Protocol Gateway
IEC60870-5-103 Master/Slave

Protocol and
eNode Designer configuration

eNode Configuration Manual
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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. All other product’s names referenced herein are registered trademarks of their respective companies.

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# IEC 60870-5-103 User Manual

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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-60870-5-103 master/slave and describes how to use the IEC-60870-5-103 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 3 major sections:

- General Description;
- Configuration Guide; and
- Interoperability

1.2 Document Reference

Revision: Version 1.00


1.3 List of Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADH</td>
<td>Application Data Hub</td>
</tr>
<tr>
<td>IEC</td>
<td>International Electrotechnical Commission</td>
</tr>
<tr>
<td>IED</td>
<td>Intelligent Electronic Device</td>
</tr>
</tbody>
</table>
2 General Description

The IEC 60870-5-103 eNode Module can be used to configure the IEC 60870-5-103 ADH Application as a master or slave. For naming consistency across eNode Designer, the master is called a client, and the slave is called a server.

The client can communicate with many servers, whose data point details can be configured using this module. Atop's Protocol Gateway supports one server/slave per protocol per device.

2.1 IEC 60870-5-103 Standard

IEC 60870-5-103 is an international standard, released by IEC(International Electrotechnical Commission), used for telecontrol (supervisory control and data acquisition) in electrical engineering and power system automation applications.

This manual assumes that reader has some basic knowledge of the IEC 60870 standard documents and the IEC 60870-5-103 protocol.

<table>
<thead>
<tr>
<th>IEC 60870 Document Part</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEC 60870-5-1</td>
<td>Transmission Frame Formats</td>
</tr>
<tr>
<td>IEC 60870-5-2</td>
<td>Data Link Transmission Services</td>
</tr>
<tr>
<td>IEC 60870-5-3</td>
<td>General Structure of Application Data</td>
</tr>
<tr>
<td>IEC 60870-5-4</td>
<td>Definition and Coding of Information Elements</td>
</tr>
<tr>
<td>IEC 60870-5-5</td>
<td>Basic Application Functions</td>
</tr>
<tr>
<td>IEC 60870-5-6</td>
<td>Guidelines for conformance testing for the IEC 60870-5 companion standards</td>
</tr>
<tr>
<td>IEC 60870-5-103</td>
<td>Transmission Protocols, companion standard for the informative interface of protection equipment</td>
</tr>
</tbody>
</table>

2.2 ISO/OSI of IEC 60870-5-103

<table>
<thead>
<tr>
<th>Data Unit</th>
<th>Layer</th>
<th>Functional</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data</td>
<td>7. Application Layer</td>
<td>IEC 60870-5-4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IEC 60870-5-5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IEC 60870-5-103 standard</td>
</tr>
<tr>
<td></td>
<td>6. Presentation Layer</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>5. Session Layer</td>
<td>N/A</td>
</tr>
<tr>
<td>Segments</td>
<td>4. Transport Layer</td>
<td>N/A</td>
</tr>
</tbody>
</table>
### 2.3 Configuration Theory

Most configuration properties describe a server. When configuring the ADH application server, you are configuring the properties of the server itself. When configuring the ADH application client, you are describing the properties of all the remote servers with which the client is communicating.

Configuring the protocol specific information (such as object addressing) is handled in the module. This is explained in this document.

Communication port properties (such as Baud Rate) are configured on the communication port itself. The Device module handles the communication port properties, so heavy details are outside the scope of this document. Port configuration instructions are provide in the eNode Designer general user manual. However, screenshots of the typical configuration method are shown in section 4.
2.4 General Screen Description

A small configuration example is shown below to better help describe the layout of the screen.

![Example screen diagram](image)

**Figure 2-1 - Example screen.**

1. **Tabs** – There is one single “Settings” tab in both client and server. The server is allocated to a single tab. The client may communicate with many servers of different protocols, so there may be many server tabs. In a server application, there is only one server tab that is used to describe the properties of the local server itself.

2. **Server IED Properties** – Describes the protocol-specific properties of the server IED.

3. **Data Table and buttons** – Shows all (information) data associated with the IED, and buttons used to modify them.

4. **Commands Table and buttons** – Shows all commands associated with the IED, and buttons used to modify them.

The user is able to add, delete and organise data points using buttons. The user may also edit the contents of the data and command tables freely after points are created.

