

# CAP 505

## Protocol Mapping Tool

### Operation Manual



**ABB**



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### 1. About this manual

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#### 1.3. General

The Protocol Mapping Tool (PMT) is used to create and edit the protocol mapping configuration, which is a cross-reference table between the application and the communication protocol. This table defines what information can be accessed from the device using the protocol interface. As REM 54\_, REF 54\_, RET 54\_, REC 52\_ and REX 52\_ terminals are programmable devices which may run various application setups (different sets of function blocks), the mapping is also reconfigurable.

The mapping can contain a lot of information the device needs, but which is not necessarily important for viewing and changing from the configuration engineering point of view. Therefore, the mapping will be presented as a list of accessible protocol points instead of a spreadsheet-like table with all the rows and all the attributes.

The Protocol Mapping Tool uses the relay configuration project to create a mapping for a given application. After a mapping has been created, the user can modify it by removing or adding points, changing their order and creating protocol compositions, such as user-defined registers (bit-field and analog) or control structures.

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The whole process of creating the communication interface configuration is presented in Fig. 1.3.-1.

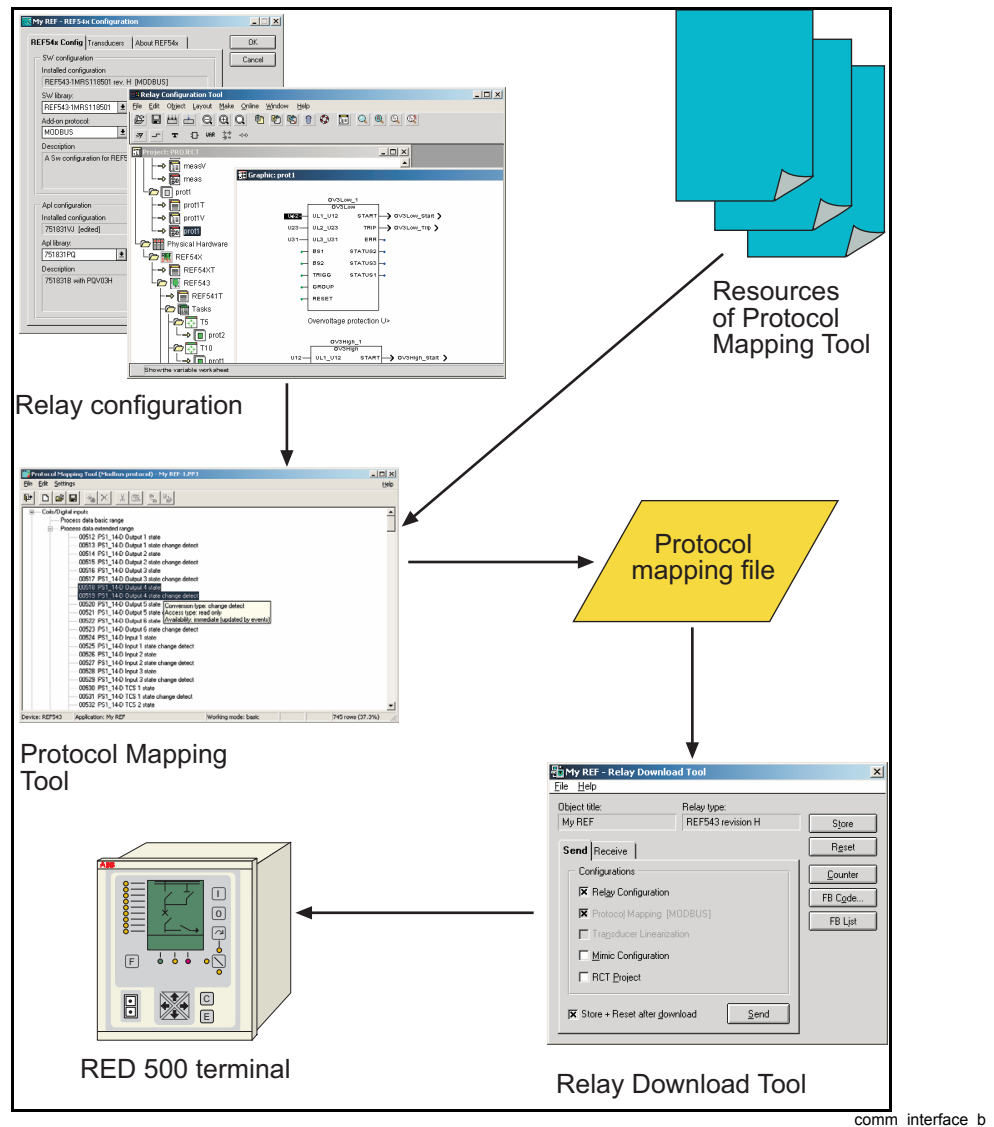


Fig. 1.3.-1 Flow of information during a communication interface creation

### 1.4.

#### Using this manual

This manual describes the functionality of the Protocol Mapping Tool.

Chapter 2. General describes general application concepts such as Protocol Mapping Tool Wizard, Protocol Mapping Tool and the working modes.

Chapter 3. Quick start reference contains a step-by-step description on how to create a protocol mapping and how to activate an add-on protocol for a relay.

Chapter 4. Working with the Protocol Mapping Tool presents the Protocol Mapping Tool and the interface elements, and their functions.



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Chapter 5. Modbus, Chapter 6. DNP 3.0 and Chapter 7. IEC 60870-5-101 provide a detailed description of the Protocol Mapping Tool features supporting the given protocol.

Chapter 8. Troubleshooting contains frequently asked questions and their answers.

### 1.5.

#### Use of symbols

This publication includes warning, caution, and information icons that point out safety related conditions or other important information. It also includes tip icons to point out useful information to the reader. The corresponding icons should be interpreted as follows:



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



The information icon alerts the reader to relevant facts and conditions.



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

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

### 1.6.

#### Terminology

Add-on protocol	Optional communication protocol, which can be configured and activated separately. Add-on protocols are supported by certain REM 54_, REF 54_ and RET 54_ terminals.
DNP 3.0	Distributed Network Protocol. The communication protocol defined by Harris Controls based on the early versions of the IEC 870-5 specifications.
IEC 60870-5-101 and IEC 60870-5-103	International Standard IEC 60870-5-101 and IEC 60870-5-103, communication protocols that has been prepared by the IEC Technical Committee 57: Power system control and associated communications.
Modbus	Modbus communication protocol is a messaging structure developed by Modicon in 1979, used to establish master-slave/client-server communication between intelligent devices.
Pattern	Function block specific resource file describing what kind of data and how the data of a function block is mapped for a protocol.

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### 1.7. Abbreviations

ASDU	Application Service Data Unit
LON	Local Operating Network, communication protocol developed by Echelon
PMT	Protocol Mapping Tool
SPA	Data communication protocol developed by ABB

### 1.8. Related documents

Name of the manual	Document ID
CAP 505 User's Guide	1MRS752292-MUM
IEC 60870-5-101 Remote Communication Protocol for REC 523, Technical Description	1MRS750956-MUM
LIB, CAP and SMS, Tools for Relays and Terminals, User's Guide	1MRS752008-MUM

### 1.9. Document revisions

Version	Date	History
A	14.04.2004	Document created
B	30.06.2004	REX 521 support added
C	20.12.2004	RET 54_ additions
D	01.03.2005	IEC 60870-5-101 protocol, REC 52_ additions

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## 2. General

The Protocol Mapping Tool is used for creating and editing the protocol mapping configuration. It supports the editing of mappings for the following terminals and protocols:

- REM 54\_
  - Modbus
- REF 54\_
  - DNP 3.0
  - Modbus
- RET 54\_
  - DNP 3.0
  - Modbus
- REX 52\_
  - DNP 3.0
- REC 52\_
  - IEC 60870-5-101

### 2.1. Protocol Mapping Tool Wizard

The Protocol Mapping Tool Wizard enables a quick start to create a mapping. The Wizard starts automatically when the Protocol Mapping Tool is started from the CAP 505's Project Structure Navigator window. The Protocol Mapping Tool Wizard can be called any time, provided that the Create New Mapping option is selected in the main menu or toolbar.

The Wizard guides the user through:

- Creating a new mapping
- Opening an existing mapping
- Importing a mapping
- Deleting a mapping

The Protocol Mapping Tool gets most of the necessary information directly from the CAP 505 project, i.e. the relay application the user has been working on and the selected add-on protocol.

The Protocol Mapping Tool Wizard is described in detail in Section 4.1. Protocol Mapping Tool Wizard.

### 2.2. Protocol Mapping Tool

The editing features of the Protocol Mapping Tool are available when the user proceeds through all the steps of the Wizard and the Protocol Mapping Tool is shown.

The Protocol Mapping Tool is able to:

- Add new points to a mapping
- Remove points from a mapping

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- Change the addresses and the order of points within a whole data category
- Change the conversion factors of analog points
- Add predefined structures to a mapping
- Manage event definitions mapped as points within mapping
- Export mapping information into HTML or text documents

The Protocol Mapping Tool provides certain features available exclusively for a selected protocol and/or terminal, e.g. an unsolicited reporting disabling and enabling provided for DNP 3.0 dependent mappings.

The Protocol Mapping Tool is described in detail in Section 4.2. Protocol Mapping Tool.

### 2.2.1.

#### **Working modes**

The Protocol Mapping Tool provides working modes to force some limitations during mapping editing. The Protocol Mapping Tool supports the following working modes:

##### **Basic (default mode)**

In the basic mode the user is allowed to modify only existing points. It is not possible to add or remove points within a mapping. The total number of points and their types is fixed.

The following features are available when editing a mapping:

##### **DNP 3.0**

- Conversion factor editing
- Class assignment
- Unsolicited reporting flags enabling/disabling

##### **Modbus**

- Conversion factor editing

The basic working mode is useful when the user needs to only slightly change settings in a mapping.

##### **IEC 60870-5-101**

- Conversion factor editing
- General interrogation assignment
- Measurement value format change
- Data class (priority) assignment

##### **Advanced**

In the advanced mode the user can execute all the available editing features (i.e. adding points).

Entering the advanced mode is not restricted, since the purpose of the two different modes only is to minimize unwanted changes.

All the editing features are described in detail in Section 4.2.3.3. Mapping editing

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### 3. Quick start reference

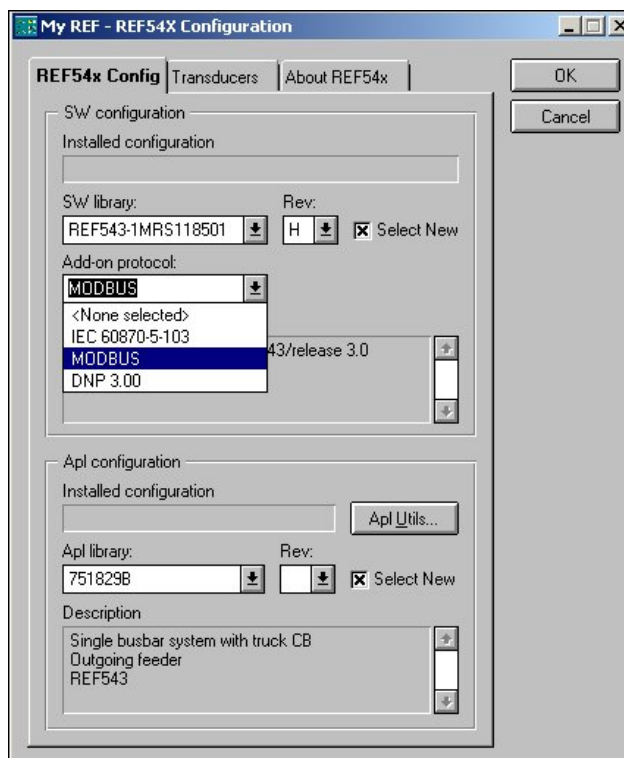
This chapter contains a step-by-step description on how to create a protocol mapping and how to activate a protocol for a relay. For details on how to add and configure relay objects in general in CAP 505, refer to the User's Guide, the Tools for Relays and Terminals manual and the Relay Configuration Tool manuals of CAP 505 (information can be found in Section 1.8. Related documents).

#### 3.1. Configuring a relay object for REF 54\_, REM 54\_ and RET 54\_

The Protocol Mapping Tool is an object tool in CAP 505. However, it is not available by default in the Project Structure Navigator for a newly created relay object, and is generally available only for certain relay types and revisions.

