 4-6 – Command configuration options for an IEC 60870-5-104 Client.

1. Left click **Add** to add one or more commands. For more information on the Add command tool, see: **Adding Commands**. Initially only this button will be available. Only once a command has been created and/or selected by left clicking (command will be highlighted) the other buttons will be available.
2. While one or more data points are selected, pressing **Delete** will remove it/them immediately.
3. While one or more data points are selected, pressing **Modify Selected Points** will bring up the a dialogue box similar to the *Add Data Points* Dialogue box. This box shows the original data point configuration as well as the new configuration for comparison.
4. **Move Up** and **Move Down** can be used to shift selected data points within the list.

4.1.4.1 Adding Commands

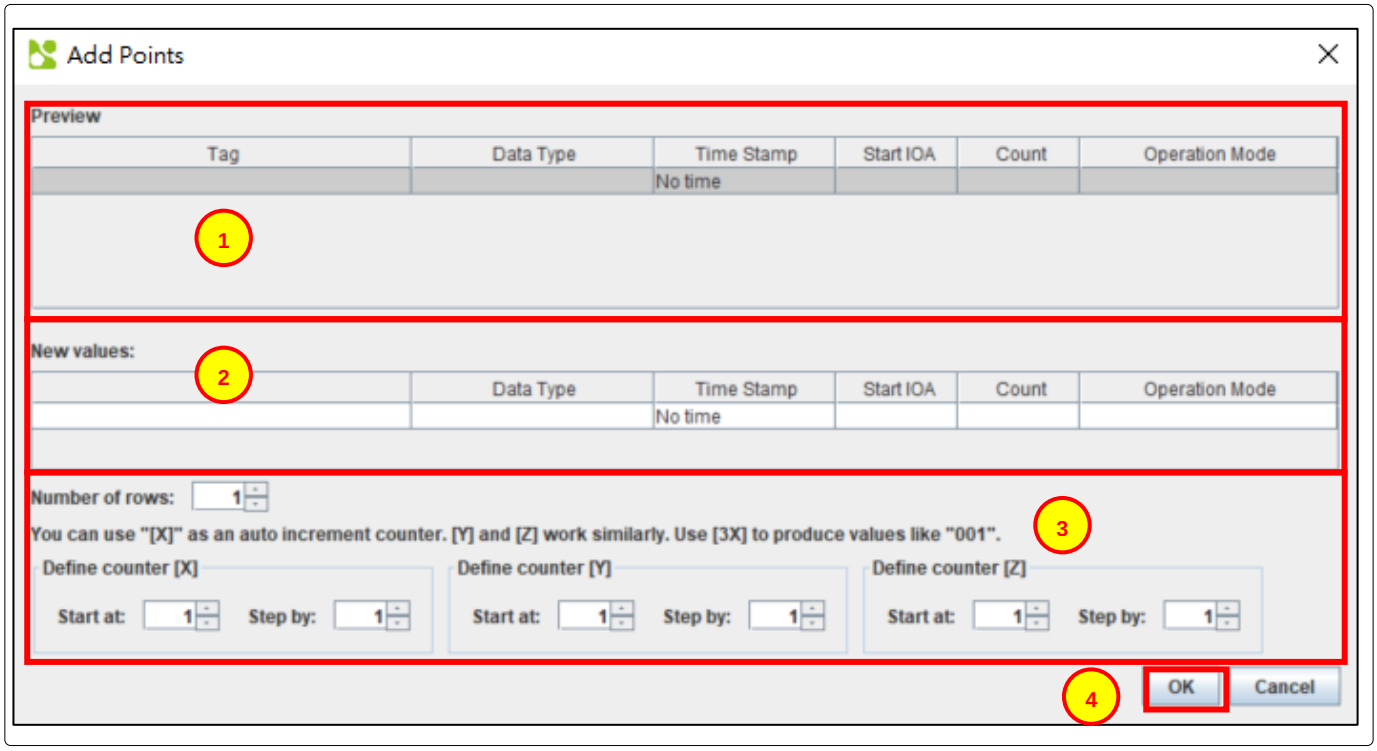

Figure 4-7 – Adding Commands to an IEC 60870-5-104 Client.

When adding commands, the dialogue box above will be shown.

1. Commands will appear in this section as a preview before they are added to the ADH application.
2. Command information is entered here. *Tag, Description, IOA* and *SBO Timeout (ms)* are entered manually while *Data type, Time Stamp* and *Operate Mode* have drop down menus for selection.
3. This section can be utilised to make adding multiple similar commands easier. The values “[X]”, “[Y]” or “[Z]” can be entered in *Tag, Description* or *IOA* as an auto increment counter. For more information on how to use the auto-increment feature, see: **Using Auto-Increment**.
4. Once the required commands are shown in the preview section. Press **OK** to add them to the IED.

4.1.5 IEC 60870-5-104 Remote IED Data Point and Command Parameters

The following parameters are found in both Data and Commands.

4.1.5.1 Tag

Description	A unique Tag value for each data point.
Data Entry	String
Min Length	*1*
Max Length	N/A
Input Option	Mandatory

4.1.5.2 Data Type

Description	IEC 60870-5 defined data type for each data point.
Data Entry	Drop Down Menu
Types	*Single Point, Double Point, Step Position, Bitstring 32, Measured Value Normalized, Measured Value Scaled, Measured Value Float, Integrated Totals, Parameter - Measured Value Normalized, Parameter - Measured Value Scaled, Parameter - Measured Value Float*
Input Option	Mandatory

4.1.5.3 Time Stamp

Description	Time Stamp Format for each data point. The available time stamp types are dependent on the Data Type selected.
Data Entry	Drop Down Menu
Types	*No time, CP24Time2a, CP56Time2a*
Input Option	Mandatory

4.1.5.4 Start IOA

Description	A unique Information Object Address for each data point.
Data Entry	Integer
Range	1 to 16777215
Input Option	Mandatory

4.1.5.5 Count

Description	Command count for request address
Data Entry	Integer
Range	1 to 65000
Input Option	Mandatory

4.1.5.6 Operation Mode

Description	Assigns the command type to a command point.

Data Entry	Drop Down Menu
Types	*Direct Operate, Select Before Operate*
Input Option	Mandatory

Available only for command points.

4.2 IEC 60870-5-104 Server configuration

The following view is shown after an IEC 60870-5-104 client is added. It is also accessible by left clicking the ADH application in the *Project Tree*. Please note that ATOP Protocol Gateway supports one server/slave per protocol per device.

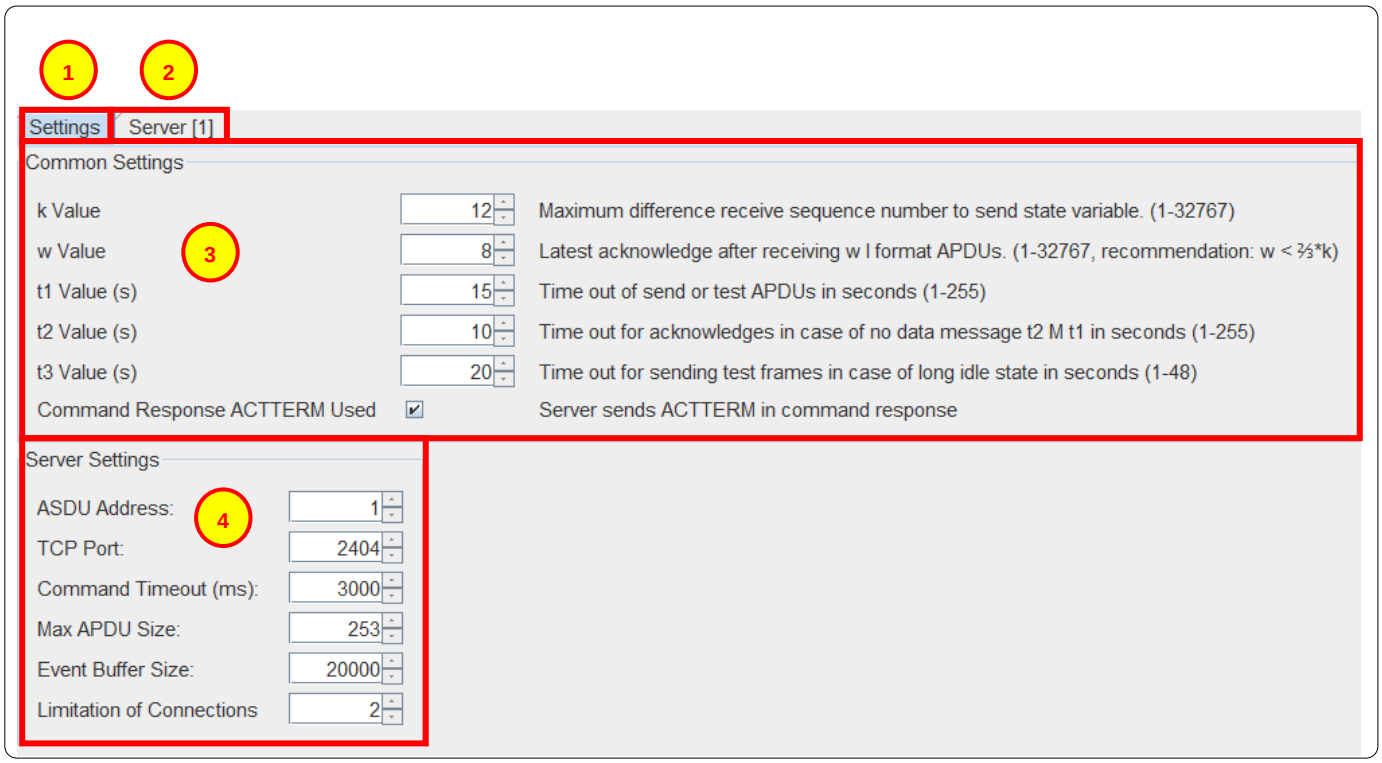

Figure 4-8 – Server configuration settings for the IEC 60870-5-104 server.

1. The *Settings* tab is shown when left clicking on an IEC 60870-5-104 ADH application in the *Project Tree*.

2. The *Server* tab shows the *Data* and *Commands* settings for server ADH application. The settings in this tab are specific to the individual IED. For more information see: **IEC 60870-5-104 Server Tab Layout and Address Settings**.

3. The *Common settings*. These settings apply to the entire IEC 60870-5-104 ADH application and are shown regardless of whether the application is configured as a Client or a Server. For more information see: **IEC 60870-5-104 Common Settings**.

4. The *Server Settings*. These are specific to ADH applications configured as a server. For more information see **IEC 60870-5-104 Server Settings**

4.2.1 IEC 60870-5-104 Server Settings

The configuration of all Server settings is mandatory.