Each tab is named “IED \{X\}: \{Y\}” where \(X\) is the link address and \(Y\) is the common address.
3 IEC60870-5-103 Configuration Guide

3.1 Adding the Module in eNode Designer

The IEC 60870-5-103 module can be added to Serial ports only.

The application can be set up as a Client or a Server. The choice will be presented when adding it to the project.

![Image of adding the module in eNode Designer]

Figure 3-1 - Adding the module in eNode Designer.

1. Right click the desired communication port.
2. Open the Add ADH Application menu.
4. Select Client or Server from the drop-down menu.
5. Click OK.

3.2 Server IED Properties

The server IED properties are at the top of the module screen. It has a single configurable item: the common address of the slave.
### 3.2.1.1 Common Address

<table>
<thead>
<tr>
<th>Description</th>
<th>The common address of the server (slave) IED. For server application it describes its own common address. For clients, it describes the common address of the remote server.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Entry</td>
<td>Integer</td>
</tr>
<tr>
<td>Range</td>
<td>0 to 255</td>
</tr>
<tr>
<td>Input Option</td>
<td>Mandatory</td>
</tr>
</tbody>
</table>
3.3 Client Configuration

Adding a client application will immediately show the following figure. The first tab shows the settings that apply to the whole client application. Each tab after this represents a single IEC 60870-5-103 server with which the client is communicating.

![Client settings panel](image)

**Figure 3-2 - Client settings panel.**

Selecting the IED tab will show the following view.

![Client IED panel](image)

**Figure 3-3 - Client IED panel.**

Here the “Add” and “+1” button can be used to add data points. Adding data points is explained in the “Add data points” section, and the other buttons are described in section 7: Reference Guide.
### 3.3.1 Client Settings

Listed below are details about each client setting.

#### 3.3.1.1 Link Address

<table>
<thead>
<tr>
<th>Description</th>
<th>The link address address to use.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Entry</td>
<td>Integer</td>
</tr>
<tr>
<td>Range</td>
<td>0 to 255</td>
</tr>
<tr>
<td>Input Option</td>
<td>Mandatory</td>
</tr>
</tbody>
</table>

#### 3.3.1.2 Link Layer Timeout (ms)

<table>
<thead>
<tr>
<th>Description</th>
<th>The timeout for a data link layer confirmation in milliseconds.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Entry</td>
<td>Integer</td>
</tr>
<tr>
<td>Range</td>
<td>100 to 65535</td>
</tr>
<tr>
<td>Input Option</td>
<td>Mandatory</td>
</tr>
</tbody>
</table>

#### 3.3.1.3 Station Initialisation

<table>
<thead>
<tr>
<th>Description</th>
<th>The option to use in the station initialisation (reset communications) command. CU = Communications unit, FCB = Frame count bit.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Entry</td>
<td>Drop down menu</td>
</tr>
<tr>
<td>Options</td>
<td>Reset CU, Reset FCB</td>
</tr>
<tr>
<td>Input Option</td>
<td>Mandatory</td>
</tr>
</tbody>
</table>

#### 3.3.1.4 Time Sync Interval (s)

<table>
<thead>
<tr>
<th>Description</th>
<th>The interval that the time synchronisation commands are sent, in seconds.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Entry</td>
<td>Integer</td>
</tr>
<tr>
<td>Range</td>
<td>1 to 65535. Default: 3600</td>
</tr>
<tr>
<td>Input Option</td>
<td>Mandatory</td>
</tr>
</tbody>
</table>

#### 3.3.1.5 General Interrogation Interval (s)

<table>
<thead>
<tr>
<th>Description</th>
<th>The interval that general interrogation commands are sent, in seconds.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Entry</td>
<td>Integer</td>
</tr>
<tr>
<td>Range</td>
<td>0 to 65535</td>
</tr>
<tr>
<td>Input Option</td>
<td>Mandatory</td>
</tr>
</tbody>
</table>

#### 3.3.1.6 Poll Class Interval (ms)

<table>
<thead>
<tr>
<th>Description</th>
<th>The interval at which the classes are polled, in milliseconds.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Entry</td>
<td>Integer</td>
</tr>
<tr>
<td>Range</td>
<td>0 to 65535</td>
</tr>
<tr>
<td>Input Option</td>
<td>Mandatory</td>
</tr>
</tbody>
</table>
### 3.3.1.7 Command Timeout (ms)

<table>
<thead>
<tr>
<th>Description</th>
<th>The timeout to wait for a command to complete, in milliseconds.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Entry</td>
<td>Integer</td>
</tr>
<tr>
<td>Range</td>
<td>0 to 65535</td>
</tr>
<tr>
<td>Input Option</td>
<td>Mandatory</td>
</tr>
</tbody>
</table>
3.3.2 Adding Data Points

To add data points, left click the "Add" button beneath the tables in the main view. Doing so will show the following window. The window is used to add many data points at once with the specified values. For details on the meaning of each column, see section 7.2.