To be able to use the Protocol Mapping Tool, the relay object has to be configured so that the selected SW configuration (SW library and its revision) supports one or more add-on protocols. During the configuration, the support availability of the add-on protocol can be seen from the "Add-on protocol" list contents (see Fig. 3.1.-1).

As an example, a REF 543 relay and Modbus protocol is used here. The figures are captured from the current versions of the related tools, so they are only to be regarded as samples.



config\_ref

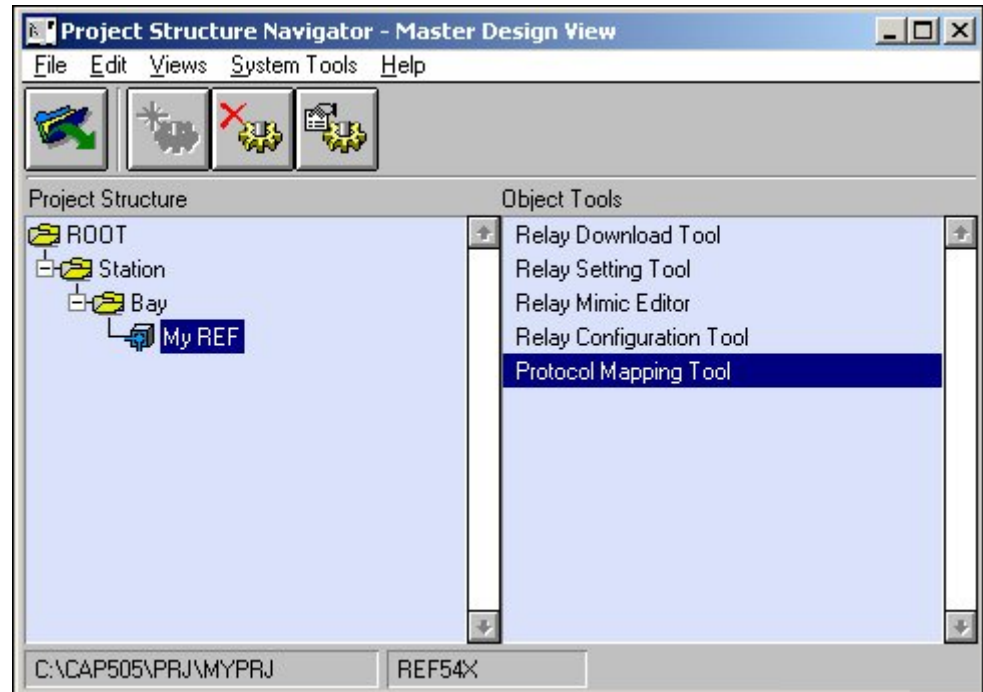
Fig. 3.1.-1 Configuring the REF 54\_ relay object

Depending on the need, the appropriate add-on protocol has to be selected from the list, as well as a proper "Apl configuration" (relay application).

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After the selections have been accepted, the Protocol Mapping Tool will appear on the Object Tools list (see Fig. 3.1.-2). However, if the Protocol Mapping Tool is still not visible in the project tree, the selections in the configuration dialog must be checked.



ref\_object\_tools

Fig. 3.1.-2 REF 54\_ Object Tools list

### 3.1.1.

#### Configuring a relay application

The protocol mapping is based on the relay application (relay configuration). If the "Apl configuration" selection made in the configuration dialog (see Fig. 3.1.-1) is not adequate, the Relay Configuration Tool must be used to create or modify the relay application.

If the Relay Configuration Tool is used to modify the application, it is important to remember to compile the application when it is ready. Only by doing this, the related description files are updated.



If function blocks are added to or removed from the application later, the protocol mapping must be changed accordingly or created again.

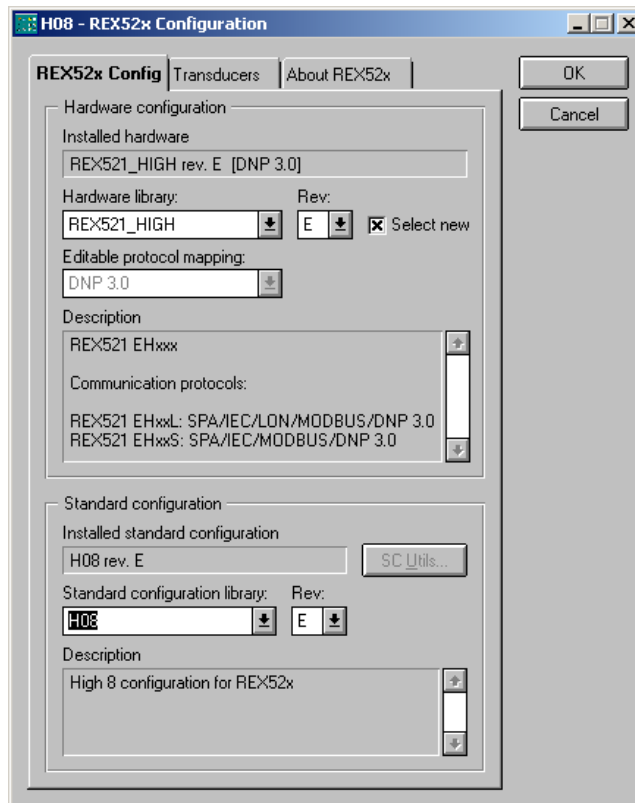
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### 3.2. Configuring a relay object for REX 52\_

The Protocol Mapping Tool is an object tool in CAP 505. However, it is not available by default in the Project Structure Navigator for the newly created REX 52\_ relay objects, and is generally available only for certain relay configurations.

To be able to use the Protocol Mapping Tool, the relay object has to be configured so that both the Hardware library and Standard configuration revisions are "E" or later (see Fig. 3.2.-1). The Protocol Mapping Tool supports only the DNP 3.0 protocol, when using REX 52\_ type relays.



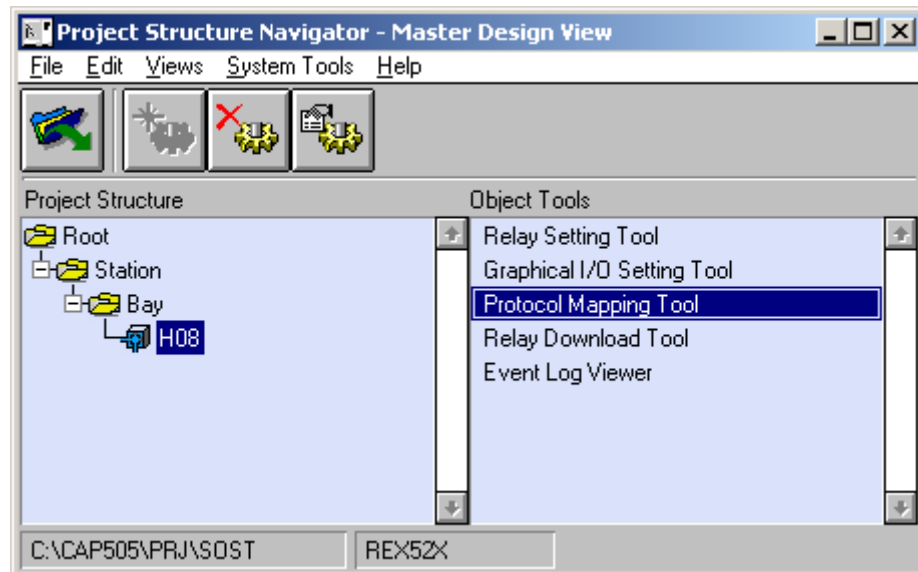
config\_rex

Fig. 3.2.-1 Configuring the REX 52\_ relay object

After the selections have been accepted, the Protocol Mapping Tool will be displayed on the Object Tools list (see Fig. 3.2.-2). If the Protocol Mapping Tool is not visible on the list, check that Hardware library is Rev. E or later in the attributes settings (see Fig. 3.2.-1).

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rex\_object\_tools

Fig. 3.2.-2 REX 52\_ Object Tools list

### 3.3.

#### Configuring a relay object for REC 52\_

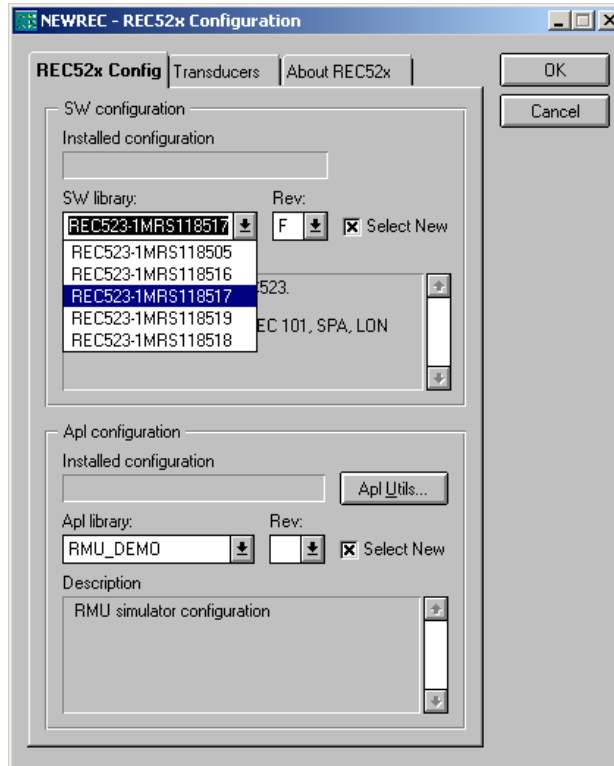
The Protocol Mapping Tool is an object tool in CAP 505. However, it is not available by default in the Project Structure Navigator for the newly created REC 52\_ relay objects, and it is generally available only for certain relay configurations.

To be able to use the Protocol Mapping Tool, the relay object has to be configured so that the SW library is REC523-1MRS118517 and the revision is F or later (see Fig. 3.3.-1). The Protocol Mapping Tool supports only the IEC 60870-5-101 protocol, when using the REC 52\_ type relays.



# Protocol Mapping Tool

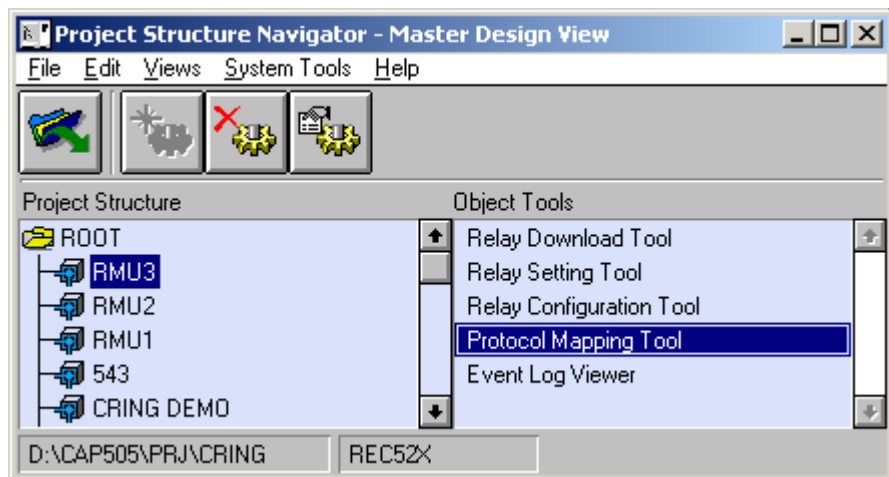
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config\_REC52\_

Fig. 3.3.-1 Configuring the REC 52\_ relay object

After the selection has been accepted, the Protocol Mapping Tool is displayed on the Object Tools list (see Fig. 3.3.-2). If the Protocol Mapping Tool is not visible on the list, check that the SW library is REC523-1MRS118517 and the revision is F or later in the attributes settings (see Fig. 3.3.-1).



object\_REC52\_

Fig. 3.3.-2 REC 52\_ Object Tools list

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#### 3.3.1. Configuring a relay application

The protocol mapping is based on the relay application (relay configuration). If the "Apl configuration" selection made in the configuration dialog (see Fig. 3.3.-1) is not adequate, the Relay Configuration Tool must be used to create or modify the relay application.

If the Relay Configuration Tool is used to modify the application, it is important to remember to compile the application when it is ready. Only by doing this, the related description files are updated.



If function blocks are added to or removed from the application later, the protocol mapping must be changed accordingly or created again.

#### 3.4. Creating protocol mapping

The mapping must be created and downloaded for REF 54\_, REM 54\_ and RET 54\_. The default mapping already exists in REX 52\_ and in REC 52\_.