4.2.1.1 ASDU Address

Description	Defines the address of the ASDU.
Data Entry	Integer
Range	*1 to 65534* (*Default: 1*)
Input Option	Mandatory

4.2.1.2 Max ADPU size

Description	Configures the maximum size of the ADPU (Application Protocol Data Unit). Maximum is typically 253 as the control header is 2 bytes.
Data Entry	Integer
Range	*43 to 255* (*Default: 253*)
Input Option	Mandatory

4.2.1.3 Event Buffer Size

Description	The size of the event buffer in this server.
Data Entry	Integer
Range	*20000 to 65535* (*Default: 20000*)
Input Option	Mandatory

4.2.1.4 TCP Port

Description	The TCP connection port.
Data Entry	Integer
Range	*1 to 65535* (*Default: 2404*)
Input Option	Mandatory

4.2.1.5 Command Timeout (ms)

Description	The timeout to wait for a command to complete before it is considered an error.
Data Entry	Integer
Range	*1000 to 10000* (*Default: 3000*)
Input Option	Mandatory

4.2.1.6 Limitation of Connections

Description	The maximum TCP connections allowed.
Data Entry	Integer

Range	*1 to 5 (Default: 2)*
Input Option	Mandatory

4.2.2 IEC 60870-5-104 Server Tab Layout and Address Settings

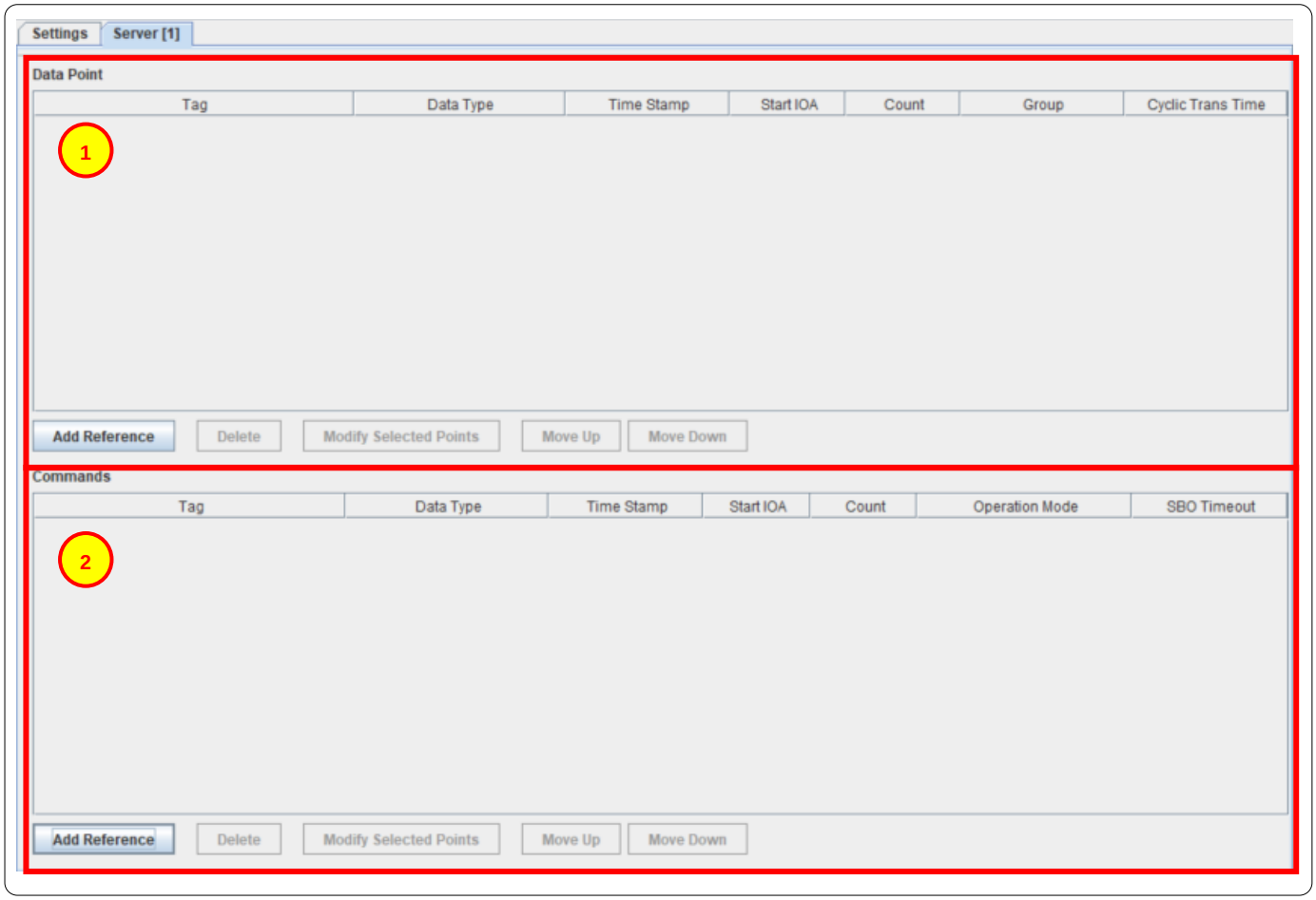

Figure 4-9 – IED configuration settings for an IEC 60870-5-104 Server.

1 Data point list: for more information on adding and editing data points, see **IEC 60870-5-104 Server Data point and Command Reference list.**

2 Commands list: for more information on adding and editing commands, see **IEC 60870-5-104 Server Data point and Command Reference list.**

4.2.3 IEC 60870-5-104 Server Data point and Command Reference list

This section shows the data point references for the server. It allows addition, modification and deletion of data point references as well as sorting. This set of buttons is shown under the *Data* section and under the *Commands* section. They both function exactly the same.

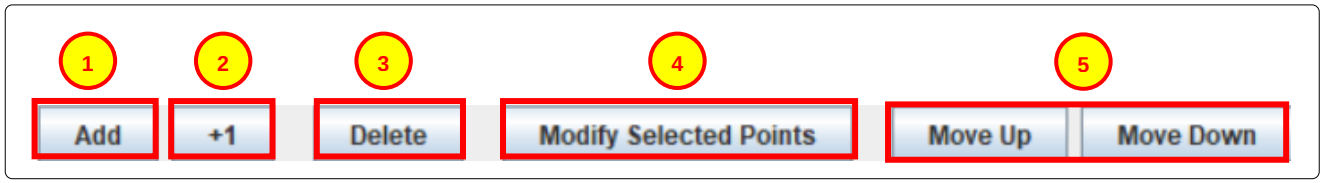

Figure 4 10 – Data Point Reference configuration options for an IEC 60780-5-104 Server.

1. Left click **Add** to add one or more new data point references. For more information on the Add data point reference tool, see **Adding Data Point and Command References.** Initially only this button will be available to. Only once a data point reference has been created and/or selected by left clicking (data point reference will be highlighted) the other buttons will become available.

2. Click the **+1** button– This will add a new command with details copied from the selected command, with an automatically increased Address. eNode Designer will make sure that a new unique tag name is generated for the point.

3. When one or more data point references are selected, pressing **Delete** will show a dialogue box asking for confirmation on the deletion of that reference.

4. When one or more data point references are selected, pressing **Modify Selected Points** will bring up the a dialogue box similar to the *Add* Data point reference*s* Dialogue box. This box shows the original data point reference configuration as well as the new configuration for comparison.

5. **Move Up** and **Move Down** can be used to shift selected data point references within the list.

4.2.3.1 Adding Data Point and Command References

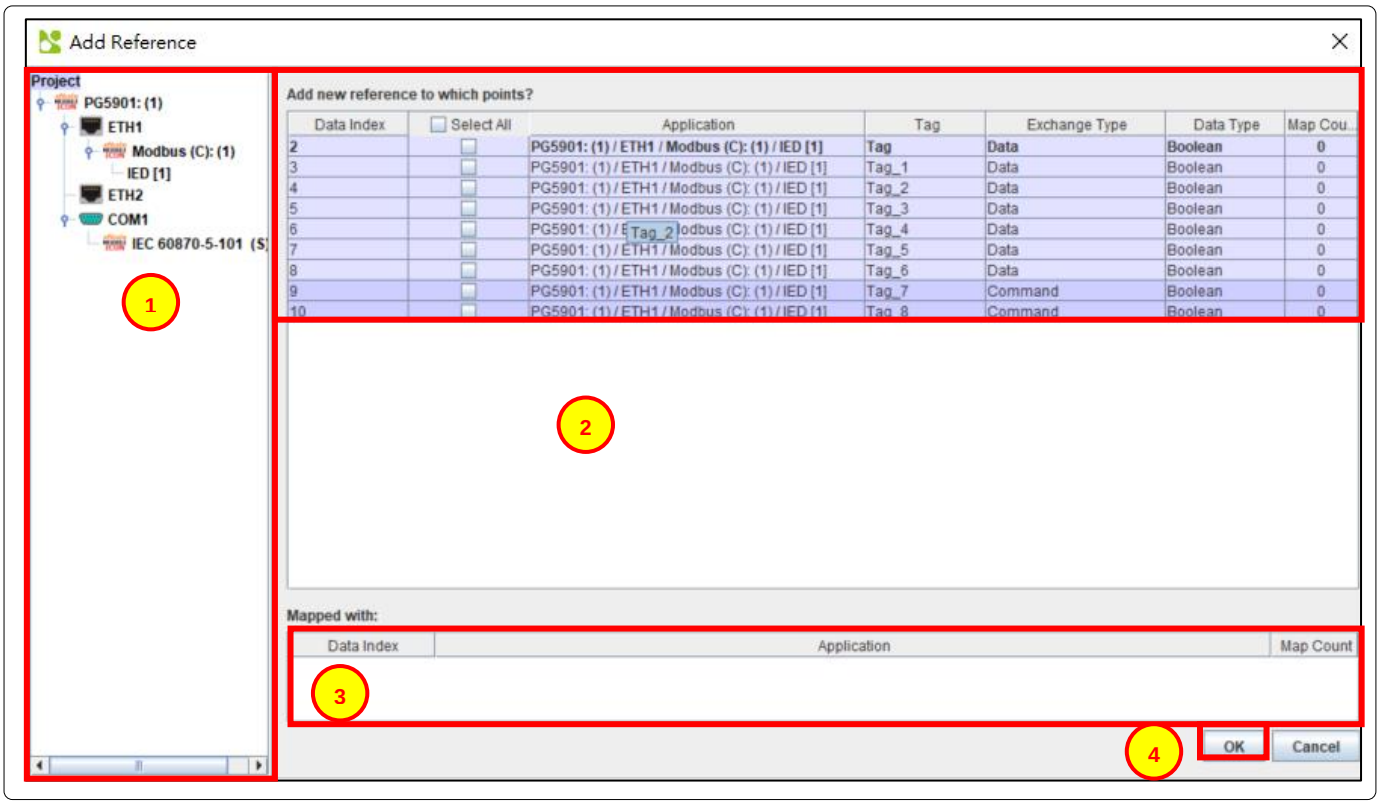

Figure 4-10 – Adding Data Point and Command References to an IEC 60780-5-104 Server.

When adding data point references, this dialogue box above will be shown.

1. The *Project Tree* can be used to search specific locations for data points. Left clicking **Project** at the top shows every data point or command found within the entire project. Left clicking individual ADH applications or IEDs narrows that list down to local data points and commands.

2. Available data points and commands can be selected here. Data points and commands show up slightly differently. Data points are highlighted in a light blue color shown on the top of the list and have the exchange type “data”. Commands are highlighted a dark blue color shown at the bottom of the list and have the exchange type “command”. To map a point, left click the box on that point’s row under the *Map* column. It will be included in the list for mapping and mapped when **OK** is clicked.

3. This section shows details on a point mapping if it has already been mapped to an application. This will only show the points that have been selected.

4. When the required data points for reference are selected, press **OK** to add them.

4.3 IEC 60870-5-104 Common Settings

The configuration of all common settings is mandatory.