![Add Data Points Window](image)

Figure 3-4 - Add data points window.

1. **Preview Area** – Shows the preview of the data points that will be added.
2. **New values** – This area is used to enter values. Tag and description use manual data entry (click the box and type new values). Data type and class use drop-down menus.
3. **Number of rows** – This counter can be used to add many data points at once.
4. **Auto-increment** – Chooses what increment type to use in each successive row.
   - **None** – No increments in any row
   - **Information Number** – Increments the information number by one per row
   - **Data Object** – Increments the data object by one per row. When no more data objects for that information number exist, the next information number is used and the data object index resets to the first item.
5. **Counters** – The starting values and step values of counters can be set in this area. Counters are used in the input areas resulting in the substituted values appearing in the preview area. See also 5 Using Counters.
6. **OK button** – to accept the new data points.
3.3.2.1  Add a Single Data Point

A single data point can be added at a time using the “+1” button beneath the desired table. Clicking “+1” will copy the information of the selected row, and automatically increase the address field to the next unused address. This means increasing the data object, or if the data object is at the last value, it increases the information number and uses the first data object in the new information number. This process continues until it finds an unused address.

---

**Figure 3-5 - Adding a single data point with +1 button.**

1. (Optional) **Select the data point to copy.** Using no selection will just add a default data point.
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. A new point has been added. You may want to change the tags, descriptions etc. as required.
3.3.3 Connected Servers (Remote IEDs)

Each slave IED is represented by a single tab and a tree node in the eNode Designer project tree.

![eNode Designer](image)

Figure 3-6 - Multiple connected servers example.

To modify the connected IEDs list follow the instructions below:

1. **To add** a new remote IED, click the "+" tab at the end of the list of existing remote servers.

![Add a connected server](image)

Figure 3-7 - Add a connected server.

To remove a remote IED, it must have no data points specified. If there are data points in the table and you still wish to remove the IED, you will have to remove such data points first.

1. **To remove** a remote IED, click the cross on the right side of the tab of the IED you wish to remove.

![Remove a connected server](image)

Figure 3-8 - Remove a connected server.
3.4 **Server Configuration**

A server application outputs data from the ADH database, receives commands and passes them into the ADH system to command another application to perform the operation. Therefore, all server operations use data point references to already existing data points that have been created by other application clients or client-servers.

The options describe the local server itself. The settings tab can be used to set the local settings, while the IED tab is used to configure data points and appears similar to the client. Example figures of both are shown below.

![Server settings panel](image)

**Figure 3-9 - Server settings panel.**

![Server IED panel](image)

**Figure 3-10 – Server IED panel.**

Here the "Add Reference" button can be used to add data point references. The procedure is explained fully in the next section. The other buttons are described in section 7: Reference Guide.
### 3.4.1 Server Settings

All server settings are explained in the headings below.

#### 3.4.1.1 Link Address

<table>
<thead>
<tr>
<th>Description</th>
<th>The link address to use.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Entry</td>
<td>Integer</td>
</tr>
<tr>
<td>Range</td>
<td>0 to 255 (default 1)</td>
</tr>
<tr>
<td>Input Option</td>
<td>Mandatory</td>
</tr>
</tbody>
</table>

#### 3.4.1.2 Common Address

<table>
<thead>
<tr>
<th>Description</th>
<th>The common address to use.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Entry</td>
<td>Integer</td>
</tr>
<tr>
<td>Range</td>
<td>0 to 255 (default 1)</td>
</tr>
<tr>
<td>Input Option</td>
<td>Mandatory</td>
</tr>
</tbody>
</table>