It is not possible to add more points to the default mapping. The available points are defined by the Protocol Mapping Tool.

#### 3.4.1. Opening Protocol Mapping Tool

The Protocol Mapping Tool is opened by double-clicking its name from the object tool list.



With REF 54\_, REM 54\_ and RET 54\_ there are two cases, where the opening might be prevented (see Fig. 3.4.1.-1 and Fig. 3.4.1.-2).

1. If no add-on protocol was selected during the relay object configuration, the tool cannot be opened.



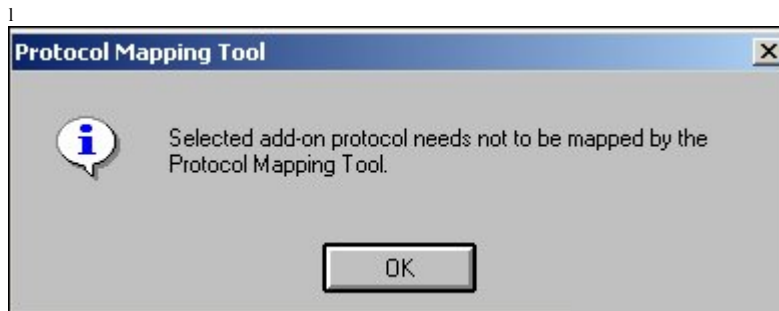
pmt\_notification\_1

*Fig. 3.4.1.-1 Message shown during startup of the Protocol Mapping Tool, when no add-on protocol has been selected.*

2. If the selected add-on protocol is IEC 60870-5-103, the mapping is fixed in the relay, and it needs not to be mapped by the Protocol Mapping Tool.

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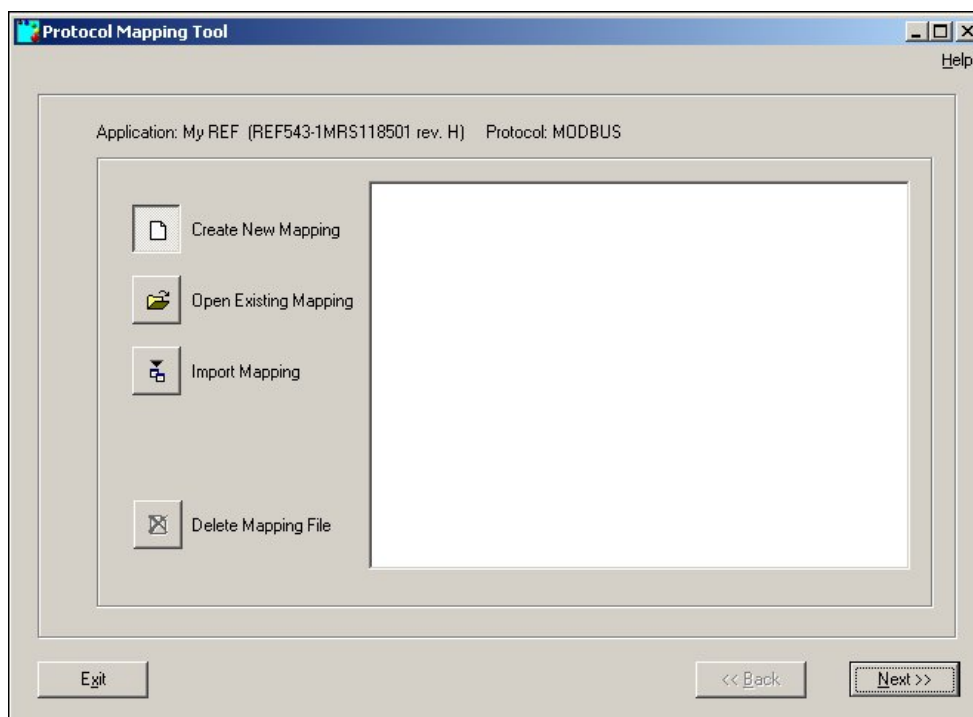
pmt\_notification\_2

*Fig. 3.4.1.-2 Message shown during startup of the Protocol Mapping Tool, when the add-on protocol selected does not need to be mapped by the tool.*

### 3.4.2.

#### Creating new protocol mapping

When the Protocol Mapping Tool is opened, the wizard dialog will always be shown first (see Fig. 3.4.2.-1).



pmt\_wizard

*Fig. 3.4.2.-1 Creating a new protocol mapping with the Protocol Mapping Tool wizard.*

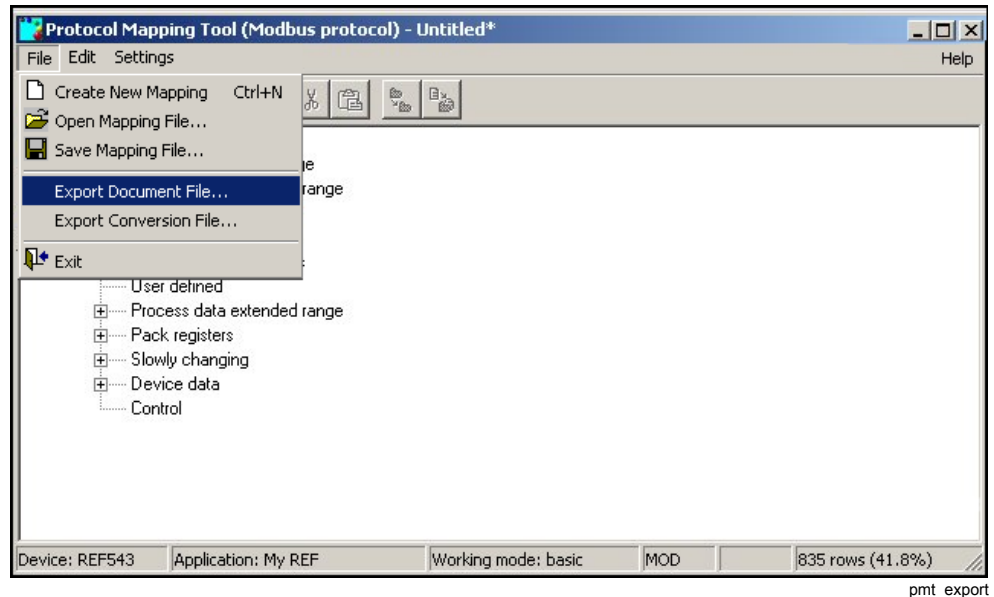
The fastest way to create a protocol mapping is to select Create New Mapping from the wizard dialog and accept the default values provided by the wizard until the Protocol Mapping Tool dialog is opened. Then, if the default mapping is accepted, the mapping is ready to be saved. Otherwise, the editing features of the tool can be utilized.

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#### 3.4.3. Exporting mapping data

When the protocol mapping is ready from the relay point of view, it is recommended to export the mapping data to a file. This export file can then be used as a reference when configuring the protocol master system (see Fig. 3.4.3.-1).



*Fig. 3.4.3.-1 Functions to export protocol mapping data for master system configuration.*

#### 3.4.4. Saving protocol mapping file

Before exiting the Protocol Mapping Tool, the created mapping must be saved. The default mapping file name can be accepted or another name given (see Fig. 3.4.4.-1).

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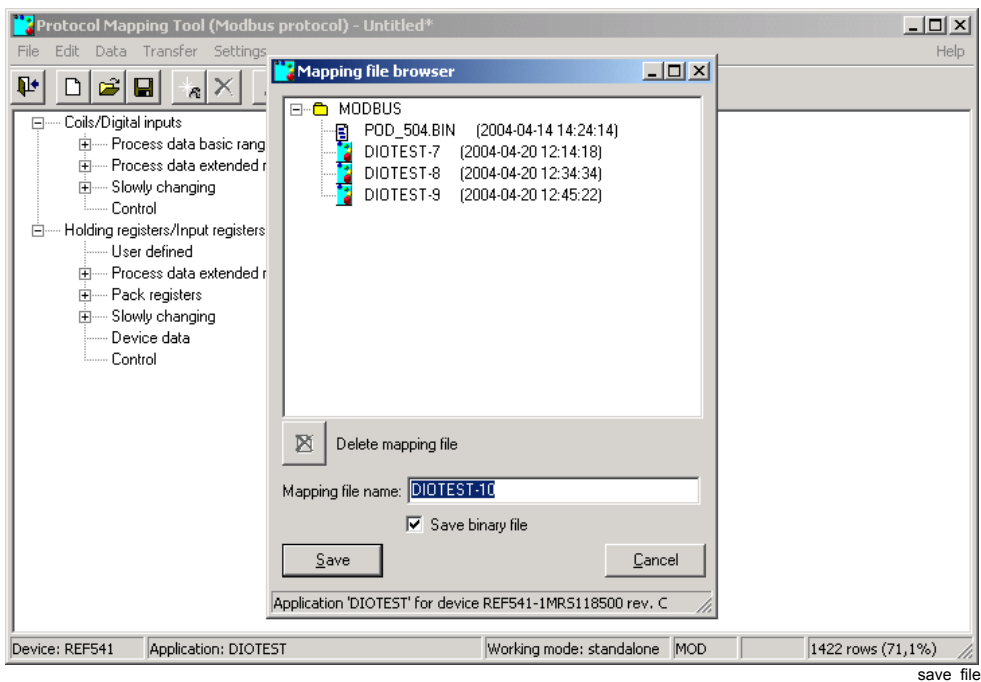


Fig. 3.4.4.-1 Saving a protocol mapping file

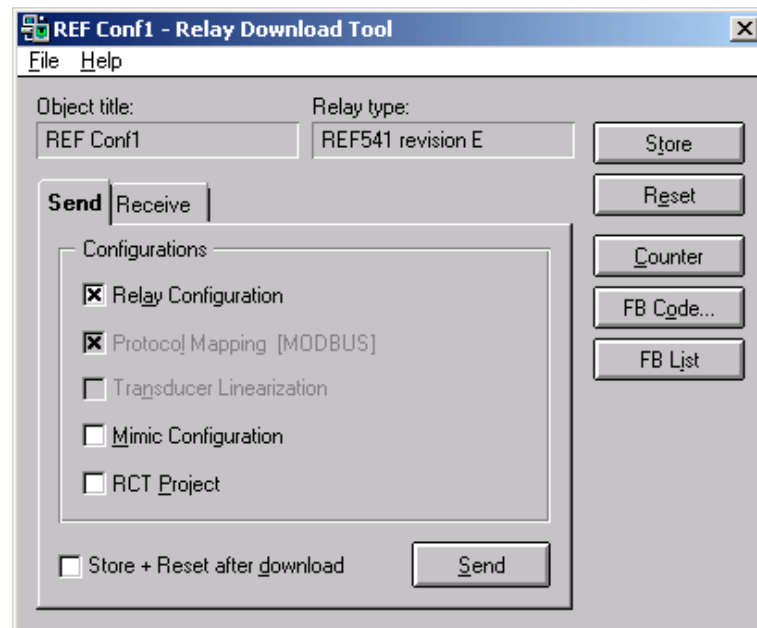


It is very important to check that the option "Save binary file" has been set. Otherwise, the actual mapping file to be sent to the relay is not created.

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### 3.5. Downloading protocol mapping to REF 54\_, REM 54\_ and RET 54\_



Rdt\_send\_b

Fig. 3.5.-1 Downloading protocol mapping file to a REF 54\_ relay



The following should be noticed when downloading a protocol mapping file:

- Downloading the relay configuration inactivates the add-on protocol and deletes the protocol mapping. Therefore, also the protocol mapping must be sent again, if the relay configuration is sent.
- Due to the above, the protocol mapping must be received from the relay before downloading the relay configuration, if the protocol mapping file is not available elsewhere. The "RCT Project" does not include the protocol mapping file.
- The protocol mapping file can also be downloaded separately, if the active add-on protocol in the relay is the same as the one being downloaded.
- The protocol mapping file for the IEC 60870-5-103 protocol is never used; it does not need to be downloaded and cannot be uploaded. Downloading this protocol only activates the protocol in the relay.



After downloading the protocol mapping, the Store and Reset functions must be performed to activate the add-on protocol.

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### 3.5.1.

### Setting add-on protocol related parameters

If the object configuration has been made correctly, the Relay Setting Tool includes the parameter page for the selected add-on protocol. If the parameters are not visible, the relay object configuration must be checked and the relay applications compiled again in the Relay Configuration Tool (see Fig. 3.5.1).



REM 54\_ units do not yet support the setting of add-on protocol parameters using the Relay Setting Tool. The parameters have to be set locally.