4.3.1.1 K Value

Description	The maximum difference in received sequence number to the send state variable. The transmitter stops the transmission at *k* unacknowledged I format APDUs.
Data Entry	Integer
Range	*1 to 32767* (*Default: 12*)
Input Option	Mandatory

4.3.1.2 w Value

Description	The receiver acknowledges at the latest after receiving *w* I format APDUs. (Recommendation: w should not exceed two-thirds of k)
Data Entry	Integer
Range	*1 to 32767* (*Default: 8*)
Input Option	Mandatory

4.3.1.3 t0 Value (s) – Connection Establishment Timeout

Description	The time-out of connection establishment in seconds.
Data Entry	Integer
Range	*1 to 255* (*Default: 30*)
Input Option	Mandatory

4.3.1.4 t1 Value (s) – Send or Test APDU Timeout

Description	The time-out of send or test APDUs.
Data Entry	Integer
Range	*1 to 255* (*Default: 15*)
Input Option	Mandatory

4.3.1.5 t2 Value (s) – Acknowledgement Timeout

Description	Time-out for acknowledges in case of no data messages. $t_2 < t_1$
Data Entry	Integer
Range	*1 to 255* (*Default: 10*)
Input Option	Mandatory

4.3.1.6 t3 Value (s) – Idle State Test Frame Timeout

Description	Time-out for sending test frames in case of a long idle state.
Data Entry	Integer
Range	*1 to 172800* (*Default: 20*)
Input Option	Mandatory

4.3.1.7 Clock Sync Period (ms) (Client only)

Description	The clock synchronisation period. If set to 0 then clock synchronisation command is not expected from the Master.
Data Entry	Integer
Range	*30000 to 3600000* (*Default: 30000*)
Input Option	Mandatory

4.3.1.8 Command Response ACTTERM used (Sever only)

Description	The server sends ACTTERM in the command response when this option is ticked.
Data Entry	Tick box
Types	*Yes or No (Default: Yes)*
Input Option	Mandatory

5 Using Auto-increment

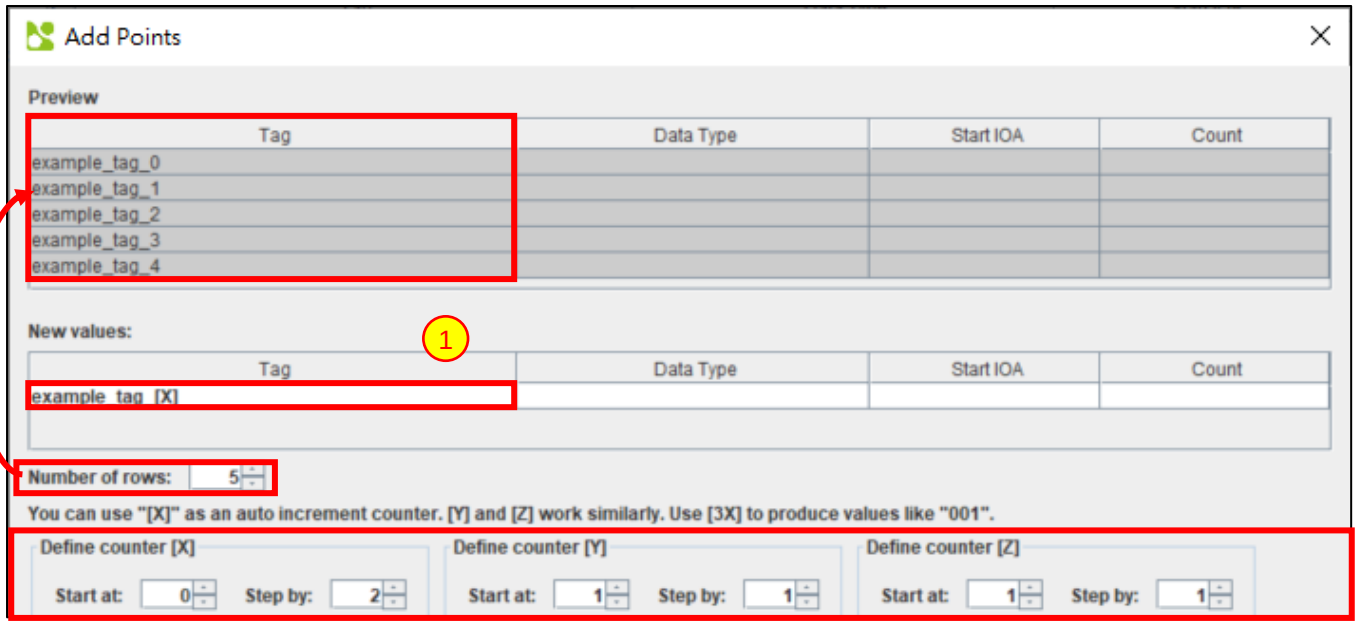

Figure 5-1 – Using Auto Increment when adding Data Points or Commands.

1 The *Number of Rows* can be modified to set the number of data points or commands created from the *New values* section. As shown in the example above, five data points/commands are created and shown in the preview section as the *Number of Rows* is set to 5.

When using the auto increment counters by default, they will start at one and increment by one. Anyway auto-increment value has its own section for configuration. Adjusting *Start At* will change the value that the first data point/command receives. Adjusting *Step By* will change the value that the second and subsequent values will be incremented by.

2 In this example, the *[X]* counter is used. The *Start At* value has been set to 0 and the *Step By* value has been set to 2. This results in the values seen in the preview section.

It is also possible to include a number within the square brackets and before the X, Y or Z while using auto increment. This will produce values that contain the entered number of digits. Any digit that is not taken up by the value determined by the *Start At* and *Step By* values will be shown as zeros.

If no auto increment value is entered in any field, each data point/command field value will be created the same with the exception of *Tag* and *IOA*. The first new data point/command's *Tag* value will represent what was entered in the *New value* section. However, the subsequent data points/commands will contain the initial *Tag* value followed by an underscore and a number incrementing by one from 1 onwards. (Example: tag, tag_1, tag_2 etc.)
The first data point/command's *IOA* value will represent what was entered in the *New value* section. However, the subsequent data points/commands will contain the initial *IOA* value incremented by one each new value. (Example 1, 2, 3, 4 or 23, 24, 25, 26 etc.)

6 IEC 60870-5-101 Interoperability

This companion standard presents sets of parameters and alternatives from which subsets have to be selected in order to implement particular telecontrol systems. The values of certain parameters, such as the number of octets in the COMMON ADDRESS of ASDUs, represent mutually exclusive alternatives. This means that only one value of the defined parameters is admitted per system.
Other parameters, such as the listed set of different process information in command and in monitor direction, allow the specification of the complete set or subsets, as appropriate for given applications. This Clause summarizes the parameters of the previous Clauses to facilitate a suitable selection for a specific application. If a system is composed of equipment stemming from different manufacturers, it is necessary that all partners agree on the selected parameters.

The selected parameters should be marked in the white boxes as follows:

	Function or ASDU is not used,
X	Function or ASDU is used as standardized (default),
R	Function or ASDU is used in reverse mode,
B	Function or ASDU is used in standard and reverse mode,

The possible selection (blank, X, R, or B) should be specified for each specific Clause or parameter.

▸NOTE In addition, the full specification of a system may require individual selection of certain parameters for certain parts of the system, such as the individual selection of scaling factors for individually addressable measured values.

6.1 System or device

(System-specific parameter: indicate the definition of a system or a device by marking one of the following with an "**X**").

	System Definition
X	Controlling station definition (master)
X	Controlled station definition (slave)

6.2 Network configuration

(Network-specific parameter: all configurations that are used are to be marked with an "**X**").

X	Point to point	**X**	Multipoint party line
	Multiple point to point		Multipoint star

6.3 Physical layer

(Network-specific parameter: all interfaces and data rates that are used are to be marked with an "**X**").

Transmission speed (control direction)

Unbalanced interchange Circuit V.24/V.28 Standard	**Unbalanced interchange Circuit V.24/V.28 Recommended if >1 200 bit/s**	**Balanced interchange Circuit X.24/X.27**
☐ 100 bit/s	☒ 2 400 bit/s	☐ 2 400 bit/s
☐ 200 bit/s	☒ 4 800 bit/s	☐ 4 800 bit/s
☐ 300 bit/s	☒ 9 600 bit/s	☐ 9 600 bit/s
☐ 600 bit/s		☐ 19 200 bit/s
☐ 1 200 bit/s		☐ 38 400 bit/s
		☐ 56 000 bit/s
		☐ 64 000 bit/s

Transmission speed (monitor direction)

Unbalanced interchange Circuit V.24/V.28 Standard	**Unbalanced interchange Circuit V.24/V.28 Recommended if >1 200 bit/s**	**Balanced interchange Circuit X.24/X.27**
☐ 100 bit/s	☒ 2 400 bit/s	☐ 2 400 bit/s
☐ 200 bit/s	☒ 4 800 bit/s	☐ 4 800 bit/s
☐ 300 bit/s	☒ 9 600 bit/s	☐ 9 600 bit/s
☐ 600 bit/s		☐ 19 200 bit/s
☐ 1 200 bit/s		☐ 38 400 bit/s
		☐ 56 000 bit/s
		☐ 64 000 bit/s

6.4 Link layer

(Network-specific parameter: all options that are used are to be marked "**X**". Specify the maximum frame length. If a non-standard assignment of class 2 messages is implemented for unbalanced transmission, indicate the Type ID and COT of all messages assigned to class 2.).

Frame format FT 1.2, single character 1 and the fixed time out interval are used exclusively in this companion standard.

Link transmission procedure

- [ ] Balanced transmission
- [X] Unbalanced transmission

Address field of the link

- [ ] Not Present (balanced transmission only)
- [X] One octet
- [X] Two octets
- [ ] Structured
- [X] Unstructured

Frame Length

- **230** Maximum length L (control direction)
- **230** Maximum length L (monitor direction)
- [ ] Time during which repetitions are permitted (Trp) or number of repetitions

When using an unbalanced link layer, the following ASDU types are returned in class 2 messages (low priority) with the indicated causes of transmission:

[X] The standard assignment of ASDUs to class 2 messages is used as follows:

Type identification	Cause of Transmission
9,11,13,21 (configurable)	<1>

[X] The special assignment of ASDUs to class 2 messages is used as follows:

Type identification	Cause of Transmission
(configurable)	

▸NOTE: In response to a class 2 poll, a controlled station may respond with class 1 data when there is no class 2 data available.

6.5 Application layer

Transmission mode for application data

Mode 1 (least significant octet first), as defined in 4.10 of IEC 60870-5-4, is used exclusively in this companion standard.

Common address of ASDU

(System-specific parameter, all configurations that are used are to be marked with an "**X**").

[X] One octet	[X] Two Octets

Information object address

(System-specific parameter, all configurations that are used are to be marked with an "**X**").

[X] One octet	[ ] Structured
[X] Two octets	[X] Unstructured
[X] Three octets	

Cause of transmission

(System-specific parameter, all configurations that are used are to be marked with an "**X**").

[X] One octet	[X] Two Octets (with originator address). Originator address is set to zero if not used.