#### 3.4.1.3 Link Layer Timeout (ms)

<table>
<thead>
<tr>
<th>Description</th>
<th>The timeout for a data link layer confirmation in milliseconds.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Entry</td>
<td>Integer</td>
</tr>
<tr>
<td>Range</td>
<td>100 to 65535 (default 1000)</td>
</tr>
<tr>
<td>Input Option</td>
<td>Mandatory</td>
</tr>
</tbody>
</table>

#### 3.4.1.4 Command Timeout (ms)

<table>
<thead>
<tr>
<th>Description</th>
<th>The timeout for a command in milliseconds.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Entry</td>
<td>Integer</td>
</tr>
<tr>
<td>Range</td>
<td>100 to 10000 (default 3000)</td>
</tr>
<tr>
<td>Input Option</td>
<td>Mandatory</td>
</tr>
</tbody>
</table>

#### 3.4.1.5 Class {X} Event Buffer Size

<table>
<thead>
<tr>
<th>Description</th>
<th>The buffer size for class {X}: the maximum number of events to store.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Entry</td>
<td>Integer</td>
</tr>
<tr>
<td>Range</td>
<td>0 - 65535</td>
</tr>
<tr>
<td>Input Option</td>
<td>Mandatory</td>
</tr>
</tbody>
</table>

#### 3.4.1.6 Class {X} Event Buffer Overflow Percentage

<table>
<thead>
<tr>
<th>Description</th>
<th>If the buffer for class {X} fills to this percent full, a buffer overflow event is sent to the master station.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Entry</td>
<td>Integer</td>
</tr>
<tr>
<td>Range</td>
<td>0-100. Recommended 50-95. Default: 90</td>
</tr>
<tr>
<td>Input Option</td>
<td>Mandatory</td>
</tr>
</tbody>
</table>
3.4.2 Adding Data Point References

To add new data point references, left click the “Add Reference” button underneath the tables in the main view. This will bring up the Add References window defined by the eNode Designer main application. It should appear similar to the following figure. Here we are adding references to data points created by an IEC 60870-5-104 client.

![Add new references window.](image)

**Figure 3-11 - Add new references window.**

1. **Select Data Points** – Adding a reference to a point creates a “mapping” to that point. Select which data points the server application is interested in using.

2. Left click OK when done to accept the new references.

The data points that will appear in the list and that will be available for mapping are those whose data point type is compatible with the IEC 60870-5-103 application. For the table matching IEC 60870-5-103 data types to ADH types, see section 7.3.
After the new points have been added, you can modify the data points directly in the table. Cyclic transmission time is a normal typed field, while the others use drop-down menus that are restricted based on which IEC 60870-5-103 types are valid for the ADH data point type. For example, 2-bit values can only be mapped to type IDs which have a 2-bit data type in the data object list: the protocol's "DPI" type.

![Data type restricted drop down menu example](image)

A “complete” example is shown below.

![Server data point configuration example](image)
3.5 Miscellaneous Common

3.5.1 Incomplete, Conflicting and not needed Information

Incomplete or conflicting information is shown in red. This will cause warning symbols on the tab and in the project tree. Hovering over the warning icons will show further details about what is causing the warning. This allows the user to quickly fix invalid information.

![Figure 3-15 – Incomplete and missing information example.](image)

1. **Mouse-over a warning** to show a tooltip explaining the warning.
2. **Invalid data** shows in red. The dark red color means the data is invalid, and the light red color means there is an address conflict.
3. **Unneeded data** is hidden and not editable. For example, the Cyclic transmission time is only used for Measurand types. So, non-measurand points have these table cells with a grey background, have no contents and cannot be edited.
3.5.2 Modify Selected Points Window

The "Modify Selected Points" window is used to change many row properties in one single step.

Select the data points you want to change, and then click the "Modify Selected Points" button beneath the tables. It will generate the following window.

![Figure 3-16 - Modify data points window example.](image)

1. **Original table data** – Shows the original table data.
2. **Preview** – Shows the new table data that will be used if the modifications are accepted. These fields update according to the contents of (3).
3. **New values** – The new values for the table cells. "[N]" can be used to maintain the original value of the cell, and the auto-incrementing counters [X], [Y] and [Z] can be used to add numbers. For details, see Using Counters.
4. **Auto-increment**: Chooses what increment type to use in each successive row.
   - **None** – No increments in any row
   - **Information Number** – Increments the information number by one per row
   - **Data Object** – Increments the data object by one per row. When no more data objects for that information number exist, the next information number is used and the data object index resets to the first item.
5. **Counter properties** – Sets the initial values and step amounts of the counters [X], [Y] and [Z].
6. **OK button** – to accept the modifications.
4 Communication Port Properties

The device module handles how the communication port properties are displayed. However, the typical method is briefly described below.