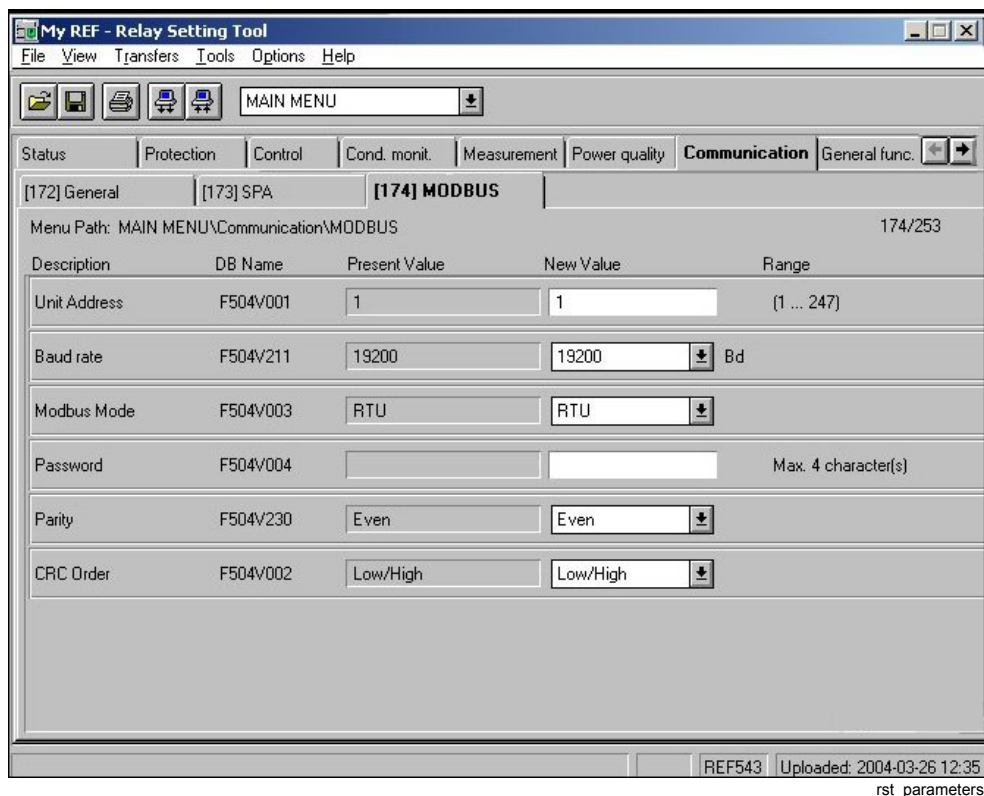


Fig. 3.5.1.-1 Setting add-on protocol related parameters for REF 54\_



After setting and downloading the parameters, the Store function must be performed to store the parameters to the non-volatile memory of the relay.

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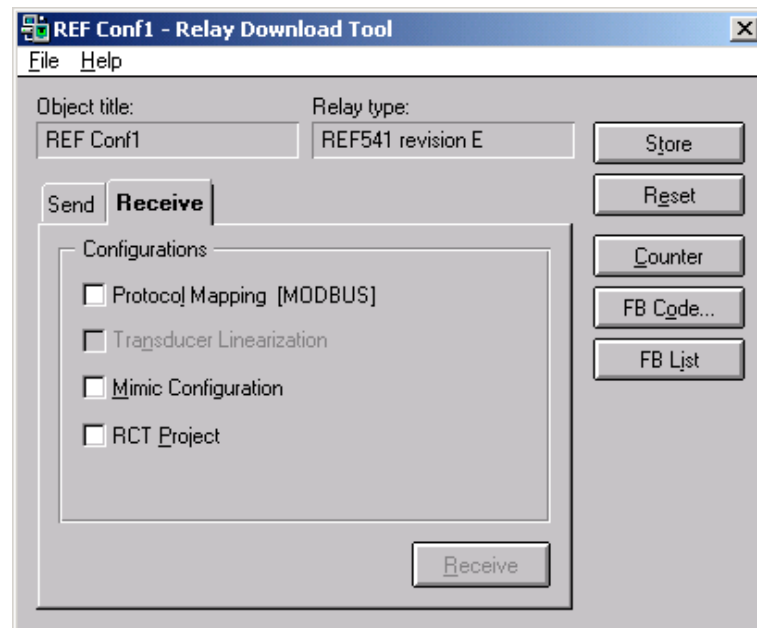
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### 3.5.2. Uploading protocol mapping from REF 54\_, REM 54\_ and RET 54\_

It is possible to upload the protocol mapping file from REF 54\_, REM 54\_ and RET 54\_. This is useful if the mapping in the relay has been modified or is unknown. For more information, see Section 4.2.3.1. Opening of an existing mapping.



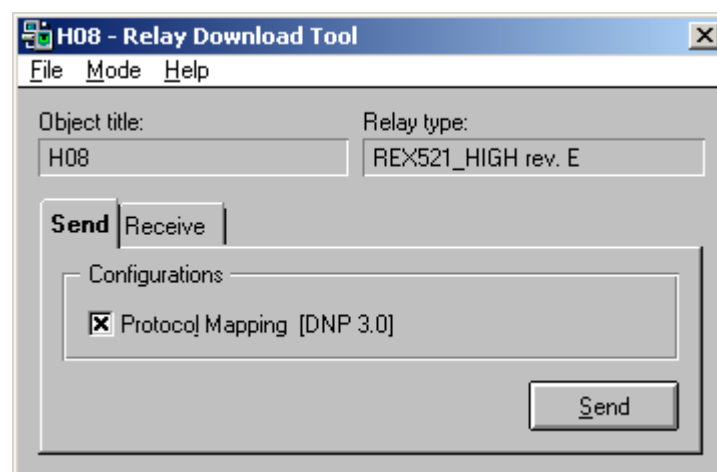
It is not possible to upload a mapping from an empty relay.



Rtd\_receive\_b

Fig. 3.5.2.-1 Uploading protocol mapping file from REF 54\_

### 3.6. Downloading protocol mapping to REX 52\_



rtd\_send\_rex

Fig. 3.6.-1 Downloading protocol mapping file to a REX 52\_ relay



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When downloading a new protocol mapping file to the relay, the relay is switched from the protection mode to the configuration mode. During this sending process all the protection functions are disabled until the relay is set back to the protection mode.



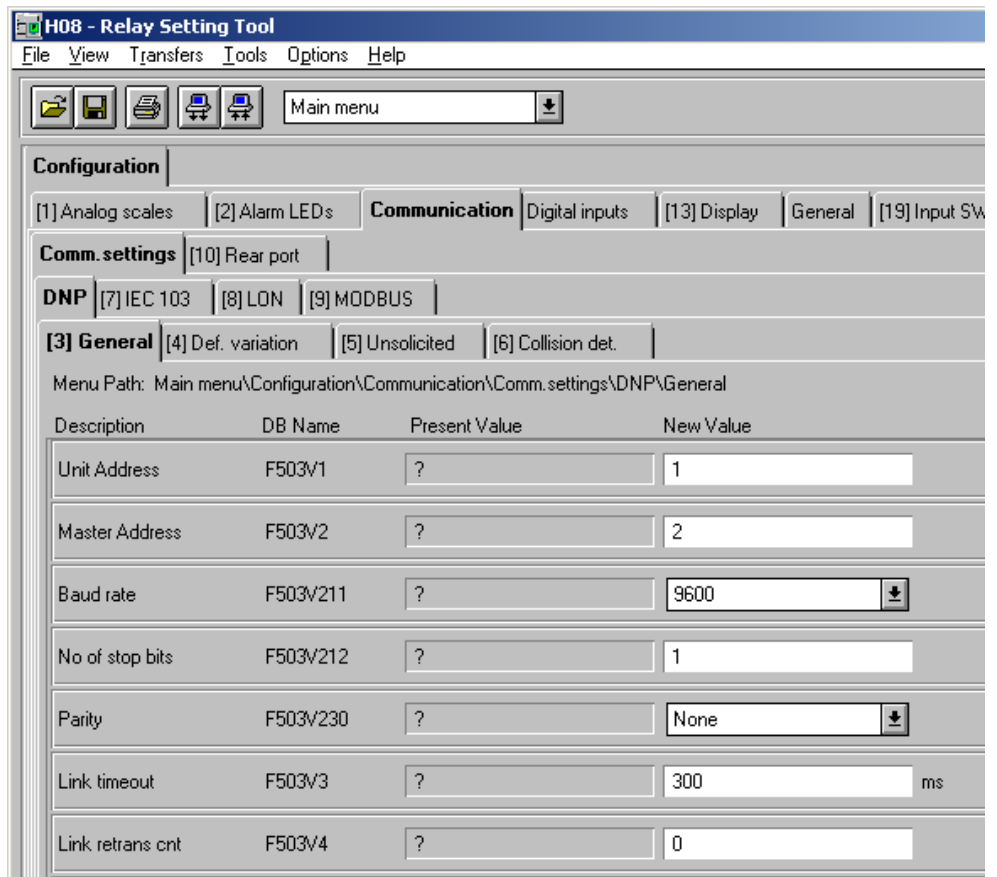
Sending the protocol mapping file to REX 52\_ is possible only with the SPA protocol via the optical front panel connector. Rear connectors (SPA or LON) are not supported for downloading. However, receiving the protocol mapping from REX 52\_ is possible also via the rear connections.

The downloaded protocol mapping is taken into use immediately after a successful mapping transfer and when the relay has been switched back to the protection mode.

### 3.6.1.

### Setting protocol related parameters

The protocol specific communication parameters are configured in the Relay Setting Tool. When the settings are done, they are sent to the relay.



rst\_parameters\_rex

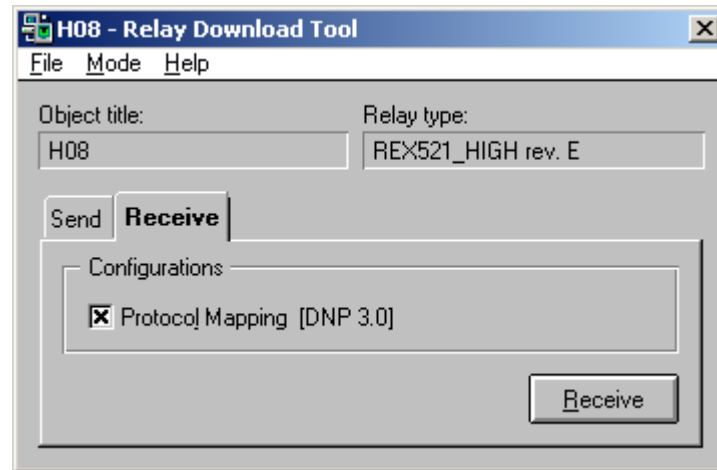
Fig. 3.6.1.-1 Setting protocol related parameters for REX 52\_

## Protocol Mapping Tool

Operation Manual

### 3.6.2. Uploading protocol mapping from REX 52\_

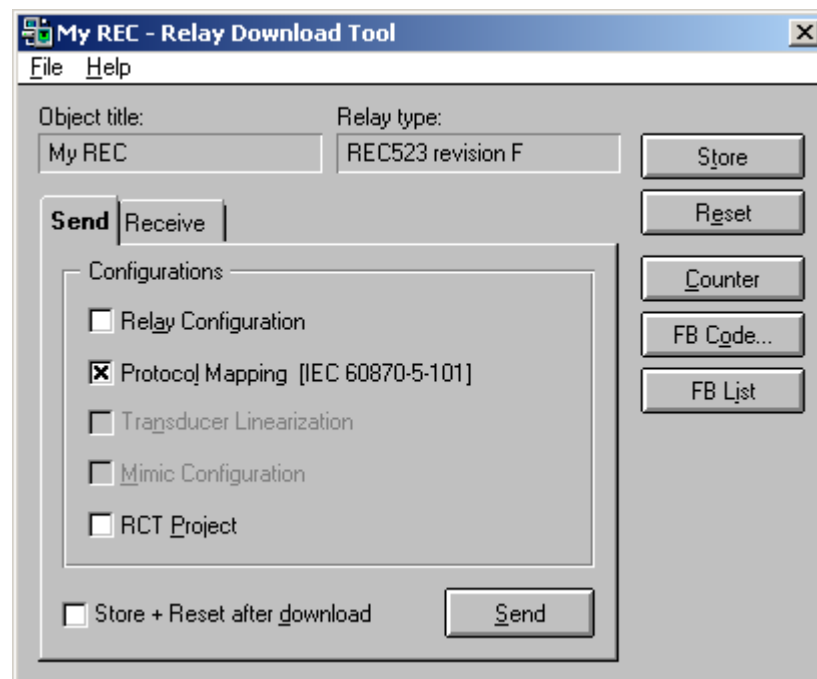
It is also possible to upload the protocol mapping file from the REX 52\_. This is useful if the mapping in the relay has been modified and is unknown. For more information, see Section 4.2.3.1. Opening of an existing mapping.



rdt\_receive\_rex

Fig. 3.6.2.-1 Uploading protocol mapping file from REX 52\_

### 3.7. Downloading protocol mapping to REC 52\_



rdt\_send\_rec

Fig. 3.7.-1 Downloading protocol mapping file to a REC 52\_ relay

# Protocol Mapping Tool

## Operation Manual

The protocol mapping file for IEC 60870-5-101 can be downloaded either separately or together with the configuration. Downloading of the relay configuration does not affect the existing protocol mapping in REC 52\_.