Selection of standard ASDUs

Process information in monitor direction
(Station-specific parameter, mark each type ID with an "**X**" if it is only used in the standard Direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

X	<1> := Single-point information	M_SP_NA_1
X	<2> := Single-point information with time tag	M_SP_TA_1
X	<3> := Double-point information	M_DP_NA_1
X	<4> := Double-point information with time tag	M_DP_TA_1
X	<5> := Step position information	M_ST_NA_1
X	<6> := Step position information with time tag	M_ST_TA_1
X	<7> := Bitstring of 32 bit	M_BO_NA_1
X	<8> := Bitstring of 32 bit with time tag	M_BO_TA_1
X	<9> := Measured value, normalized value	M_ME_NA_1
X	<10> := Measured value, normalized value with time tag	M_ME_TA_1
X	<11> := Measured value, scaled value	M_ME_NB_1
X	<12> := Measured value, scaled value with time tag	M_ME_TB_1
X	<13> := Measured value, short floating point value	M_ME_NC_1
X	<14> := Measured value, short floating point value with time tag	M_ME_TC_1
X	<15> := Integrated totals	M_IT_NA_1
X	<16> := Integrated totals with time tag	M_IT_TA_1
X	<17> := Event of protection equipment with time tag	M_EP_TA_1
X	<18> := Packed start events of protection equipment with time tag	M_EP_TB_1
	<19> := Packed output circuit information of protection equipment with time tag	M_EP_TC_1
	<20> := Packed single-point information with status change detection	M_PS_NA_1
X	<21> := Measured value, normalized value without quality descriptor	M_ME_ND_1
X	<30> := Single-point information with time tag CP56Time2a	M_SP_TB_1
X	<31> := Double-point information with time tag CP56Time2a	M_DP_TB_1
X	<32> := Step position information with time tag CP56Time2a	M_ST_TB_1
X	<33> := Bitstring of 32 bit with time tag CP56Time2a	M_BO_TB_1
X	<34> := Measured value, normalized value with time tag CP56Time2a	M_ME_TD_1
X	<35> := Measured value, scaled value with time tag CP56Time2a	M_ME_TE_1
X	<36> := Measured value, short floating point value with time tag CP56Time2a	M_ME_TF_1
X	<37> := Integrated totals with time tag CP56Time2a	M_IT_TB_1
	<38> := Event of protection equipment with time tag CP56Time2a	M_EP_TD_1
	<39> := Packed start events of protection equipment with time tag CP56Time2a	M_EP_TE_1
	<40> := Packed output circuit information of protection equipment with time tag CP56Time2	M_EP_TF_1

Either ASDUs of the set <2>, <4>, <6>, <8>, <10>, <12>, <14>, <16>, <17>, <18>, <19> or of the set <30 – 40> are used.

Process information in control direction

(Station-specific parameter, mark each type ID with an "**X**" if it is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

X	<45> := Single command	C_SC_NA_1
X	<46> := Double command	C_DC_NA_1
X	<47> := Regulating step command	C_RC_NA_1
X	<48> := Set point command, normalized value	C_SE_NA_1
X	<49> := Set point command, scaled value	C_SE_NB_1
X	<50> := Set point command, short floating point value	C_SE_NC_1
X	<51> := Bitstring of 32 bit	C_BO_NA_1
X	<58> = Single command with time tag CP56Time2a	C_SC_TA_1*
X	<59> = Double command with time tag CP56Time2a	C_DC_TA_1*
X	<60> = Regulating step command with time tag CP56Time2a	C_RC_TA_1*
X	<61> = Set point command, normalized value with time tag CP56Time2a	C_SE_TA_1*
X	<62> = Set point command, scaled value with time tag CP56Time2a	C_SE_TB_1*
X	<63> = Set point command, short floating point value with time tag CP56Time2a	C_SE_TC_1*
X	<64> = Bitstring of 32 bit command with time tag CP56Time2a	C_BO_TA_1*

*Implemented apart from protocol specification

System information in monitor direction

(Station-specific parameter, mark with an "**X**" if it is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

X	<70> := End of initialisation	M_EI_NA_!

System information in control direction

(Station-specific parameter, mark with an "**X**" if it is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

X	<100>:= Interrogation command	C_IC_NA_1
X	<101>:= Counter interrogation command	C_CI_NA_1
X	<102>:= Read command	C_RD_NA_1
X	<103>:= Clock synchronization command	C_CS_NA_1
X	<104>:= Test command	C_TS_NA_1
X	<105>:= Reset process command	C_RP_NA_1
X	<106>:= Delay acquisition command	C_CD_NA_1
X	<107>:= Delay acquisition command	C_TS_TA_1*

*Implemented apart from protocol specification

Parameter in control direction

(Station-specific parameter, mark each type ID with an "**X**" if it is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

X	<110>:= Parameter of measured value, normalized value	P_ME_NA_1
X	<111>:= Parameter of measured value, scaled value	P_ME_NB_1
X	<112>:= Parameter of measured value, short floating point value	P_ME_NC_1
	<113>:= Parameter activation	P_AC_NA_1

File transfer

(Station-specific parameter, mark each type ID with an "**X**" if it is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

X	<120>:= File ready	F_FR_NA_1
X	<121>:= Section ready	F_SR_NA_1
X	<122>:= Call directory, select file, call file, call section	F_SC_NA_1
X	<123>:= Last section, last segment	F_LS_NA_1
X	<124>:= Ack file, ack section	F_AF_NA_1
X	<125>:= Segment	F_SG_NA_1
	<126>:= Directory {blank or X, only available in monitor (standard) direction}	F_DR_TA_1

Type identification and cause of transmission assignments

(Station-specific parameters) / Shaded boxes are not required.
Blank = function or ASDU is not used.
Mark type identification/cause of transmission combinations:
"**X**" if used only in the standard direction;
"**R**" if used only in the reverse direction;
"**B**" if used in both directions.

Type identification		Cause of Transmission																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	20 to 36	37 to 41	44	45	46	47
<1>	M_SP_NA_1			X		X														
<2>	M_SP_TA_1																			
<3>	M_DP_NA_1			X		X														
<4>	M_DP_TA_1																			
<5>	M_ST_NA_1																			
<6>	M_ST_TA_1																			
<7>	M_BO_NA_1																			
<8>	M_BO_TA_1			X		X														
<9>	M_ME_NA_1																			
<10>	M_ME_TA_1			X		X														
<11>	M_ME_NB_1																			
<12>	M_ME_TB_1			X		X														
<13>	M_ME_NC_1																			
<14>	M_ME_TC_1			X																
<15>	M_IT_NA_1															X				
<16>	M_IT_TA_1																			
<17>	M_EP_TA_1																			
<18>	M_EP_TB_1																			
<19>	M_EP_TC_1																			
<20>	M_PS_NA_1																			
<21>	M_ME_ND_1																			
<30>	M_SP_TB_1			X		X														
<31>	M_DP_TB_1			X		X														
<32>	M_ST_TB_1																			
<33>	M_BO_TB_1																			
<34>	M_ME_TD_1			X																
<35>	M_ME_TE_1			X																
<36>	M_ME_TF_1			X																
<37>	M_IT_TB_1			X												X				
<38>	M_EP_TD_1																			
<39>	M_EP_TE_1																			
<40>	M_EP_TF_1																			
<45>	C_SC_NA_1						X	X			X									
Type identification		Cause of Transmission																		

		1	2	3	4	5	6	7	8	9	10	11	12	13	20 to 36	37 to 41	44	45	46	47
<46>	C_DC_NA_1						X	X			X									
<47>	C_RC_NA_1																			
<48>	C_SE_NA_1						X	X			X									
<49>	C_SE_NB_1						X	X			X									
<50>	C_SE_NC_1						X	X			X									
<51>	C_BO_NA_1																			
<70>	M_EI_NA_1				X															
<100>	C_IC_NA_1						X	X			X									
<101>	C_CI_NA_1																			
<102>	C_RD_NA_1																			
<103>	C_CS_NA_1			X			X	X												
<101>	C_TS_NA_1																			
<105>	C_RP_NA_1						X	X												
<106>	C_CD_NA_1																			
<110>	P_ME_NA_1						X	X												
<111>	P_ME_NB_1																			
<112>	P_ME_NC_1																			
<113>	P_AC_NA_1																			
<120>	F_FR_NA_1													X						
<121>	F_SR_NA_1													X						
<122>	F_SC_NA_1													X						
<123>	F_LS_NA_1													X						
<124>	F_AF_NA_1													X						
<125>	F_SG_NA_1													X						
<126>	F_DR_TA_1 a)					X														

a) Blank or X only.

6.6 Basic application functions

Station initialization

(Station-specific parameter, mark with an "**X**" if function is used).

[**X**] Remote initialization

Cyclic data transmission

(Station-specific parameter, mark with an "**X**" if function is used only in the standard direction, "**R**" if used only in the reverse direction, and "**B**" if used in both directions).

[**X**] Cyclic data Transmission

Read Procedure

(Station-specific parameter, mark with an "**X**" if function is used only in the standard direction, "**R**" if used only in the reverse direction, and "**B**" if used in both directions).

[**X**] Read procedure

Spontaneous transmission

(Station-specific parameter, mark with an "**X**" if function is used only in the standard direction, "**R**" if used only in the reverse direction, and "**B**" if used in both directions).

[**X**] Spontaneous transmission

Double transmission of information objects with cause of transmission spontaneous

(Station-specific parameter, mark each information type with an "**X**" where both a type ID without time and corresponding type ID with time are issued in response to a single spontaneous change of a monitored object).

The following type identifications may be transmitted in succession because of a single status change of an information object. The particular information object addresses for which double transmission is enabled are defined in a project-specific list.

[**X**] Single-point information M_SP_NA_1, M_SP_TA_1, M_SP_TB_1 and M_PS_NA_1

[**X**] Double-point information M_DP_NA1, M_DP_TA_1 and M_DP_TB_1

[**X**] Step position information M_ST_NA_1, M_ST_TA_1 and M_ST_TB_1

[**X**] Bitstring of 32 bit M_BO_NA_1, M_BO_TA_1 and M_BO_TB_1 (if defined for a specific project, see 7.2.1.1)

[**X**] Measured value, normalized value M_ME_NA_1, M_ME_TA_1, M_ME_ND_1 and M_ME_TD_1

[**X**] Measured value, scaled value M_ME_NB_1, M_ME_TB_1 and M_ME_TE_1

[**X**] Measured value, short floating point number M_ME_NC_1, M_ME_TC_1 and M_ME_TF_1

Station interrogation

(Station-specific parameter, mark with an "**X**" if function is used only in the standard direction, "**R**" if used only in the reverse direction, and "**B**" if used in both directions).

[X] global		
[X] group 1	[X] group 7	[X] group 13
[X] group 2	[X] group 8	[X] group 14
[X] group 3	[X] group 9	[X] group 15
[X] group 4	[X] group 10	[X] group 16
[X] group 5	[X] group 11	
[X] group 6	[X] group 12	

Clock synchronization

(Station-specific parameter, mark with an "**X**" if function is used only in the standard direction, "**R**" if used only in the reverse direction, and "**B**" if used in both directions).

- [X] Clock synchronization
- [ ] Day of week used
- [ ] RES1, GEN (time tag substituted/ not substituted) used
- [ ] SU-bit (summertime) used

Command transmission

(Object-specific parameter, mark with an "**X**" if function is used only in the standard direction, **R**" if used only in the reverse direction, and "**B**" if used in both directions).