![Diagram of eNode Designer showing serial port properties]

**Figure 4-1 - Serial port properties.**

1. **Select the communication port in the project tree** – This will typically let the central panel show the port’s properties.

2. **Properties** – The communication port’s properties can be set.
The following is a full example that shows how auto-increment works. The example given shows the IEC 60870-5-104 window. The IEC 60870-5-103 auto-increment works in the same way.

![Image of Add Points window](image)

**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.

   3. In this example, the \[Y\] counter has been used with the integer 4 to indicate the number structure. This results in the values shown in the preview section.

   4. In this example, the \[Z\] counter has been used. The **Start At** and **Step By** values have been left at default, this results in the values shown.

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.). This is an artefact of eNode Designer ensuring all data point tag names are unique.
6 Interoperability

This interoperability list refers to section 8 of the IEC 60870-5-103 International Standard (reference number CEI/IEC 60870-5-103:1997, pages 159 to 171).

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

<table>
<thead>
<tr>
<th></th>
<th>Function or ASDU is not used</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐</td>
<td>Function or ASDU is used as standardized (default)</td>
</tr>
<tr>
<td>❌</td>
<td>Function or ASDU is not supported</td>
</tr>
<tr>
<td>☑</td>
<td>Function or ASDU is used in reverse mode</td>
</tr>
<tr>
<td>☑</td>
<td>Function or ASDU supported in addition to the standard</td>
</tr>
</tbody>
</table>

6.1 Physical layer

6.1.1 Electrical Interface

☑ EIA RS-485
☐ Number of loads _____ for one protection equipment
☑ RS-232
☑ RS-422

6.1.2 Optical Interface

☐ Glass fibre
☐ Plastic fibre
☐ F-SMA type connector
☐ BFOC/2.5 type connector

6.1.3 Transmission speed

☑ 300 bit/s  ☑ 9600 bit/s  ☑ 57600 bit/s
☑ 1200 bit/s  ☑ 14400 bit/s  ☑ 115200 bit/s
☑ 2400 bit/s  ☑ 19200 bit/s  ☑ 230400 bit/s
☑ 4800 bit/s  ☑ 38400 bit/s
6.2 Link Layer

There are no choices for the link layer.

6.3 Application Layer

6.3.1 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.

6.3.2 Common address of ASDU

- One COMMON ADDRESS OF ASDU (identical with station address)
- More than one COMMON ADDRESS OF ASDU

6.3.3 Selection of standard information numbers in monitor direction

6.3.3.1 System functions in monitor direction

INF Semantics
- <0> End of general interrogation
- <0> Time synchronization
- <2> Reset FCB
- <3> Reset CU
- <4> Start/restart
- <5> Power on

6.3.3.2 Status indications in monitor direction

INF Semantics
- <16> Auto-recloser active
- <17> Teleprotection active
- <18> Protection active
- <19> LED reset
- <20> Monitor direction blocked
- <21> Test mode
- <22> Local parameter setting
- <23> Characteristic 1
- <24> Characteristic 2
- <25> Characteristic 3
- <26> Characteristic 4
- <27> Auxiliary input 1
- <28> Auxiliary input 2
6.3.3.3 *Supervision indications in monitor direction*

**INF** Semantics

- <32> Measurand supervision I
- <33> Measurand supervision V
- <35> Phase sequence supervision
- <36> Trip circuit supervision
- <37> I>> back-up operation
- <38> VT fuse failure
- <39> Teleprotection disturbed
- <46> Group warning
- <47> Group alarm

6.3.3.4 *Earth fault indications in monitor direction*

**INF** Semantics

- <48> Earth fault L1
- <49> Earth fault L2
- <50> Earth fault L3
- <51> Earth fault forward, i.e. line
- <52> Earth fault reverse, i.e. busbar