After downloading the protocol mapping, the Store and Reset functions must be performed to activate the changes.

### 3.7.1.

#### Setting protocol related parameters

The protocol specific communication parameters are configured in the Relay Setting Tool (see Fig. 3.7.1.-1). When the settings are done, they are sent to the relay.

For more information on protocol specific communication parameters, see the Technical Description for IEC 60870-5-101 (information can be found in Section 1.8. Related documents).

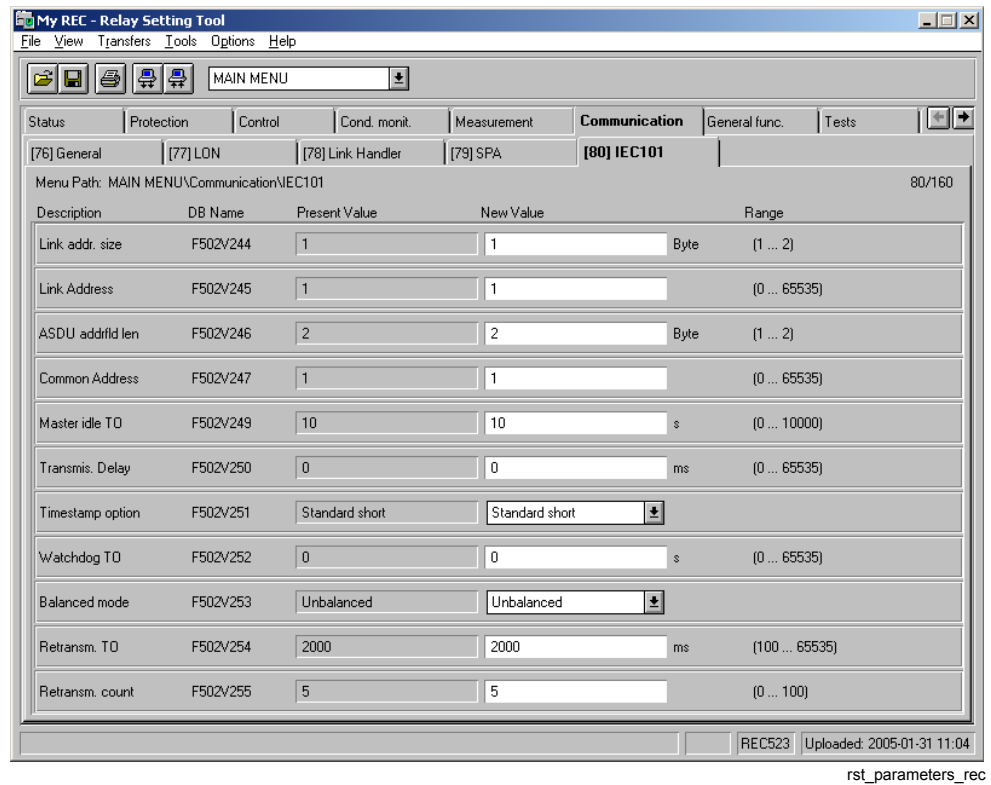


Fig. 3.7.1.-1 Setting protocol related parameters for REC 52\_



After setting and downloading the parameters, the Store function must be performed to store the parameters to the non-volatile memory of the relay.

## Protocol Mapping Tool

Operation Manual

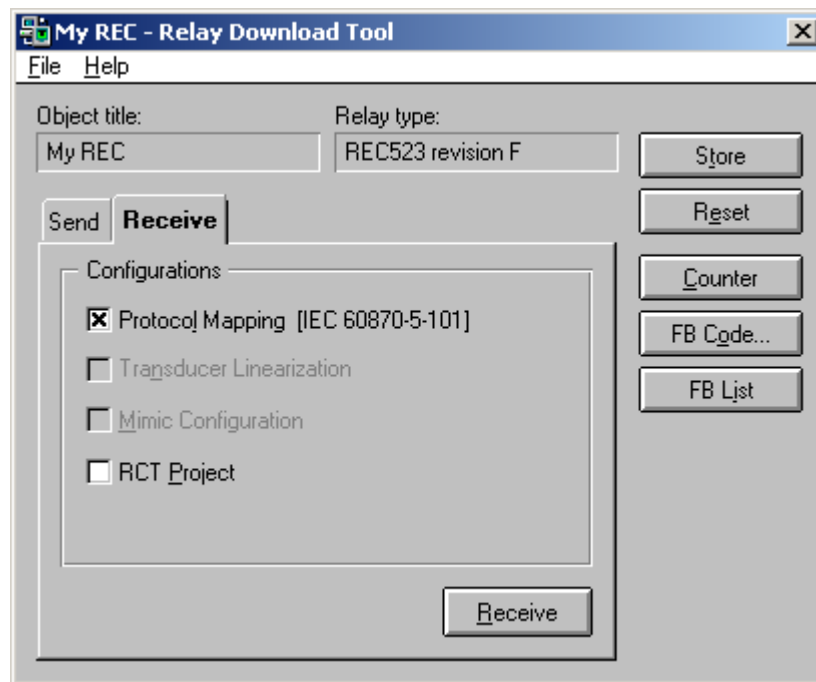
## 3.7.2.

**Uploading protocol mapping from REC 52\_**

It is possible to upload the protocol mapping file from REC 52\_. This is useful if the mapping in the relay has been modified or is unknown. For more information, see Section 4.2.3.1. Opening of an existing mapping.



Also a not configured REC 52\_ contains a default mapping.



rdt\_receive\_rec

Fig. 3.7.2.-1 Uploading protocol mapping file from REC 52\_

# Protocol Mapping Tool

## Operation Manual

### 4. Working with the Protocol Mapping Tool

This chapter presents the user interfaces and editing features of the Protocol Mapping Tool.

#### 4.1. Protocol Mapping Tool Wizard

Fig. 4.1.-1 shows the user interface of the Protocol Mapping Tool Wizard. The user can decide whether to create a new mapping, open an existing one or import a mapping from a different relay object. It is also possible to delete no longer needed mappings.

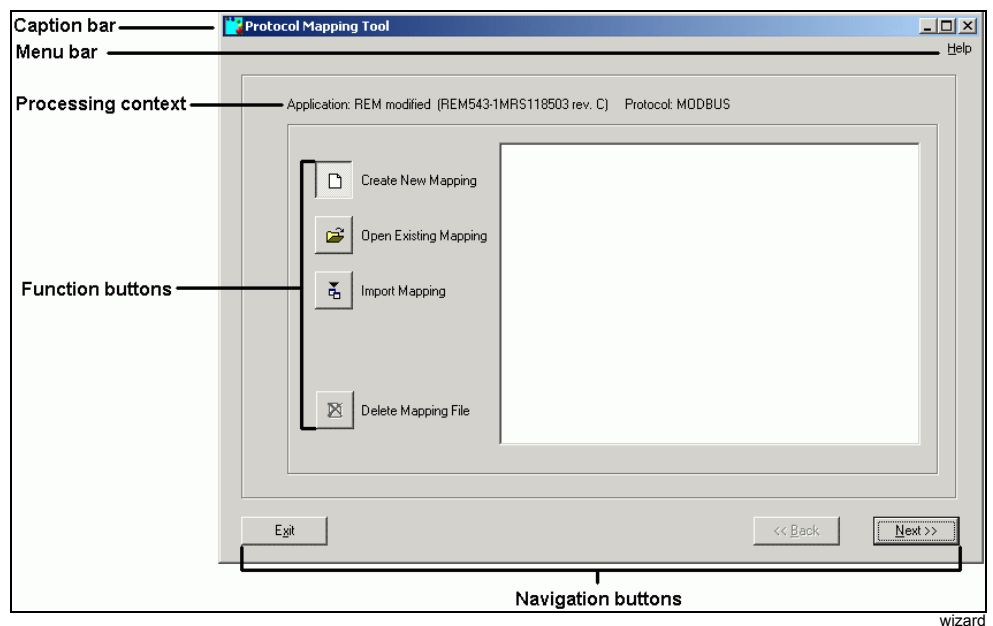


Fig. 4.1.-1 Protocol Mapping Tool Wizard

The Wizard consists of the following elements:

- Caption bar
- Menu bar
- Processing context
- Function buttons
- Navigation buttons

#### Caption bar

The caption bar contains the full name of the Protocol Mapping Tool.

#### Menu bar

The menu bar provides access to the Help menu. The content of this menu is presented in Section 4.2.1.4. Help menu

# Protocol Mapping Tool

## Operation Manual

---

### Processing context

The processing context presents basic information describing the edited mapping and contains:

- The application name (i.e. relay object title) with the related device name and its revision
- The protocol name

### Function buttons

The function buttons allow the user to choose the operation to be performed. Available operations are described in detail in Section 4.1.1. Creating a new mapping - Section 4.1.4. Deleting mapping

### Navigation buttons

Navigation buttons allow the user to move between the steps in the Wizard.

- The Exit button quits the Protocol Mapping Tool

**Note:** If the Wizard is started from the Protocol Mapping Tool, Exit is replaced by Cancel button, which quits the Wizard and returns to the Protocol Mapping Tool.

- The Next/Finish button moves to the next Wizard step or switches to the Protocol Mapping Tool
- The Back button moves to the previous Wizard step

## 4.1.1.

### Creating a new mapping

By selecting this feature, the user can create a new mapping.

The creation of a new mapping is always supervised by the Protocol Mapping Tool Wizard dialog. If a mapping was changed but not saved, the Protocol Mapping Tool shows a message box that prompts the user to save.

Advance in the Wizard by clicking the Next and Finish buttons.

More information on the mapping creation process can be found in Section 5.1.1. Creating a new mapping for Modbus and in Section 6.1.1. Creating a new mapping for DNP 3.0 and in Section 7.1.1. Creating a new mapping for IEC 60870-5-101.

Selected addresses can be changed later during the editing, this is described in Section 6.5. Mapping editing features (DNP) and in Section 7.4. Mapping editing features (IEC 60870-5-101).

Overlapping-check is performed for the Modbus and IEC 60870-5-101 protocols. This is described in Section 5.4. Complex structures (Modbus) and in Section 7.4. Mapping editing features (IEC 60870-5-101).

# Protocol Mapping Tool

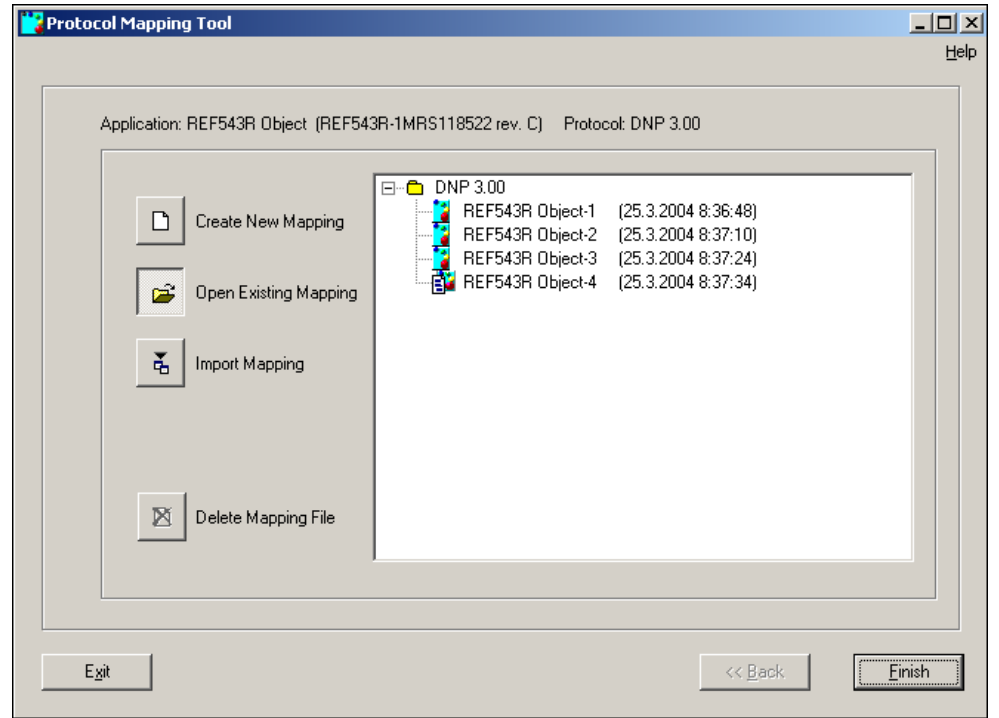
## Operation Manual

### 4.1.2.

### Opening an existing mapping

To open an existing mapping, select the mapping file and click the Finish button (see Fig. 4.1.2.-1). The Protocol Mapping Tool will open with its content.