- [X] Direct command transmission
- [X] Direct set point command transmission
- [X] Select and execute command
- [X] Select and execute set point command
- [opt] C_SE ACTTERM used
- [X] No additional definition
- [ ] Short-pulse duration (duration determined by a system parameter in the controlled station)
- [ ] Long-pulse duration (duration determined by a system parameter in the controlled station)
- [ ] Persistent output

Transmission of integrated totals

(Station- or object-specific parameter, mark with an "**X**" if function is used only in the standard direction, "**R**" if used only in the reverse direction, and "**B**" if used in both directions).

- [X] Mode A: local freeze with spontaneous transmission
- [X] Mode B: local freeze with counter interrogation
- [X] Mode C: freeze and transmit by counter interrogation commands
- [X] Mode D: freeze by counter-interrogation command, frozen values reported
- [X] Counter read
- [X] Counter freeze without reset
- [X] Counter freeze with reset
- [X] Counter reset
- [X] General request counter
- [X] Request counter group 1
- [X] Request counter group 2
- [X] Request counter group 3
- [X] Request counter group 4

Parameter loading

(Object-specific parameter, mark with an "**X**" if function is used only in the standard direction, "**R**" if used only in the reverse direction, and "**B**" if used in both directions).

- [ ] Threshold value
- [ ] Smoothing factor
- [ ] Low limit for transmission of measured value
- [ ] High limit for transmission of measured value

Parameter activation

(Object-specific parameter, mark with an "**X**" if function is used only in the standard direction, **R**" if used only in the reverse direction, and "**B**" if used in both directions).

☐ Activate/deactivate persistent cyclic or periodic transmission of the addressed object

Test procedure

(Station-specific parameter, mark with an "**X**" if function is used only in the standard direction, **R**" if used only in the reverse direction, and "**B**" if used in both directions).

☒ Test procedure

File transfer

(Station-specific parameter, mark with an "**X**" if function is used).

File transfer in monitor direction

☒ Transparent file
☐ Transmission of disturbance data of protection equipment
☐ Transmission of sequences of events
☐ Transmission of sequences of recorded analogue values

File transfer in control direction

☐ Transparent file

Background scan

(Station-specific parameter, mark with an "**X**" if function is used only in the standard direction, "**R**" if used only in the reverse direction, and "**B**" if used in both directions).

☒ Background scan

Acquisition of transmission delay

(Station-specific parameter, mark with an "**X**" if function is used only in the standard direction, "**R**" if used only in the reverse direction, and "**B**" if used in both directions).

☒ Acquisition of transmission delay

7 IEC 60870-5-104 Interoperability

7.1 Protocol overview

IEC 60870-5-104 is an international standard, released by IEC(International Electrotechnical Commission). It enables communication between control station and substation via a standard TCP/IP network.

Application layer of **IEC 60870-5-104** is preserved same as that of IEC 60870-5-101with some of data types and facilities not used. For instance, there are two separate link layers defined in the standard, which is suitable for data transfer over Ethernet & Serial line, IEC 60870-5-104 does not support short time stamps (3 octets) with monitor direction.

This manual assumes that reader has some basic knowledge of the IEC 60870 standard documents and the IEC 60870-5-104 protocol.

IEC 60870 Document Part	Description
IEC 60870-5-1	Transmission Frame Formats
IEC 60870-5-2	Data Link Transmission Services
IEC 60870-5-3	General Structure of Application Data
IEC 60870-5-4	Definition and Coding of Information Elements
IEC 60870-5-5	Basic Application Functions
IEC 60870-5-6	Guidelines for conformance testing for the IEC 60870-5 companion standards
IEC 60870-5-104	Network access for IEC 60870-5-101 using standard transport profiles

7.1.1 ISO/OSI model of IEC 60870-5-104

Data Unit	Layer	Functional
Data	7. Application Layer	IEC 60870-5-4 IEC 60870-5-5 IEC 60870-5-104 standard
	6. Presentation Layer	N/A
	5. Session Layer	N/A
Segments	4. Transport Layer	TCP (RFC 793)
Packet/Datagram	3. Network Layer	IP (RFC 791)
Bit/Frame	2. Data Link Layer	PPP (Point To Point, balanced) Transmission of IP datagrams over Ethernet Network(RFC 894)
	1. Physical Layer	Ethernet (IEEE 802.3)

7.2 Interoperability: IEC 60870-5-104 Client

This companion standard presents sets of parameters and alternatives from which subsets have to be selected to implement particular telecontrol systems. Certain parameter values, such as the number of octets in the COMMON Address of ASDUs represent mutually exclusive alternatives. This means that only one value of the defined parameters is admitted per system.
Other parameters, such as the listed set of different process information in command and in monitor direction allow the specification of the complete set or subsets, as appropriate for given applications. This Clause summarizes the parameters of the previous Clauses to facilitate a suitable selection for a specific application. If a system is composed of equipment stemming from different manufacturers, it is necessary that all partners agree on the selected parameters.

The selected parameters should be marked in the white boxes as follows:

☐ Function or ASDU is not used.
☒ Function or ASDU is used as standardized (default).
■ Function or ASDU is not supported.

Max ASDU size:
Maximum of ASDU size
Default value is 253.

NOTE In addition, the full specification of a system may require individual selection of certain parameters for certain Parts of the system, such as the individual selection of scaling factors for individually addressable measured values.

7.2.1 System or device

System-specific parameter, indicate the definition of a system or a device by marking one of the following with "**X**".

☐ System definition
☒ Controlling station definition(master, TCP client)
☐ Controlled station definition (slave, TCP server)

7.2.2 Link layer

Network-specific parameter, all options that are used are to be marked with an "**X**".
Specify the maximum frame length. If a non-standard assignment of class 2 messages is implemented for unbalanced transmission, indicate the type ID and COT of all messages assigned to class 2.

~~Frame format FT 1.2, single character 1 and the fixed time out interval are used exclusively in this companion standard.~~

Link transmission
■ ~~Balanced transmission~~
■ ~~Unbalanced transmission~~

Address field of the link
■ not present (balanced transmission only)
■ ~~one octet~~
■ ~~two octets~~
■ ~~Structured~~
■ ~~Unstructured~~

Frame length

■ ~~Maximum length L(number of octets)~~

When using an unbalanced link layer, the following ASDU types are returned in class 2 messages (low priority) with the indicated causes of transmission:

■ ~~The standard assignment of ASDUs to class 2 messages is used as follows:~~

Type identification	Cause of transmission

■ ~~A special assignment of ASDUs to class 2 messages is used as follows:~~

Type identification	Cause of transmission

~~Note: (In response to a class 2 poll, a controlled station may respond with class 1 data when there is no class 2 data available).~~

7.2.3 Application layer

Transmission mode for application data

Mode 1 (least significant octet first), as defined in 4.10 of IEC 60870-5-4, is used exclusively in this companion standard.

Common address of ASDU

(System-specific parameter, all configurations that are used are to be marked with an "**X**").

■ ~~One octet~~ [X] Two Octets

Information object address

(System-specific parameter, all configurations that are used are to be marked with an "**X**").

■ ~~One octet~~
☐ Structured
■ ~~Two octets~~
☐ Unstructured
☒ Three octets

Cause of transmission

(System-specific parameter, all configurations that are used are to be marked with an "**X**").

■ ~~One octet~~ [X] Two Octets (with originator address).
Originator address is set to zero if not used

Originator address

Originator address is set to zero if not used.

Length of APDU

(System-specific parameter, specify the maximum length of the APDU per system)
The maximum length of the APDU is 253 (TCP server mode default). The maximum length may be reduced by the system.

■ Maximum length of APDU per system in control direction
■ Maximum length of APDU per system in monitor direction

7.2.4 Selection of standard ASDUs

Process information in monitor direction

(Station-specific parameter, mark each type ID with an "**X**" if it is only used in the standard Direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

☒ <1> := Single-point information	M_SP_NA_1
■ ~~<2> := Single-point information with time tag~~	~~M_SP_TA_1~~
☒ <3> := Double-point information	M_DP_NA_1
■ ~~<4> := Double-point information with time tag~~	~~M_DP_TA_1~~
☒ <5> := Step position information	M_ST_NA_1
■ ~~<6> := Step position information with time tag~~	~~M_ST_TA_1~~
☒ <7> := Bit string of 32 bit	M_BO_NA_1
■ ~~<8> := Bit string of 32 bit with time tag~~	~~M_BO_TA_1~~
☒ <9> := Measured value, normalized value	M_ME_NA_1
■ ~~<10> := Measured value, normalized value with time tag~~	~~M_ME_TA_1~~
☒ <11> := Measured value, scaled value	M_ME_NB_1
■ ~~<12> := Measured value, scaled value with time tag~~	~~M_ME_TB_1~~
☒ <13> := Measured value, short floating point value	M_ME_NC_1
■ ~~<14> := Measured value, short floating point value with time tag~~	~~M_ME_TC_1~~
☒ <15> := Integrated totals	M_IT_NA_1
■ ~~<16> := Integrated totals with time tag~~	~~M_IT_TA_1~~
■ ~~<17> := Event of protection equipment with time tag~~	~~M_EP_TA_1~~
■ ~~<18> := Packed start events of protection equipment with time tag~~	~~M_EP_TB_1~~
■ ~~<19> := Packed output circuit information of protection equipment with time tag~~	~~M_EP_TC_1~~
☐ <20> := Packed single-point information with status change detection	M_PS_NA _1
☐ <21> := Measured value, normalized value without quality descriptor	M_ME_ND_1
☒ <30> := Single-point information with time tag CP56Time2a	M_SP_TB_1
☒ <31> := Double-point information with time tag CP56Time2a	M DP TB 1

☒<32> := Step position information with time tag CP56Time2a	M_ST_TB_1
☒<33> := Bitstring of 32 bit with time tag CP56Time2a	M_BO_TB_1
☒<34> := Measured value, normalized value with time tag CP56Time2a	M_ME_TD_1
☒<35> := Measured value, scaled value with time tag CP56Time2a	M_ME_TE_1
☒<36> := Measured value, short floating point value with time tag CP56Time2a	M ME TF 1
☒<37> := Integrated totals with time tag CP56Time2a	M_IT_TB_1
☐<38> := Event of protection equipment with time tag CP56Time2a	M_EP_TD_1
☐<39> := Packed start events of protection equipment with time tag CP56Time2a	M_EP_TE_1
☐<40> := Packed output circuit information of protection equipment with time tag CP56Time2a	M_EP_TF_1

Process information in control direction

(Station-specific parameter, mark each type ID with an "**X**" if it is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

☒<45> := Single command	C_SC_NA_1
☒<46> := Double command	C_DC_NA_1
☒<47> := Regulating step command	C_RC_NA_1
☒<48> := Set point command, normalized value	C_SE_NA_1
☒<49> := Set point command, scaled value	C_SE_NB_1
☒<50> := Set point command, short floating point value	C_SE_NC_1
☒<51> := Bitstring of 32 bit	C_BO_NA_1
☒<58> = Single command with time tag CP56Time2a	C_SC_TA_1 *
☒<59> = Double command with time tag CP56Time2a	C_DC_TA_1 *
☒<60> = Regulating step command with time tag CP56Time2a	C_RC_TA_1 *
☒<61> = Set point command, normalized value with time tag CP56Time2a	C_SE_TA_1 *
☒<62> = Set point command, scaled value with time tag CP56Time2a	C_SE_TB_1 *
☒<63> = Set point command, short floating point value with time tag CP56Time2a	C_SE_TC_1 *
☒<64> = Bitstring of 32 bit command with time tag CP56Time2a	C_BO_TA_1 *

Either the ASDUs of the set <45> – <51> or of the set <58> – <64> are used.