6.3.3.5 *Fault indications in monitor direction*

**INF** Semantics

- <64> Start /pick-up L1
- <65> Start /pick-up L2
- <66> Start /pick-up L3
- <67> Start /pick-up N
- <68> General trip
- <69> Trip L1
- <70> Trip L2
- <71> Trip L3
- <72> Trip I>> (back-up operation)
- <73> Fault location X in ohms
- <74> Fault forward/line
- <75> Fault reverse/busbar
- <76> Teleprotection signal transmitted
- <77> Teleprotection signal received
- <78> Zone 1
- <79> Zone 2
- <80> Zone 3
- <81> Zone 4
- <82> Zone 5
- <83> Zone 6
- <84> General start/pick-up
- <85> Breaker failure
- <86> Trip measuring system L1
- <87> Trip measuring system L2
- <88> Trip measuring system L3
- <89> Trip measuring system E
- <90> Trip I>
6.3.3.6  Auto-reclosure indications in monitor direction

INF  Semantics
☒  <128>  CB ‘on’ by AR
☒  <129>  CB ‘on’ by long-time AR
☒  <130>  AR blocked

6.3.3.7  Measurands in monitor direction

INF  Semantics
☒  <144>  Measurand I
☒  <145>  Measurands I, V
☒  <146>  Measurands I, V, P, Q
☒  <147>  Measurands IN, VEN
☒  <148>  Measurands IL1,2,3, VL1,2,3, P, Q, f

6.3.3.8  Generic functions in monitor direction

INF  Semantics
☐  <240>  Read headings of all defined groups
☐  <241>  Read values or attributes of all entries of one group
☐  <243>  Read directory of a single entry
☐  <244>  Read value or attribute of a single entry
☐  <245>  End of general interrogation of generic data
☐  <249>  Write entry with confirmation
☐  <250>  Write entry with execution
☐  <251>  Write entry aborted

6.3.4  Selection of standard information numbers in control direction

6.3.4.1  System functions in control direction

INF  Semantics
☒  <0>  Initiation of general interrogation
☒  <0>  Time synchronization

6.3.4.2  General commands in control direction

INF  Semantics
☒  <16>  Auto-recloser on/off
☒  <17>  Teleprotection on/off
☒  <18>  Protection on/off
☒  <19>  LED reset
☒  <23>  Activate characteristic 1
- <24> Activate characteristic 2
- <25> Activate characteristic 3
- <26> Activate characteristic 4

### 6.3.4.3 General functions in control direction

<table>
<thead>
<tr>
<th>INF</th>
<th>Semantics</th>
</tr>
</thead>
<tbody>
<tr>
<td>240</td>
<td>Read headings of all defined groups</td>
</tr>
<tr>
<td>241</td>
<td>Read values or attributes of all entries of one group</td>
</tr>
<tr>
<td>243</td>
<td>Read directory of a single entry</td>
</tr>
<tr>
<td>244</td>
<td>Read value or attribute of a single entry</td>
</tr>
<tr>
<td>245</td>
<td>End of general interrogation of generic data</td>
</tr>
<tr>
<td>248</td>
<td>Write entry</td>
</tr>
<tr>
<td>249</td>
<td>Write entry with confirmation</td>
</tr>
<tr>
<td>250</td>
<td>Write entry with execution</td>
</tr>
<tr>
<td>251</td>
<td>Write entry abort</td>
</tr>
</tbody>
</table>

### 6.3.5 Basic application functions

- Test mode
- Blocking of monitor direction
- Disturbance data
- Generic services
- Private data

### 6.3.6 Miscellaneous

Measurands are transmitted with ASDU 3 as well as with ASDU 9. As defined in 7.2.6.8, the maximum MVAL can either be 1,2 or 2,4 times the rated value. No different rating shall be used in ASDU 3 and ASDU 9, i.e. for each measurand there is only one choice.

<table>
<thead>
<tr>
<th>Measurand</th>
<th>Max. MVAL = rated value times 1,2</th>
<th>Max. MVAL = rated value times 2,4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current L1</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Current L2</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Current L3</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Voltage L1-E</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Voltage L2-E</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Voltage L3-E</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Active power P</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Reactive power Q</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Frequency f</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Voltage L1 – L2</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>
7 Reference Guide

7.1 Table Buttons

Client Options:

<table>
<thead>
<tr>
<th>Button</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Add</td>
<td>Adds new data points in the client. See section 3.3.2.</td>
</tr>
<tr>
<td>+1</td>
<td>Adds a single new data point in the client. See section 3.3.2.1.</td>
</tr>
<tr>
<td>Add Reference</td>
<td>Adds a new data point reference in the server. See section 3.4.2.</td>
</tr>
<tr>
<td>Delete</td>
<td>Deletes the selected data points.</td>
</tr>
<tr>
<td>Modify Selected Points</td>
<td>Modify the properties of the selected data points. See section 3.5.2.</td>
</tr>
<tr>
<td>Move Up</td>
<td>Moves the selected data points up one row in the table.</td>
</tr>
<tr>
<td>Move Down</td>
<td>Moves the selected data points down one row in the table.</td>
</tr>
<tr>
<td>Sort</td>
<td>Sorts the table. Groups by Type ID, Function Type, Information Number, Data Object.</td>
</tr>
</tbody>
</table>

Server Options:

<table>
<thead>
<tr>
<th>Button</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Add Reference</td>
<td>Adds a new data point reference in the server. See section 3.4.2.</td>
</tr>
<tr>
<td>Delete</td>
<td>Deletes the selected data points.</td>
</tr>
<tr>
<td>Modify Selected Points</td>
<td>Modify the properties of the selected data points. See section 3.5.2.</td>
</tr>
<tr>
<td>Move Up</td>
<td>Moves the selected data points up one row in the table.</td>
</tr>
<tr>
<td>Move Down</td>
<td>Moves the selected data points down one row in the table.</td>
</tr>
<tr>
<td>Sort</td>
<td>Sorts the table. Groups by Type ID, Function Type, Information Number, Data Object.</td>
</tr>
</tbody>
</table>

7.2 Table Columns

7.2.1.1 Tag

<table>
<thead>
<tr>
<th>Description</th>
<th>A unique Tag name for each data point. Since data point references use the tag name of the “real” point, the tag cannot be changed in the server instance.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Entry</td>
<td>String</td>
</tr>
<tr>
<td>Min Length</td>
<td>1</td>
</tr>
<tr>
<td>Max Length</td>
<td>N/A</td>
</tr>
<tr>
<td>Input Option</td>
<td>Mandatory</td>
</tr>
</tbody>
</table>

7.2.1.2 Description

<table>
<thead>
<tr>
<th>Description</th>
<th>User defined description for each data point. Since data point references use the description of the “real” point, the description cannot be changed in the server instance.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Entry</td>
<td>String</td>
</tr>
<tr>
<td>Min Length</td>
<td>1</td>
</tr>
<tr>
<td>Max Length</td>
<td>N/A</td>
</tr>
<tr>
<td>Input Option</td>
<td>Mandatory</td>
</tr>
</tbody>
</table>

7.2.1.3 Function Type

<table>
<thead>
<tr>
<th>Description</th>
<th>The IEC 60870-5-103 function type.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Entry</td>
<td>Drop Down Menu</td>
</tr>
</tbody>
</table>
7.2.1.4 Type ID

The IEC 60870-5-103 Type ID. This can be used to restrict the available items in shown in the "Information Number" menu.

Data Entry
Drop Down Menu

Types
- Time Tag Message
- Relative Time Tag Message
- Measurands I
- Relative Time Tag Measurands
- Identification
- Measurands II

Input Option
Mandatory

7.2.1.5 Information Number

The IEC 60870-5-103 information number. The drop down menus will only show relevant information numbers for the data point (usually, just shows information numbers with the given type ID).

Data Entry
Drop Down Menu

Types
- Info Reset FCB
- Info Reset CU
- Info Start Restart
- Info Power On
- Auto Recloser Status
- Tele Protection Status
- Protection Status
- Led Reset
- Monitor Direction Blocked
- Test Mode Info
- Local Parameter Setting
- Characteristic 1
- Characteristic 2
- Characteristic 3
- Characteristic 4
- Auxiliary Input 1
- Auxiliary Input 2
- Auxiliary Input 3
- Auxiliary Input 4
- Measurand Supervision I
- Measurand Supervision V
- Phase Sequence Supervision
- Trip Circuit Supervision
- Over I Backup Operation
38  Vt Fuse Failure
39  Teleprotection Disturbed
46  Group Warning
47  Group Alarm
48  Earth Fault L1
49  Earth Fault L2
50  Earth Fault L3
51  Earth Fault Forward
52  Earth Fault Reverse
64  Start Pickup L1
65  Start Pickup L2
66  Start Pickup L3
67  Start Pickup N
68  General Trip
69  Trip L1
70  Trip L2
71  Trip L3
72  Trip Over I Backup
73  Fault Location
74  Fault Forward
75  Fault Reverse
76  Teleprotection Signal Transmitted
77  Teleprotection Signal Received
78  Zone 1
79  Zone 2
80  Zone 3
81  Zone 4
82  Zone 5
83  Zone 6
84  General Start Pickup
85  Breaker Failure
86  Trip Measuring System L1
87  Trip Measuring System L2
88  Trip Measuring System L3
89  Trip Measuring System E
90  Trip I
91  Trip Over I
92  Trip In
93  Trip Over In
128 CB On By AR
129 CB On By Long Time AR
130 Auto Recloser Blocked
144 Measurand I
145 Measurands I V
146 Measurands I V P Q
147 Measurands In Ven
148 Measurands Il123 Vil123 P Q F