Opening a mapping is described in detail in Section 4.2.1.3. Settings menu.



wizard\_opn

Fig. 4.1.2.-1 Opening an existing mapping

## Protocol Mapping Tool

### Operation Manual

#### 4.1.3. Importing a mapping

It is possible to import a mapping from a different relay object. It only requires browsing the CAP project's tree structure and choosing the desired file. If the source and destination objects have the same target terminals (revisions may be different) importing is possible (see Fig. 4.1.3.-1).

To import an existing mapping, select the mapping file and click the Import button the Protocol Mapping Tool will open with its content.

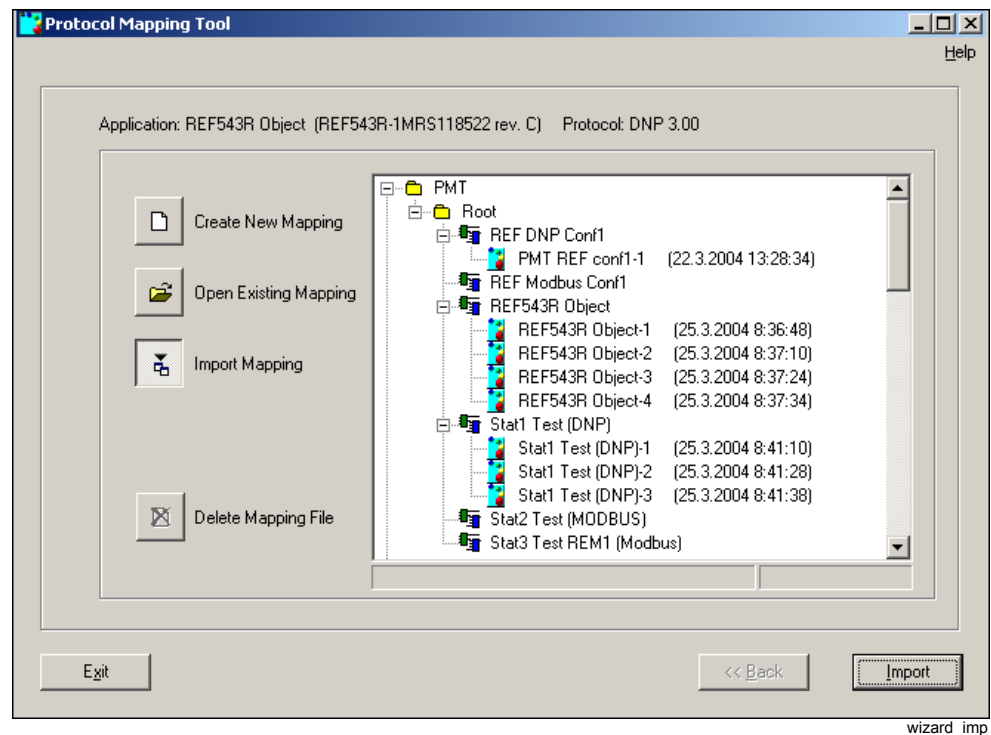


Fig. 4.1.3.-1 Importing a mapping

#### Dealing with unsupported points

It is possible that some function blocks and their protocol points are not supported by the destination project. In this case it is required to choose how to treat the unsupported points (see Fig. 4.1.3.-2).

- If the user wants to keep the addressing from an already prepared mapping, non-existing points can be replaced by so called 'dummy points' with the value 0.
- If the efficiency of data transfer is more important, unsupported points should be removed and the mapping readdressed.



# Protocol Mapping Tool

## Operation Manual

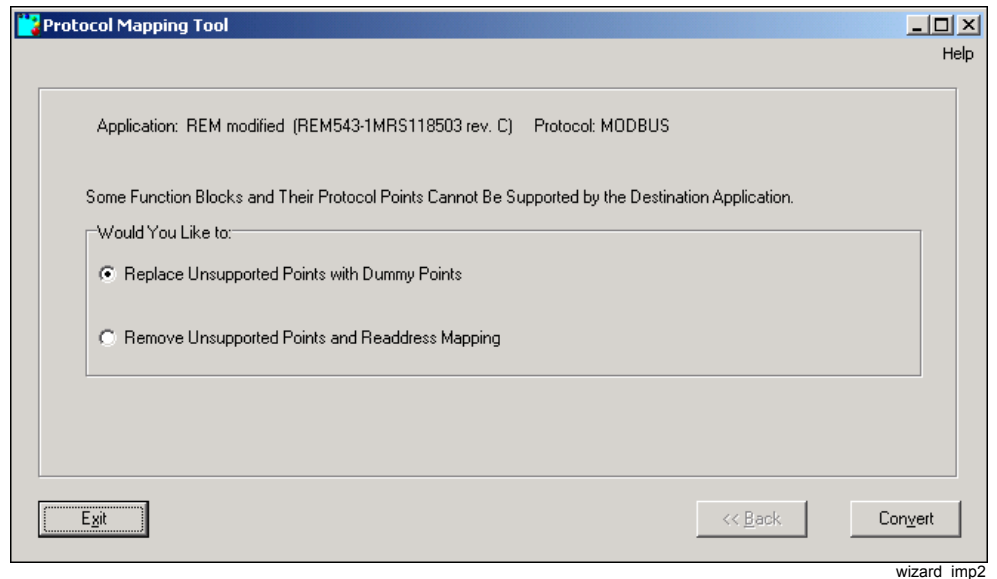


Fig. 4.1.3.-2 Choosing how to treat unsupported points

### 4.1.4.

#### Deleting mapping

Delete Mapping removes selected mapping files from the relay object. This option can be used to clean up possible unnecessary mapping files created during the engineering phase.

This operation is irreversible and thus the mapping deletion is limited. The following files cannot be removed:

- Binary mapping files
- Mapping files having associated binary mapping file

# Protocol Mapping Tool

## Operation Manual

### 4.2. Protocol Mapping Tool

Fig. 4.2.-1 shows the user interface of the Protocol Mapping Tool during mapping editing.

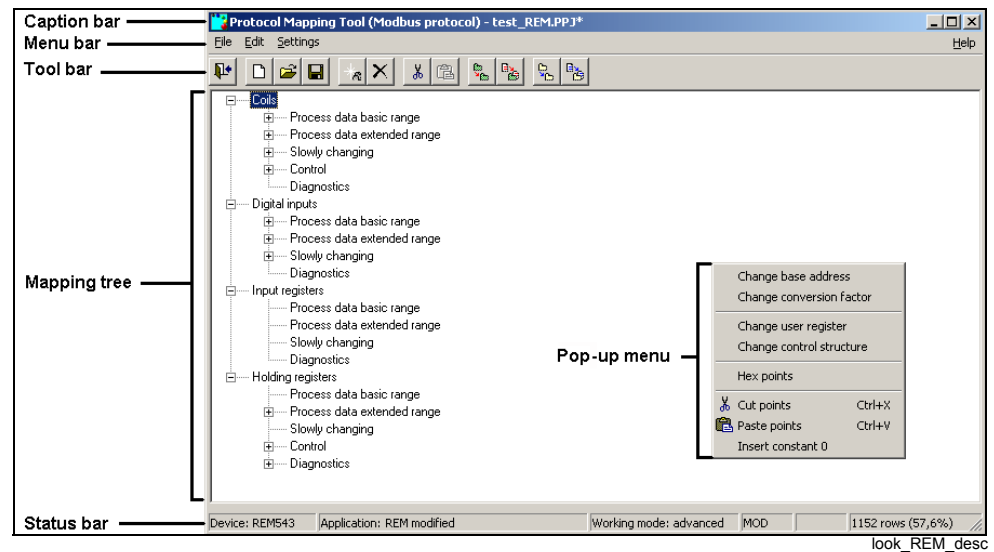


Fig. 4.2.-1 Protocol Mapping Tool

The main dialog is composed of the following elements:

- Caption bar
- Menu bar
- Tool bar
- Mapping tree
- Status bar
- Pop-up menu

All the listed pieces of the user interface are briefly described below. The mapping tree is described in detail in Section 5.2. Mapping tree for Modbus, in Section 6.2. Mapping tree for DNP 3.0 and in Section 7.2. Mapping tree for IEC 60870-5-101. The menu bar and the toolbar are described in Section 4.2.1. Description of menu items and toolbar buttons and the pop-up menu in Section 4.2.2. Description of the pop-up menus.

#### Caption bar

The caption bar contains the full name of the Protocol Mapping Tool followed by the names of the selected add-on protocol and of the edited mapping file (see Fig. 4.2.-1).

If the name of the mapping file has not already been set, the word "Untitled" will be shown instead.

If the edited mapping has been changed but not yet saved, the mapping file name will be followed by an asterisk (\*).

# Protocol Mapping Tool

## Operation Manual

### Menu bar

The menu bar provides access to the File, Edit, Settings and Help menus. The contents of the listed menus are described in Section 4.2.1. Description of menu items and toolbar buttons

### Toolbar

The toolbar provides fast access to most of the Menu bar functions. A description and instructions on how to use of the buttons are provided in Section 4.2.1. Description of menu items and toolbar buttons.

### Mapping tree

The mapping tree is the main area of the Protocol Mapping Tool. The mapping tree provides a tree structure, which presents points stored within a mapping as leaves in a tree. This is described in greater detail in Section 5.2. Mapping tree for Modbus, in Section 6.2. Mapping tree for DNP 3.0 and in Section 7.2. Mapping tree for IEC 60870-5-101.

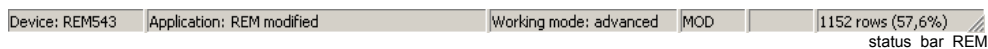
### Pop-up menu

The pop-up menu is available in the area of the mapping tree. It provides the most common editing operations of points currently selected within the mapping tree.

Details concerning the pop-up menu are available in Section 4.2.2. Description of the pop-up menus.

### Status bar

The status bar presents the basic information of the mapping (see Fig. 4.2.-2).



*Fig. 4.2.-2 Status bar of Protocol Mapping Tool*

The status bar contains five fields:

1. Device name (related to the selected project)
2. Selected application name (relay object title)
3. Selected working mode
4. Modification indicator showing the word “MOD”, when the mapping has been changed but not saved
5. Number/percentage of occupied rows

#### 4.2.1.

### Description of menu items and toolbar buttons

The toolbar and the menus are not the same in both working modes. Some menu options and toolbar buttons are visible in both modes, whereas other options and toolbar buttons are disabled in the basic mode because of the mode restrictions. There are four user interface menus in the Protocol Mapping Tool. The menus will all be presented in the following sections.

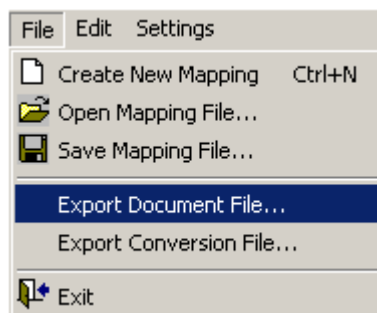
# Protocol Mapping Tool

## Operation Manual

### 4.2.1.1.

### File menu

Fig. 4.2.1.1.-1 shows the Protocol Mapping Tool's File menu. The different menu functions are explained below.



menu\_file

Fig. 4.2.1.1.-1 The File menu in the Protocol Mapping Tool

### Create New Mapping

By selecting this item in the menu, the user can create a new mapping. This feature is described in Section 4.2.2.5. Selecting address format (Hex/Decimal Points) under Creating a new mapping.