System information in monitor direction

(Station-specific parameter, mark with an "**X**" if it is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions)

X <70> := End of initialisation	M_EI_NA_1

System information in control direction

(Station-specific parameter, mark with an "**X**" if it is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions)

☒<100>:= Interrogation command	C_IC_NA_1
☒<101>:= Counter interrogation command	C_CI_NA_1
☐<102>:= Read command	C_RD_NA_1
☒<103>:= Clock synchronization command	C CS NA 1
■~~<104>:= Test command~~	~~C_TS_NA_1~~
☐<105>:= Reset process command	C_RP_NA_1
■~~<106>:= Delay acquisition command~~	~~C_CD_NA_1~~
☐<107>:= Test command with time tag CP56Time2a	C_TS_TA_1

Parameter in control direction

(Station-specific parameter, mark each type ID with an "**X**" if it is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

☐<110>:= Parameter of measured value, normalized value	P_ME_NA_1
☐<111>:= Parameter of measured value, scaled value	P_ME_NB_1
☐<112>:= Parameter of measured value, short floating point value	P_ME_NC_1
☐<113>:= Parameter activation	P_AC_NA_1

File transfer

(Station-specific parameter, mark each type ID with an "**X**")

☐<120>:= File ready	F_FR_NA_1
☐<121>:= Section ready	F_SR_NA_1
☐<122>:= Call directory, select file, call file, call section	F_SC_NA_1
☐<123>:= Last section, last segment	F_LS_NA_1
☐<124>:= Ack file, ack section	F_AF_NA_1
☐<125>:= Segment	F_SG_NA_1
☐<126>:= Directory {blank or X, only available in monitor (standard) direction}	F_DR_TA_1
☐<127>:= Query Log – Request archive file	F_SC_NB_1

Type identification and cause of transmission assignments

(Station-specific parameters)

Shaded boxes are not required.
Blank = function or ASDU is not used.
Mark type identification/cause of transmission combinations:
"**X**" if used only in the standard direction;
"**R**" if used only in the reverse direction;
"**B**" if used in both directions.

Type identification		Cause of Transmission																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	20 to 36	37 to 41	44	45	46	47
<1>	M_SP_NA_1														X					
~~<2>~~	~~M_SP_TA_1~~																			
<3>	M_DP_NA_1														X					
~~<4>~~	~~M_DP_TA_1~~																			
<5>	M_ST_NA_1														X					
~~<6>~~	~~M_ST_TA_1~~																			
<7>	M_BO_NA_1														X					
~~<8>~~	~~M_BO_TA_1~~																			
<9>	M_ME_NA_1														X					
~~<10>~~	~~M_ME_TA_1~~																			
<11>	M_ME_NB_1														X					
~~<12>~~	~~M_ME_TB_1~~																			
<13>	M_ME_NC_1														X					
~~<14>~~	~~M_ME_TC_1~~																			
<15>	M_IT_NA_1															X				
<16>	M_IT_TA_1																			
<17>	M_EP_TA_1																			
<18>	M_EP_TB_1																			
<19>	M_EP_TC_1																			
<20>	M_PS_NA_1																			
<21>	M_ME_ND_1																			
<30>	M_SP_TB_1																			
<31>	M_DP_TB_1																			
<32>	M_ST_TB_1																			
<33>	M_BO_TB_1																			
<34>	M_ME_TD_1																			
<35>	M_ME_TE_1																			
<36>	M_ME_TF_1																			
<37>	M_IT_TB_1															X				
<38>	M_EP_TD_1																			
<39>	M_EP_TE_1																			
<40>	M_EP_TF_1																			
<45>	C_SC_NA_1						X	X			X									
<46>	C_DC_NA_1						X	X			X									
<47>	C_RC_NA_1																			
<48>	C_SE_NA_1						X	X			X									
<49>	C_SE_NB_1						X	X			X									

Type identification		Cause of Transmission																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	20 to 36	37 to 41	44	45	46	47
<50>	C_SE_NC_1						X	X			X									
<51>	C_BO_NA_1																			
<58>	C_SC_TA_1						X	X			X									
<59>	C_DC_TA_1						X	X			X									
<60>	C_RC_TA_1																			
<61>	C_SE_TA_1						X	X			X									
<62>	C_SE_TB_1						X	X			X									
<63>	C_SE_TC_1						X	X			X									
<64>	C_BO_TA_1																			
<70>	M_EI_NA_1				X															
<100>	C_IC_NA_1						X	X			X									
<101>	C_CI_NA_1						X	X			X									
<102>	C_RD_NA_1																			
<103>	C_CS_NA_1						X	X												
~~<104>~~	~~C_TS_NA_1~~																			
<105>	C_RP_NA_1																			
~~<106>~~	~~C_CD_NA_1~~																			
<110>	P_ME_NA_1																			
<111>	P_ME_NB_1																			
<112>	P_ME_NC_1																			
<113>	P_AC_NA_1																			
<120>	F_FR_NA_1																			
<121>	F_SR_NA_1																			
<122>	F_SC_NA_1																			
<123>	F_LS_NA_1																			
<124>	F_AF_NA_1																			
<125>	F_SG_NA_1																			
<126>	F_DR_TA_1 a)																			

a) Blank or X only.

7.2.5 Basic application functions

Station initialization

(Station-specific parameter, mark with an "**X**" if function is used).

[X] Remote initialization

Cyclic data transmission

(Station-specific parameter, mark with an "**X**" if function is used only in the standard direction, "**R**" if used only in the reverse direction, and "**B**" if used in both directions).

[ ] Cyclic data Transmission

Read Procedure

(Station-specific parameter, mark with an "**X**" if function is used only in the standard direction, "**R**" if used only in the reverse direction, and "**B**" if used in both directions).

[ ] Read procedure

Spontaneous transmission

(Station-specific parameter, mark with an "**X**" if function is used only in the standard direction, "**R**" if used only in the reverse direction, and "**B**" if used in both directions).

[ ] Spontaneous transmission

Double transmission of information objects with cause of transmission spontaneous

(Station-specific parameter, mark each information type with an "**X**" where both a type ID without time and corresponding type ID with time are issued in response to a single spontaneous change of a monitored object).

The following type identifications may be transmitted in succession because of a single status change of an information object. The particular information object addresses for which double transmission is enabled are defined in a project-specific list.

[ ] Single-point information M_SP_NA_1, ~~M_SP_TA_1~~, M_SP_TB_1 and M_PS_NA_1

[ ] Double-point information M_DP_NA1, ~~M_DP_TA_1~~ and M_DP_TB_1

[ ] Step position information M_ST_NA_1, ~~M_ST_TA_1~~ and M_ST_TB_1

[ ] Bitstring of 32 bit M_BO_NA_1, ~~M_BO_TA_1~~ and M_BO_TB_1 (if defined for a specific project, see 7.2.1.1)

[ ] Measured value, normalized value M_ME_NA_1, ~~M_ME_TA_1~~, M_ME_ND_1 and M_ME_TD_1

[ ] Measured value, scaled value M_ME_NB_1, ~~M_ME_TB_1~~ and M_ME_TE_1

[ ] Measured value, short floating point number M_ME_NC_1, ~~M_ME_TC_1~~ and M_ME_TF_1

Station interrogation

(Station-specific parameter, mark with an "**X**" if function is used only in the standard direction, "**R**" if used only in the reverse direction, and "**B**" if used in both directions).

[X] global		
[X] group 1	[X] group 7	[X] group 13
[X] group 2	[X] group 8	[X] group 14
[X] group 3	[X] group 9	[X] group 15
[X] group 4	[X] group 10	[X] group 16
[X] group 5	[X] group 11	
[X] group 6	[X] group 12	

Clock synchronization

(Station-specific parameter, mark with an "**X**" if function is used only in the standard direction, "**R**" if used only in the reverse direction, and "**B**" if used in both directions).

- [X] Clock synchronization
- [ ] Day of week used
- [ ] RES1, GEN (time tag substituted/ not substituted) used
- [ ] SU-bit (summertime) used

Command transmission

(Object-specific parameter, mark with an "**X**" if function is used only in the standard direction, **R**" if used only in the reverse direction, and "**B**" if used in both directions).

- [X] Direct command transmission
- [X] Direct set point command transmission
- [X] Select and execute command
- [X] Select and execute set point command
- [X] C_SE ACTTERM used (optional)
- [X] No additional definition
- [ ] Short-pulse duration (duration determined by a system parameter in the controlled station)
- [ ] Long-pulse duration (duration determined by a system parameter in the controlled station)
- [ ] Persistent output
- [X] Supervision of maximum delay of command direction of commands and set point commands
- [X] Maximum (60s) allowable delay of commands and set point commands

Transmission of integrated totals

(Station- or object-specific parameter, mark with an "**X**" if function is used only in the standard direction, "**R**" if used only in the reverse direction, and "**B**" if used in both directions)

- [ ] Mode A: local freeze with spontaneous transmission
- [ ] Mode B: local freeze with counter interrogation
- [ ] Mode C: freeze and transmit by counter interrogation commands
- [ ] Mode D: freeze by counter-interrogation command, frozen values reported
- [X] Counter read
- [ ] Counter freeze without reset
- [ ] Counter freeze with reset
- [ ] Counter reset
- [X] General request counter
- [X] Request counter group 1
- [X] Request counter group 2
- [X] Request counter group 3
- [X] Request counter group 4

Parameter loading

(Object-specific parameter, mark with an "**X**" if function is used only in the standard direction, "**R**" if used only in the reverse direction, and "**B**" if used in both directions).

- [ ] Threshold value
- [ ] Smoothing factor
- [ ] Low limit for transmission of measured value
- [ ] High limit for transmission of measured value

Parameter activation

(Object-specific parameter, mark with an "**X**" if function is used only in the standard direction, **R**" if used only in the reverse direction, and "**B**" if used in both directions).

- [ ] Act/deact of persistent cyclic or periodic transmission of the addressed object

Test procedure

(Station-specific parameter, mark with an "**X**" if function is used only in the standard direction, **R**" if used only in the reverse direction, and "**B**" if used in both directions).

- [X] Test procedure

File transfer

(Station-specific parameter, mark with an "**X**" if function is used).

File transfer in monitor direction:

☐ Transparent file
☐ Transmission of disturbance data of protection equipment
☐ Transmission of sequences of events
☐ Transmission of sequences of recorded analogue values

File transfer in control direction:

☐ Transparent file

Background scan

(Station-specific parameter, mark with an "**X**" if function is used only in the standard direction, "**R**" if used only in the reverse direction, and "**B**" if used in both directions).

☐ Background scan

Acquisition of transmission delay

(Station-specific parameter, mark with an "**X**" if function is used only in the standard direction, "**R**" if used only in the reverse direction, and "**B**" if used in both directions).