=============== Commands ===============
16  Auto Recloser on/off
17  Teleprotection on/off
18  Protection on/off
19  LED Reset
23  Characteristic 1 Activate
24  Characteristic 2 Activate
25  Characteristic 3 Activate
26  Characteristic 4 Activate
| Input Option | Mandatory |
### 7.2.1.6 Data Object

**Description**
The IEC 60870-5-103 data object instance of the information number. The drop down menus will only show data objects relevant to the data point. Usually, this means it will show the data objects given the information number / type ID. Though in application servers, the ADH data point type must also match for it to appear in the list.

**Data Entry**
Drop Down Menu
- DPI: Double point information
- SIN: Supplementary information
- COL: Compatibility level
- SCL: Short circuit location
- FAN: Fault number
- RET: Relative time

**Types**

<table>
<thead>
<tr>
<th>MVAL (Measurand values)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I: Current $I_N$</td>
</tr>
<tr>
<td>I: Current L1</td>
</tr>
<tr>
<td>I: Current L2</td>
</tr>
<tr>
<td>I: Current L3</td>
</tr>
<tr>
<td>V: Voltage $V_{EN}$</td>
</tr>
<tr>
<td>V: Voltage L1-L2</td>
</tr>
<tr>
<td>V: Voltage L1-E</td>
</tr>
<tr>
<td>V: Voltage L2-E</td>
</tr>
<tr>
<td>V: Voltage L3-E</td>
</tr>
<tr>
<td>P: Active power</td>
</tr>
<tr>
<td>Q: Reactive power</td>
</tr>
<tr>
<td>f: Frequency</td>
</tr>
</tbody>
</table>

**Input Option**
Mandatory

### 7.2.1.7 Class

Data only

**Description**
The IEC 60870-5-103 class.

**Data Entry**
Drop down menu

**Options**
- Class 1, Class 2

**Input Option**
Mandatory

### 7.2.1.8 Cyclic Transmission Time (s)

Server, data only

**Description**
Every “cyclic transmission time” amount of time, the Measurand values are sent back to the client. Measured in seconds.

**Data Entry**
Integer

**Types**
0 to 65535

**Input Option**
Mandatory for Measurand types only
7.3  IEC 60870-5-103's Related ADH Types

The IEC 60870-5-103 data types correspond to the ADH types given in the table below.

<table>
<thead>
<tr>
<th>IEC 60870-5-103 Point Type</th>
<th>ADH Data Type</th>
<th>ADH Exchange Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>COL: Compatibility level</td>
<td>Unsigned 8</td>
<td>Data</td>
</tr>
<tr>
<td>DCO: Double point command</td>
<td>Double Point</td>
<td>Command (Single Stage)</td>
</tr>
<tr>
<td>DPI: Double point information</td>
<td>Double Point</td>
<td>Data</td>
</tr>
<tr>
<td>FAN: Fault number</td>
<td>Unsigned 16</td>
<td>Data</td>
</tr>
<tr>
<td>MVAL: Measurand value</td>
<td>Integer 16</td>
<td>Data</td>
</tr>
<tr>
<td>RET: Relative time</td>
<td>Unsigned 16</td>
<td>Data</td>
</tr>
<tr>
<td>SCL: Short circuit location</td>
<td>Float 32</td>
<td>Data</td>
</tr>
<tr>
<td>SIN: Supplementary information</td>
<td>Unsigned 8</td>
<td>Data</td>
</tr>
</tbody>
</table>

Table 7-1 — IEC 60870-5-103 data types relation to ADH data point types.
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