### Open Mapping File...

This option allows the opening of an existing mapping stored within a project directory. Details concerning the opening of an existing mapping are available in Section 4.2.3.1. Mapping management under Opening of an existing mapping.

### Save Mapping File...

Mapping and its binary representation can be stored in the CAP 505 project directory by using the Save Mapping File... menu item. A more detailed description of the saving operation is found in Section 4.2.3.1. Mapping management under Saving an edited mapping.

### Export Document File...

This option is used for documentation purposes and it allows the user to export complete information concerning the currently edited mapping. This feature is described in detail in Section 4.2.3.2. Mapping export.

### Export Conversion File...

This option is intended to be used for importing data to master systems. It allows the user to export complete information concerning points maintained by the edited mapping. This feature is described in detail in Section 4.2.3.2. Mapping export.

### Exit

This function exits the program. The program asks whether the user wants to save unsaved changes or not before exiting.

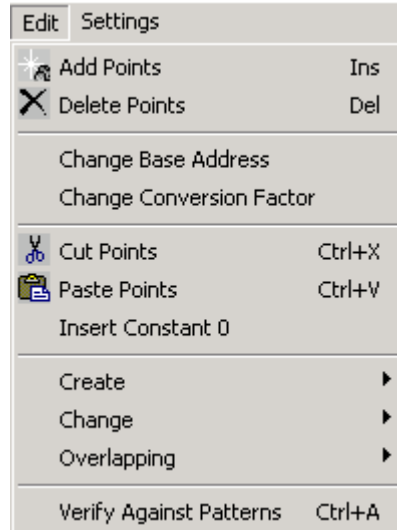
# Protocol Mapping Tool

## Operation Manual

### 4.2.1.2.

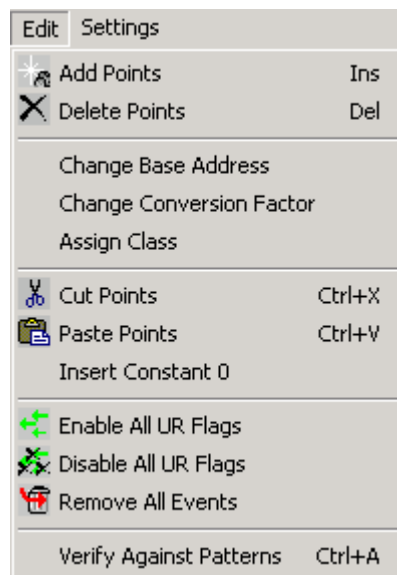
### Edit menu

Fig. 4.2.1.2.-1 shows the components of the Edit menu for Modbus mapping, Fig. 4.2.1.2.-2 for DNP 3.0 mapping and Fig. 4.2.1.2.-3 for IEC 60870-5-101 mapping. Part of the menu is generic and part is protocol specific. The protocol specific parts are described in the Modbus, DNP 3.0 and IEC 60870-5-101 specific parts of the manual.



menu\_edit\_rem

Fig. 4.2.1.2.-1 The Edit menu for Modbus mapping (in the Advanced mode)

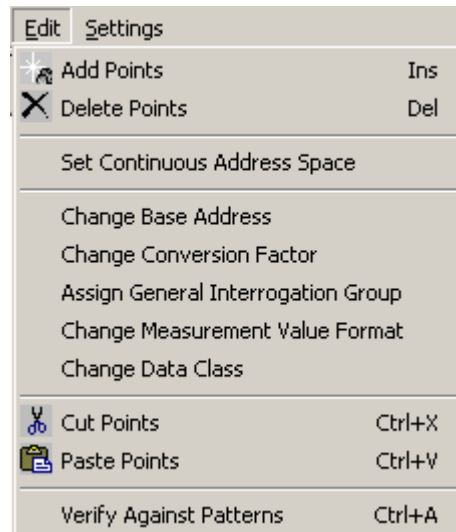


menu\_edit\_dnp

Fig. 4.2.1.2.-2 The Edit menu for DNP 3.0 mapping (in the Advanced mode)

## Protocol Mapping Tool

## Operation Manual



menu\_edit\_IEC101

Fig. 4.2.1.2.-3 The Edit menu for IEC 60870-5-101 mapping (in the Advanced mode)

### Add Points



This option is available in the advanced mode.

This menu item allows the user to add new points into an edited mapping. More information concerning the adding of points is available in Section 4.2.3.3. Mapping editing under Adding new points.

Toolbar button:



plus

Keyboard shortcut: <Ins>

### Delete Points



This option is available in the advanced mode.

The option is for removing of points existing in an edited mapping. More information can be found in Section 4.2.3.3. Mapping editing under Removing existing points.

Toolbar button:



minus

Keyboard shortcut: <Del>

# Protocol Mapping Tool

## Operation Manual

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### Change Base Address



This option is available in the advanced mode.

This menu item allows the user to change the base address of the selected data category. More information can be found in Section 5.4. Complex structures under Base address editing.

### Change Conversion Factor

This menu option is used to edit conversion factors of selected analog registers. See Section 4.2.3.5. Conversion factor editing for more details.

### Cut Points



This option is available in the advanced mode.

This menu item provides the way to select some points in a mapping in order to paste them into a different location. Cut Points is presented in Section 4.2.3.3. Mapping editing under Cut and paste operations.

Toolbar button:



sciz

Keyboard shortcut: <Ctrl>+<X>

### Paste Points



This option is available in the advanced mode.

The Paste Points function is available for performing the pasting of points into a different location. Details are available in Section 4.2.3.3. Mapping editing under the heading Cut and paste operations.

Toolbar button:



paste

Keyboard shortcut: <Ctrl>+<V>

# Protocol Mapping Tool

## Operation Manual

### Verify Against Patterns



This option is available in the advanced mode.

Patterns are function block specific resource files used by PMT. They describe what kind of data and how the data of a function block is mapped for a protocol.

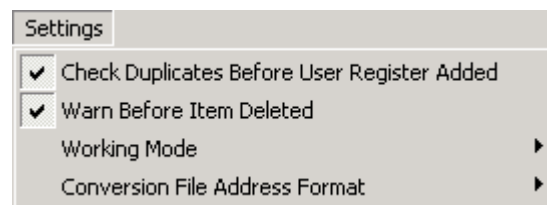
This option compares the mapping content with patterns and allows fixing all the detected errors and problems. More information can be found in Section 4.2.3.4. Verification against patterns.

Keyboard shortcut: <Ctrl>+<A>

#### 4.2.1.3.

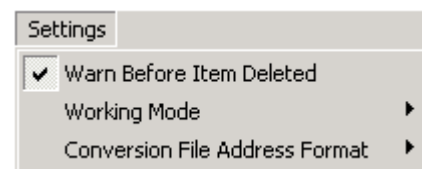
### Settings menu

The Settings menu of the Protocol Mapping Tool is presented in Fig. 4.2.1.3.-1 (Modbus) and in Fig. 4.2.1.3.-2 (DNP 3.0 and IEC 60870-5-101). Check Duplicates Before User Register Added is available only when Modbus is used.



menu\_settings\_rem

Fig. 4.2.1.3.-1 The Settings menu of Modbus



menu\_settings\_dnp

Fig. 4.2.1.3.-2 The Settings menu of DNP 3.0 and IEC 60870-5-101

### Check Duplicates Before User Register Added

This menu toggle enables/disables the scan for duplicate entries within user-defined registers. Section 5.4. Complex structures under User Registers (User-Defined Registers) describes how this setting is used.

### Warn Before Item Deleted

This menu toggle enables/disables the warning shown each time the user tries to remove any register from a mapping tree. See Section 4.2.3.3. Mapping editing under Removing existing points for more details on how to use the setting.

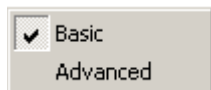
### Working Mode submenu

Fig. 4.2.1.3.-3 depicts the Working Mode submenu:



# Protocol Mapping Tool

## Operation Manual



menu\_settings\_mode

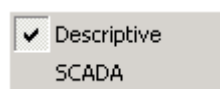
Fig. 4.2.1.3.-3 The Working Mode submenu

The Working mode submenu is composed of two menu toggles, Basic and Advanced, which are used to switch the Protocol Mapping Tool between the basic and the advanced working mode.

The basic and advanced modes are described in Section 2.2.1. Working modes.

### Conversion File Address Format submenu

Fig. 4.2.1.3.-4 depicts the Conversion File Address Format submenu:



menu\_settings\_address

Fig. 4.2.1.3.-4 The Conversion File Address Format submenu

The Conversion File Address Format submenu is composed of two menu toggles, Descriptive and SCADA, which are used to switch the address format used during exporting the binary point information into the conversion file.

- Descriptive address format is composed of a category identifier and a point address within the category (in case of Modbus, the subcategory identifier bounded by round brackets is also provided).

Table 4.2.1.3-1 and Table 4.2.1.3-2 show examples of descriptive and SCADA address formats.

**Table 4.2.1.3-1 Example of a descriptive address format:**

Protocol	Signal type	Address (visible in mapping tree)	Descriptive address
<b>Modbus</b>	Binary	Binary signal CO PDB 00139 - coil no. 139 defined in process data basic range	CO 00138 (PDB)
	Analog	HR PDE 00035 - holding register no. 35 defined in process data extended range	HR 00034 (PDE)
<b>DNP 3.0</b>	Binary	BI 00139 - binary input no. 140	BI 00139
	Analog	AO 00035 - analog output no. 36	AO 00035
<b>IEC 60870-5-101</b>	Binary	M_SP 00141	M_SP 00141
	Analog	M_ME 00035	M_ME 00035

Note! All descriptive addresses are **zero-based** counters.

- SCADA address format is composed of a category identifier and a point address within the category. In case of binary categories, all the addresses are grouped within 16-bit registers.

# Protocol Mapping Tool

## Operation Manual

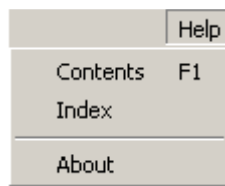
**Table 4.2.1.3-2 Example of a SCADA address format:**

Protocol	Signal type	Address (visible in mapping tree)	SCADA address
<b>Modbus</b>	Binary	CO PDB 00139 [139 = (8*16)+11]	CO 00008^10
	Analog	HR PDE 00035 - holding register no. 35 defined in process data extended range	HR 00034
<b>DNP 3.0</b>	Binary	BI 00139	BI 00008^11
	Analog	AO 00035	AO 00035
<b>IEC 60870-5-101</b>	Binary	M_SP 00141	M_SP 00008^12
	Analog	M_ME 00035	M_ME 00035

Note! All SCADA register numbers and bit numbers are **zero-based** counters.

### 4.2.1.4.

### Help menu



menu\_help

*Fig. 4.2.1.4.-1 The Help menu*

### Contents and Index

Both menu options are used to browse the Help menu's content.

Keyboard shortcut: <F1>

### About

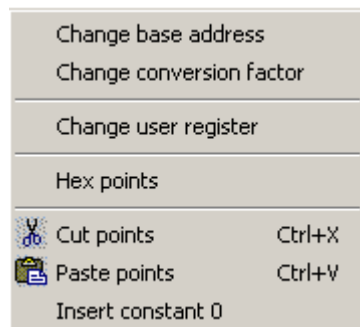
The About dialog contains the versions of the Protocol Mapping Tool and the pattern library supported by the tool.

### 4.2.2.

### Description of the pop-up menus

This section describes the pop-up menus available for the mapping tree in the Protocol Mapping Tool.