■ ~~Acquisition of transmission delay~~

Definition of time outs

Parameter	Default value	Remarks	Selected value	Range
t_0	30 s	Time-out of connection establishment		1 to 255 second(s)
t_1	15 s	Time-out of send or test APDUs		1 to 255 second(s)
t_2	10 s	Time-out for acknowledges in case of no data messages $t_2 < t_1$		1 to 255 second(s)
t_3	20 s	Time-out for sending test frames in case of a long idle state		1 to 172800 second(s) (1 second to 48 hours)

Maximum number of outstanding I format APDUs k and latest acknowledge APDUs (w)

Parameter	Default value	Remarks	Selected value
k	12 APDUs	Maximum difference receive sequence number to send state	
w	8 APDUs	Maximum difference receive sequence number to send state	

Maximum range of values k: 1 to 32767 (215–1) APDUs, accuracy 1 APDU
Maximum range of values w: 1 to 32767 APDUs, accuracy 1 APDU (Recommendation: w should not exceed two-thirds of k).

Port Number

Parameter	Default value	Remarks
Port number	2404	In all cases (1 to 65535)

RFC 2200 suite

RFC 2200 is an official Internet Standard which describes the state of standardization of the protocols used in the Internet as determined by the Internet Architecture Board (IAB). It offers a broad spectrum of actual standards used in the Internet. The suitable selection of documents from RFC 2200 defined in this standard for given projects has to be chosen by the user of this standard.

[X] Ethernet 802.3
[ ] Serial X.21 interface
[ ] Other selection from RFC

7.3 Interoperability: IEC 60870-5-104 Server

This companion standard presents sets of parameters and alternatives from which subsets have to be selected to implement particular telecontrol systems. Certain parameter values, such as the number of octets in the COMMON Address of ASDUs represent mutually exclusive alternatives. This means that only one value of the defined parameters is admitted per system.
Other parameters, such as the listed set of different process information in command and in monitor direction allow the specification of the complete set or subsets, as appropriate for given applications. This Clause summarizes the parameters of the previous Clauses to facilitate a suitable selection for a specific application. If a system is composed of equipment stemming from different manufacturers, it is necessary that all partners agree on the selected parameters.

The selected parameters should be marked in the white boxes as follows:

☐ Function or ASDU is not used.
☒ Function or ASDU is used as standardized (default).
■ Function or ASDU is not supported.

7.3.1 System or device

System-specific parameter, indicate the definition of a system or a device by marking one of the following with "**X**".

☐ System definition
☐ Controlling station definition(master, TCP client)
☒ Controlled station definition (slave, TCP server)

7.3.2 Link layer

Network-specific parameter, all options that are used are to be marked with an "**X**".
Specify the maximum frame length. If a non-standard assignment of class 2 messages is implemented for unbalanced transmission, indicate the type ID and COT of all messages assigned to class 2.

~~Frame format FT 1.2, single character 1 and the fixed time out interval are used exclusively in~~

this companion standard.

Link transmission

- ■ Balanced transmission
- ■ Unbalanced transmission

Address field of the link

- ■ not present (balanced transmission only)
- ■ one octet
- ■ two octets
- ■ Structured
- ■ Unstructured

Frame length

- ■ Maximum length L(number of octets)

When using an unbalanced link layer, the following ASDU types are returned in class 2 messages (low priority) with the indicated causes of transmission:

- ■ The standard assignment of ASDUs to class 2 messages is used as follows:

Type identification	Cause of transmission
9, 11, 13(configurable)	<1>

- ■ A special assignment of ASDUs to class 2 messages is used as follows:

Type identification	Cause of transmission

Note: (In response to a class 2 poll, a controlled station may respond with class 1 data when there is no class 2 data available).

7.3.3 Application layer

Transmission mode for application data

Mode 1 (least significant octet first), as defined in 4.10 of IEC 60870-5-4, is used exclusively in this companion standard.

Common address of ASDU

(System-specific parameter, all configurations that are used are to be marked with an "**X**").

■ ~~One octet~~ [X] Two Octets

Information object address

(System-specific parameter, all configurations that are used are to be marked with an "**X**").

■ ~~One octet~~
☐ Structured
■ ~~Two octets~~
☐ Unstructured
☒ Three octets

Cause of transmission

(System-specific parameter, all configurations that are used are to be marked with an "**X**").

■ ~~One octet~~ [X] Two Octets (with originator address).
Originator address is set to zero if not used

Originator address

Originator address is set to zero if not used.

Length of APDU

(System-specific parameter, specify the maximum length of the APDU per system)
The maximum length of the APDU is 253 (TCP server mode default). The maximum length may be reduced by the system.

■ Maximum length of APDU per system in control direction
■ Maximum length of APDU per system in monitor direction

7.3.4 Selection of standard ASDUs

Process information in monitor direction

(Station-specific parameter, mark each type ID with an "**X**" if it is only used in the standard Direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

☒ <1> := Single-point information	M_SP_NA_1
■ ~~<2> := Single-point information with time tag~~	~~M_SP_TA_1~~
☒ <3> := Double-point information	M_DP_NA_1
■ ~~<4> := Double-point information with time tag~~	~~M_DP_TA_1~~
☒ <5> := Step position information	M_ST_NA_1
■ ~~<6> := Step position information with time tag~~	~~M_ST_TA_1~~
☒ <7> := Bit string of 32 bit	M_BO_NA_1
■ ~~<8> := Bit string of 32 bit with time tag~~	~~M_BO_TA_1~~
☒ <9> := Measured value, normalized value	M_ME_NA_1
■ ~~<10> := Measured value, normalized value with time tag~~	~~M_ME_TA_1~~
☒ <11> := Measured value, scaled value	M_ME_NB_1
■ ~~<12> := Measured value, scaled value with time tag~~	~~M_ME_TB_1~~
☒ <13> := Measured value, short floating point value	M_ME_NC_1
■ ~~<14> := Measured value, short floating point value with time tag~~	~~M_ME_TC_1~~
☒ <15> := Integrated totals	M_IT_NA_1
■ ~~<16> := Integrated totals with time tag~~	~~M_IT_TA_1~~
■ ~~<17> := Event of protection equipment with time tag~~	~~M_EP_TA_1~~
■ ~~<18> := Packed start events of protection equipment with time tag~~	~~M_EP_TB_1~~
■ ~~<19> := Packed output circuit information of protection equipment with time tag~~	~~M_EP_TC_1~~
☐ <20> := Packed single-point information with status change detection	M_PS_NA _1
☐ <21> := Measured value, normalized value without quality descriptor	M_ME_ND_1
☒ <30> := Single-point information with time tag CP56Time2a	M_SP_TB_1
☒ <31> := Double-point information with time tag CP56Time2a	M DP TB 1
☒ <32> := Step position information with time tag CP56Time2a	M_ST_TB_1
☒ <33> := Bitstring of 32 bit with time tag CP56Time2a	M_BO_TB_1
☒ <34> := Measured value, normalized value with time tag CP56Time2a	M_ME_TD_1
☒ <35> := Measured value, scaled value with time tag CP56Time2a	M_ME_TE_1
☒ <36> := Measured value, short floating point value with time tag CP56Time2a	M ME TF 1
☒ <37> := Integrated totals with time tag CP56Time2a	M_IT_TB_1
☐ <38> := Event of protection equipment with time tag CP56Time2a	M_EP_TD_1
☐ <39> := Packed start events of protection equipment with time tag CP56Time2a	M_EP_TE_1
☐ <40> := Packed output circuit information of protection equipment with time tag CP56Time2a	M_EP_TF_1

Process information in control direction

(Station-specific parameter, mark each type ID with an "**X**" if it is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

☒ <45> := Single command	C_SC_NA_1
☒ <46> := Double command	C_DC_NA_1
☒ <47> := Regulating step command	C_RC_NA_1
☒ <48> := Set point command, normalized value	C_SE_NA_1
☒ <49> := Set point command, scaled value	C_SE_NB_1
☒ <50> := Set point command, short floating point value	C_SE_NC_1

☒<51> := Bitstring of 32 bit	C_BO_NA_1
☒<58> = Single command with time tag CP56Time2a	C_SC_TA_1 *
☒<59> = Double command with time tag CP56Time2a	C_DC_TA_1 *
☒<60> = Regulating step command with time tag CP56Time2a	C_RC_TA_1 *
☒<61> = Set point command, normalized value with time tag CP56Time2a	C_SE_TA_1 *
☒<62> = Set point command, scaled value with time tag CP56Time2a	C_SE_TB_1 *
☒<63> = Set point command, short floating point value with time tag CP56Time2a	C_SE_TC_1 *
☒<64> = Bitstring of 32 bit command with time tag CP56Time2a	C_BO_TA_1 *

Either the ASDUs of the set <45> – <51> or of the set <58> – <64> are used.

System information in monitor direction

(Station-specific parameter, mark with an "**X**" if it is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions)

X <70> := End of initialisation	M_EI_NA_1

System information in control direction

(Station-specific parameter, mark with an "**X**" if it is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions)

☒<100>:= Interrogation command	C_IC_NA_1
☒<101>:= Counter interrogation command	C_CI_NA_1
☐<102>:= Read command	C_RD_NA_1
☒<103>:= Clock synchronization command	C CS NA 1
■ ~~<104>:= Test command~~	~~C_TS_NA_1~~
☐<105>:= Reset process command	C_RP_NA_1
■ ~~<106>:= Delay acquisition command~~	~~C_CD_NA_1~~
☐<107>:= Test command with time tag CP56Time2a	C_TS_TA_1

Parameter in control direction

(Station-specific parameter, mark each type ID with an "**X**" if it is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

☐<110>:= Parameter of measured value, normalized value	P_ME_NA_1
☐<111>:= Parameter of measured value, scaled value	P_ME_NB_1
☐<112>:= Parameter of measured value, short floating point value	P_ME_NC_1
☐<113>:= Parameter activation	P_AC_NA_1

File transfer

(Station-specific parameter, mark each type ID with an "**X**")

☐<120>:= File ready	F_FR_NA_1
☐<121>:= Section ready	F_SR_NA_1
☐<122>:= Call directory, select file, call file, call section	F_SC_NA_1
☐<123>:= Last section, last segment	F_LS_NA_1
☐<124>:= Ack file, ack section	F_AF_NA_1
☐<125>:= Segment	F_SG_NA_1

☐<126>:= Directory {blank or X, only available in monitor (standard) direction} F_DR_TA_1

☐<127>:= Query Log – Request archive file F_SC_NB_1

Type identification and cause of transmission assignments

(Station-specific parameters)

Shaded boxes are not required.
Blank = function or ASDU is not used.
Mark type identification/cause of transmission combinations:
"**X**" if used only in the standard direction;
"**R**" if used only in the reverse direction;
"**B**" if used in both directions.

Type identification		Cause of Transmission																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	20 to 36	37 to 41	44	45	46	47
<1>	M_SP_NA_1			X		X														
~~<2>~~	~~M_SP_TA_1~~																			
<3>	M_DP_NA_1			X		X														
~~<4>~~	~~M_DP_TA_1~~																			
<5>	M_ST_NA_1			X		X														
~~<6>~~	~~M_ST_TA_1~~																			
<7>	M_BO_NA_1			X		X														
~~<8>~~	~~M_BO_TA_1~~																			
<9>	M_ME_NA_1	X		X		X														
~~<10>~~	~~M_ME_TA_1~~																			
<11>	M_ME_NB_1	X		X		X														
~~<12>~~	~~M_ME_TB_1~~																			
<13>	M_ME_NC_1	X		X		X														
~~<14>~~	~~M_ME_TC_1~~																			
<15>	M_IT_NA_1			X												X				
<16>	M_IT_TA_1																			
<17>	M_EP_TA_1																			
<18>	M_EP_TB_1																			
<19>	M_EP_TC_1																			
<20>	M_PS_NA_1																			
<21>	M_ME_ND_1																			
<30>	M_SP_TB_1			X		X														
<31>	M_DP_TB_1			X		X														
<32>	M_ST_TB_1																			
<33>	M_BO_TB_1																			
<34>	M_ME_TD_1			X																
<35>	M_ME_TE_1			X																
<36>	M_ME_TF_1			X																
<37>	M_IT_TB_1			X												X				
<38>	M_EP_TD_1																			
<39>	M_EP_TE_1																			
<40>	M_EP_TF_1																			
<45>	C_SC_NA_1						X	X			X									
<46>	C_DC_NA_1						X	X			X									
<47>	C_RC_NA_1																			
<48>	C_SE_NA_1						X	X			X									
<49>	C_SE_NB_1						X	X			X									

Type identification		Cause of Transmission																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	20 to 36	37 to 41	44	45	46	47
<50>	C_SE_NC_1						X	X			X									
<51>	C_BO_NA_1																			
<58>	C_SC_TA_1						X	X			X									
<59>	C_DC_TA_1						X	X			X									
<60>	C_RC_TA_1																			
<61>	C_SE_TA_1						X	X			X									
<62>	C_SE_TB_1						X	X			X									
<63>	C_SE_TC_1						X	X			X									
<64>	C_BO_TA_1																			
<70>	M_EI_NA_1				X															
<100>	C_IC_NA_1						X	X			X									
<101>	C_CI_NA_1																			
<102>	C_RD_NA_1																			
<103>	C_CS_NA_1						X	X												
~~<104>~~	~~C_TS_NA_1~~																			
<105>	C_RP_NA_1						X	X												
~~<106>~~	~~C_CD_NA_1~~																			
<110>	P_ME_NA_1						X	X												
<111>	P_ME_NB_1																			
<112>	P_ME_NC_1																			
<113>	P_AC_NA_1																			
<120>	F_FR_NA_1																			
<121>	F_SR_NA_1																			
<122>	F_SC_NA_1																			
<123>	F_LS_NA_1																			
<124>	F_AF_NA_1																			
<125>	F_SG_NA_1																			
<126>	F_DR_TA_1 a)																			

a) Blank or X only.

7.3.5 Basic application functions

Station initialization

(Station-specific parameter, mark with an "**X**" if function is used).

[X] Remote initialization

Cyclic data transmission

(Station-specific parameter, mark with an "**X**" if function is used only in the standard direction, "**R**" if used only in the reverse direction, and "**B**" if used in both directions).

[X] Cyclic data Transmission

Read Procedure

(Station-specific parameter, mark with an "**X**" if function is used only in the standard direction, "**R**" if used only in the reverse direction, and "**B**" if used in both directions).

[X] Read procedure

Spontaneous transmission

(Station-specific parameter, mark with an "**X**" if function is used only in the standard direction, "**R**" if used only in the reverse direction, and "**B**" if used in both directions).

[X] Spontaneous transmission

Double transmission of information objects with cause of transmission spontaneous

(Station-specific parameter, mark each information type with an "**X**" where both a type ID without time and corresponding type ID with time are issued in response to a single spontaneous change of a monitored object).

The following type identifications may be transmitted in succession because of a single status change of an information object. The particular information object addresses for which double transmission is enabled are defined in a project-specific list.

[ ] Single-point information M_SP_NA_1, ~~M_SP_TA_1~~, M_SP_TB_1 and M_PS_NA_1

[ ] Double-point information M_DP_NA1, ~~M_DP_TA_1~~ and M_DP_TB_1

[ ] Step position information M_ST_NA_1, ~~M_ST_TA_1~~ and M_ST_TB_1

[ ] Bitstring of 32 bit M_BO_NA_1, ~~M_BO_TA_1~~ and M_BO_TB_1 (if defined for a specific project, see 7.2.1.1)

[ ] Measured value, normalized value M_ME_NA_1, ~~M_ME_TA_1~~, M_ME_ND_1 and M_ME_TD_1

[ ] Measured value, scaled value M_ME_NB_1, ~~M_ME_TB_1~~ and M_ME_TE_1

[ ] Measured value, short floating point number M_ME_NC_1, ~~M_ME_TC_1~~ and M_ME_TF_1

Station interrogation

(Station-specific parameter, mark with an "**X**" if function is used only in the standard direction, "**R**" if used only in the reverse direction, and "**B**" if used in both directions).

[X] global		
[X] group 1	[X] group 7	[X] group 13
[X] group 2	[X] group 8	[X] group 14
[X] group 3	[X] group 9	[X] group 15
[X] group 4	[X] group 10	[X] group 16
[X] group 5	[X] group 11	
[X] group 6	[X] group 12	

Clock synchronization

(Station-specific parameter, mark with an "**X**" if function is used only in the standard direction, "**R**" if used only in the reverse direction, and "**B**" if used in both directions).

- [X] Clock synchronization
- [ ] Day of week used
- [ ] RES1, GEN (time tag substituted/ not substituted) used
- [ ] SU-bit (summertime) used

Command transmission

(Object-specific parameter, mark with an "**X**" if function is used only in the standard direction, **R**" if used only in the reverse direction, and "**B**" if used in both directions).

- [X] Direct command transmission
- [X] Direct set point command transmission
- [X] Select and execute command
- [X] Select and execute set point command
- [X] C_SE ACTTERM used (optional)
- [X] No additional definition
- [ ] Short-pulse duration (duration determined by a system parameter in the controlled station)
- [ ] Long-pulse duration (duration determined by a system parameter in the controlled station)
- [X] Persistent output
- [ ] Supervision of maximum delay of command direction of commands and set point commands
- [ ] Maximum (60s) allowable delay of commands and set point commands

ACTTERM respond

When this parameter is activated the IEC 60870-5-104 server will send automatically an "activation confirmation" (COT 7) or "deactivation confirmation" (COT 9) after the receipt of an "activation" (COT 6) or "deactivation" (COT 8) command.

Transmission of integrated totals

(Station- or object-specific parameter, mark with an "**X**" if function is used only in the standard direction, "**R**" if used only in the reverse direction, and "**B**" if used in both directions)

- [ ] Mode A: local freeze with spontaneous transmission
- [ ] Mode B: local freeze with counter interrogation
- [ ] Mode C: freeze and transmit by counter interrogation commands
- [X] Mode D: freeze by counter-interrogation command, frozen values reported
- [X] Counter read
- [X] Counter freeze without reset
- [X] Counter freeze with reset
- [X] Counter reset
- [X] General request counter
- [X] Request counter group 1
- [X] Request counter group 2
- [X] Request counter group 3
- [X] Request counter group 4

Parameter loading

(Object-specific parameter, mark with an "**X**" if function is used only in the standard direction, "**R**" if used only in the reverse direction, and "**B**" if used in both directions).

- [ ] Threshold value
- [ ] Smoothing factor
- [ ] Low limit for transmission of measured value
- [ ] High limit for transmission of measured value

Parameter activation

(Object-specific parameter, mark with an "**X**" if function is used only in the standard direction, **R**" if used only in the reverse direction, and "**B**" if used in both directions).

- [ ] Act/deact of persistent cyclic or periodic transmission of the addressed object

Test procedure

(Station-specific parameter, mark with an "**X**" if function is used only in the standard direction, "**R**" if used only in the reverse direction, and "**B**" if used in both directions).

[X] Test procedure

File transfer

(Station-specific parameter, mark with an "**X**" if function is used).

File transfer in monitor direction:

[ ] Transparent file
[ ] Transmission of disturbance data of protection equipment
[ ] Transmission of sequences of events
[ ] Transmission of sequences of recorded analogue values

File transfer in control direction:

[ ] Transparent file

Background scan

(Station-specific parameter, mark with an "**X**" if function is used only in the standard direction, "**R**" if used only in the reverse direction, and "**B**" if used in both directions).

[ ] Background scan

Acquisition of transmission delay

(Station-specific parameter, mark with an "**X**" if function is used only in the standard direction, "**R**" if used only in the reverse direction, and "**B**" if used in both directions).

[■] ~~Acquisition of transmission delay~~

Definition of time outs

Parameter	Default value	Remarks	Selected value	Range
t_0	30 s	Time-out of connection establishment		1 to 255 second(s)
t_1	15 s	Time-out of send or test APDUs		1 to 255 second(s)
t_2	10 s	Time-out for acknowledges in case of no data messages $t_2 < t_1$		1 to 255 second(s)
t_3	20 s	Time-out for sending test frames in case of a long idle state		1 to 172800 second(s) (1 second to 48 hours)

Maximum number of outstanding I format APDUs k and latest acknowledge APDUs (w)

Parameter	Default value	Remarks	Selected value

k	12 APDUs	Maximum difference receive sequence number to send state	
w	8 APDUs	Maximum difference receive sequence number to send state	

Maximum range of values k: 1 to 32767 (215–1) APDUs, accuracy 1 APDU
Maximum range of values w: 1 to 32767 APDUs, accuracy 1 APDU (Recommendation: w should not exceed two-thirds of k).

Port Number

Parameter	Default value	Remarks
Port number	2404	In all cases (1 to 65535)

RFC 2200 suite

RFC 2200 is an official Internet Standard which describes the state of standardization of the protocols used in the Internet as determined by the Internet Architecture Board (IAB). It offers a broad spectrum of actual standards used in the Internet. The suitable selection of documents from RFC 2200 defined in this standard for given projects has to be chosen by the user of this standard.

[X] Ethernet 802.3
[ ] Serial X.21 interface
[ ] Other selection from RFC

Limitations of connections

TCP accept max number of connection.
The valid value is from 1 to 5, default value is 2.

ATOP Technologies, Inc.

www.atoponline.com

TAIWAN HEADQUARTERS

2F, No. 146, Sec. 1, Dongxing Rd.,
Zhubei City, Hsinchu County,
302058, Taiwan, R.O.C.
Tel: +886-3-550-8137
E-mail: info@atop.com.tw
Fax: +886-3-550-8131

ATOP CHINA BRANCH

Sam Xia
3F, 75th, No. 1066 Building,
Qingzhou North Road,
Shanghai, China
Tel: +86-21-64956231
E-mail: info@atop.com.tw

ATOP JAPAN OFFICE

易傑 Takashi Eki
東京都千代田区丸の内 1-1-3
日本生命丸の内ガーデンタワー3F
Tel: +81-3-4530-3390
E-mail: eki@atop.com.tw

ATOP INDIA OFFICE & GLOBAL INQUIRIES

Prashant Mishra
No.3M-217, East of NGEF Layout, Kasturi Nagar,
Bengaluru- 560043, Karnataka, India
Tel: +91-80-492-06308
E-mail: prashant.m@atop.com.tw

ATOP INDONESIA OFFICE

Jopson Li
Wisma Slipi, Kav. 12 Lt. 3 Unit 308
Jl. Let. Jend. S. Parman 11480 - Indonesia
Tel: +6221-5326171
E-mail: jopsonli@atop.com.tw

ATOP COLOMBIA OFFICE

Brenda Solano Sarmiento
Calle 35 No. 19 - 41 - Oficina 315 Torre Norte,
Bucaramanga, Santander, Colombia
Tel: +57 322 848 9815
E-mail: Brenda.solano@atop.com.tw