Fig. 4.2.2.-1 shows the components of the pop-up menu shown for the Modbus mapping tree in the main window:



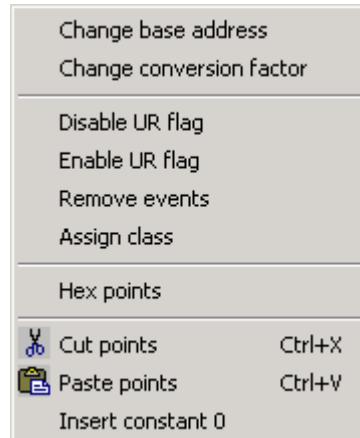
menu\_popup\_ref

*Fig. 4.2.2.-1 Pop-up menu for Modbus mapping*

# Protocol Mapping Tool

## Operation Manual

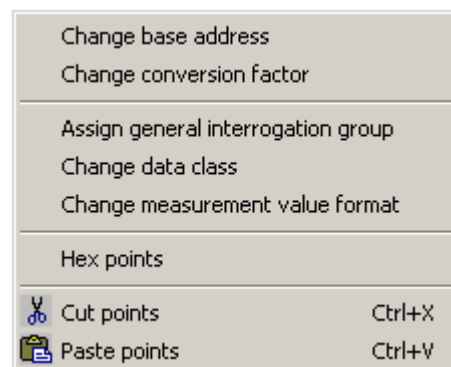
Fig. 4.2.2.-2 shows the components of the pop-up menu shown for the DNP 3.0 mapping tree in the main window:



menu\_popup\_dnp

Fig. 4.2.2.-2 Pop-up menu for DNP 3.0 mapping

Fig. 4.2.2.-3 shows the components of the pop-up menu shown for the IEC 60870-5-101 mapping tree in the main window:



menu\_popup\_IEC101

Fig. 4.2.2.-3 Pop-up menu for IEC 60870-5-101 mapping

All pop-up menu items make sense only for certain types of tree nodes, and each pop-up menu item is enabled only when the user selects the appropriate type of tree node within the mapping tree.

### 4.2.2.1.

## Menu items shared by Modbus, DNP 3.0 and IEC 60870-5-101

### Change base address

This pop-up menu item allows the user to change the base address of the selected data category. This menu item is described in detail in Section 5.4. Complex structures under “Base address editing.”

### Change conversion factor

This pop-up menu option is used to edit conversion factors of selected analog registers. See Section 4.2.3.5. Conversion factor editing for more details.

## Protocol Mapping Tool

### Operation Manual

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#### **Hex points/decimal points**

This pop-up menu item allows the user to toggle between hexadecimal and decimal values of addresses presented in the mapping tree. See Section 4.2.2.5. Selecting address format (Hex/Decimal Points) for more information.

#### **Cut points and Paste points**

These pop-up menu options allow the user to cut and paste selected registers within the same data category. These operations are thoroughly described in Section 4.2.3.3. Mapping editing under “Cut and paste operations.”

#### **4.2.2.2.**

#### **Modbus specific menu items**

##### **Change User Register**

This pop-up menu item enables the editing of the selected user register. See Section 5.4. Complex structures under “User registers editing” for more details.

##### **Insert Constant 0**

This pop-up menu item inserts a single Constant 0 point just behind the point being currently selected within the mapping tree. See Section 4.2.3.3. Mapping editing under “Constant 0 points” for more information.

#### **4.2.2.3.**

#### **DNP 3.0 specific menu items**

##### **Disable UR flag**

This menu option disables the unsolicited reporting flags of all the currently selected points. Section 6.5. Mapping editing features under “Unsolicited reporting management” describes this option in detail.

##### **Enable UR flag**

This menu option enables the unsolicited reporting flags of all the currently selected points. Section 6.5. Mapping editing features under “Unsolicited reporting management” describes this option in detail.

##### **Remove Events**

This menu item deletes the event definitions from all the currently selected points. See Section 6.5. Mapping editing features under “Removing events” for additional information.

##### **Assign Class**

Assign Class menu option is used to set the appropriate class to events produced by the currently selected points. See Section 6.5. Mapping editing features under “Class assignment” for additional information.

##### **Insert Constant 0**

This pop-up menu item inserts a single Constant 0 point just behind the point being currently selected within the mapping tree. See Section 4.2.3.3. Mapping editing under “Constant 0 points” for more information.

# Protocol Mapping Tool

## Operation Manual

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### 4.2.2.4. IEC 60870-5-101 specific menu items

#### Set Continuous Address Space

This menu option is used to switch to continuous addressing convention. More information is provided in Section 7.5.1. Edit menu under "Set continuous address space".

#### Assign General Interrogation Group

This menu item allows to change the GI assignment flag value for the selected data points. More information is provided in Section 7.4. Mapping editing features under "General interrogation assignment".

#### Change Measurement Value Format

This menu item allows to change the measurement format for the selected data points. More information is provided in Section 7.4. Mapping editing features under "Measurement value format change".

#### Change Data Class

This menu item allows to change the data class (priority) for the selected data points. More information is provided in Section 7.4. Mapping editing features under "Data class (priority) assignment".

### 4.2.2.5. Selecting address format (Hex/Decimal Points)

This operation concerns all the points defined within the edited mapping. Therefore, no tree node must be selected to execute the feature.

### 4.2.3. Mapping editing features

This section describes the general mapping editing features of the Protocol Mapping Tool. These functions are common for Modbus, DNP 3.0 and IEC 60870-5-101.

#### 4.2.3.1. Mapping management

The section describes which mapping management features are available during the mapping editing.

#### Creating a new mapping

To start the creation of a new mapping during the editing of another one, the user needs to:

- Select Create New Mapping in the File menu or
- Select the following toolbar button:



- or use the <Ctrl>+<N> keyboard shortcut

By selecting this feature, the user can abandon the editing of a current mapping and create a new one.

rod

# Protocol Mapping Tool

## Operation Manual

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The creation of a new mapping is always supervised by the Protocol Mapping Tool Wizard dialog. If a currently edited mapping is changed but not saved, the Protocol Mapping Tool will show a message box which induces the user to save a modified mapping.

For more information on the mapping creation process for Modbus, refer to Section 5.1.1. Creating a new mapping; for DNP 3.0, refer to Section 6.1.1. Creating a new mapping and for IEC 60870-5-101, refer to Section 7.1.1. Creating a new mapping.

### Opening of an existing mapping

This option allows the user to open an existing mapping stored within a project directory. The user can start the feature:

- By selecting Open Mapping File... in the File menu or
- By selecting the following toolbar button:



cap\_open

During this operation the mapping browser window will be shown to enable the selection of an existing mapping.

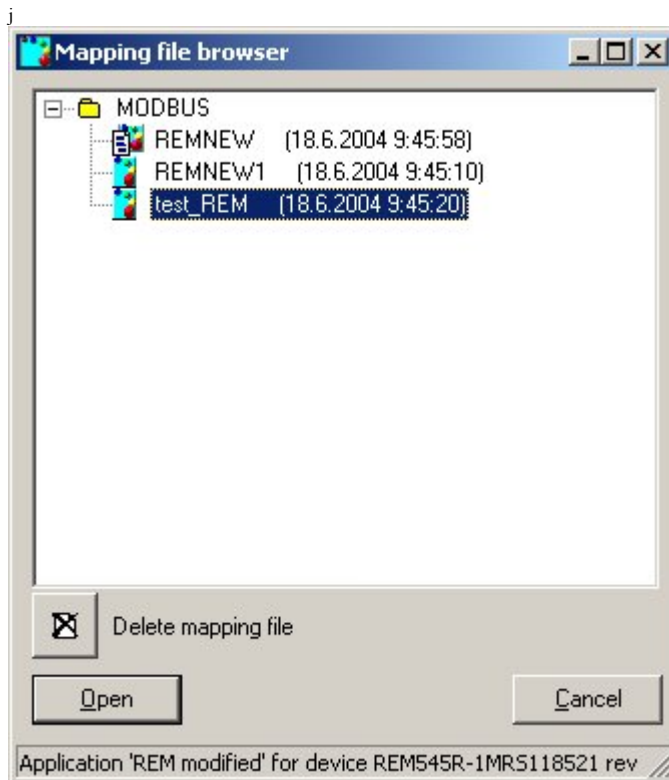
In the browser each stored mapping is marked with the following icon in the file tree (see Fig. 4.2.3.1.-1 below):



fpp

# Protocol Mapping Tool

## Operation Manual



prj\_browser

Fig. 4.2.3.1.-1 The mapping file browser



Although multiple mappings can be created for a single relay object, only one binary mapping file will be available in the CAP 505 directory.

A binary file is created when an edited mapping is saved with the “Save binary file”-option. In this case, the association between mapping and binary files is established. Mapping with an associated binary mapping file is marked with the following icon:



fppjbin

It is possible that in the beginning only a binary mapping file will be available for a certain object. In this case, it will be marked with the following icon:



fbin

If a mapping, with an associated binary mapping file is changed, but the associated binary mapping file is not updated, it will also appear in the tree as a separate node (because the association no longer exists).

The Delete mapping file button allows the user to remove any mapping file, which exists in the browsed location. Neither a binary file nor a mapping file related to the binary file can be deleted.

## Protocol Mapping Tool

### Operation Manual

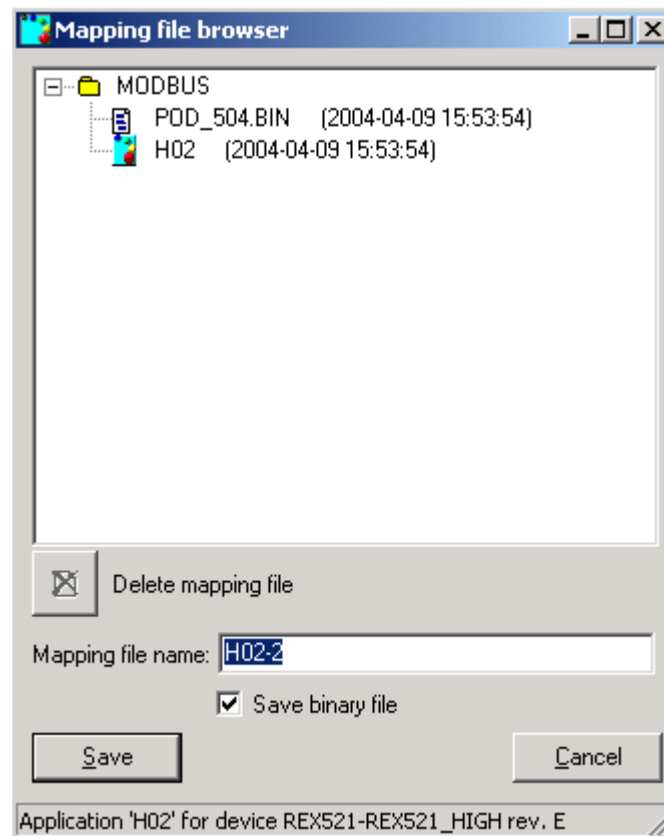
#### Saving an edited mapping

The mapping and the binary mapping file can be stored in the appropriate CAP 505 project directory by using either:

- The Save Mapping File... available in the File menu or
- The following toolbar button:



cap\_save



save

*Fig. 4.2.3.1.-2 Mapping save dialog*

The Save Binary File check box allows the user to create a binary file associated with the saved mapping (used later by the Relay Download Tool in device configuration process).



The name of the binary mapping file is automatically set.



# Protocol Mapping Tool

## Operation Manual

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### 4.2.3.2.

### Mapping export

This section presents the export features provided by the Protocol Mapping Tool.

#### Exporting of mapping information

Mapping information can be exported by selecting Export Document File... in the File menu. This option is used for documentation purposes and it allows the user to export complete information concerning the currently edited mapping.

Export information is composed of:

- A general description
- A list of function blocks
- A list of signals covered by the mapping + their addresses

Export information can be saved as a HTML or text file. If it is saved as a text file after exporting a table, the user can open the text file with an external tool. The columns within a text file are separated by tabulator signs. The formats of export files generated for different protocols are also different.



Exported files cannot be imported back into the Protocol Mapping Tool.

#### Exporting of point information

Mapping information can be exported by selecting Export Conversion File... in the File menu. This feature allows the user to export complete information concerning the points defined in the edited mapping.

Export information is composed of rows. Each row contains information concerning a single point:

- Address
- Signal description
- Scaling factor
- Value range
- Unit of measure, etc.

Address format can be changed by selecting the appropriate toggle in Conversion File Address Format option in the Settings menu (see Section 4.2.1.3. Settings menu, Conversion File Address Format submenu for more details).

Export information can be saved as a text file and the user can open it with an external tool. The columns within a text file are separated by tabulator signs.

The formats of export files generated for different protocols are very similar. Exported files cannot be imported back into the Protocol Mapping Tool.

For more information on the Export file format, see the Appendix at the end of this manual.

## Protocol Mapping Tool

### Operation Manual

#### 4.2.3.3.

### Mapping editing

This section describes all the editing features available within the Protocol Mapping Tool.

#### Adding new points



This option is available in the advanced mode.

To add new points to the mapping, the user has to:

- Select Add points in the Edit menu or
- Select the following toolbar button or



plus

- Use the <Ins> keyboard shortcut

This feature allows the user to add new points into the mapping. Selecting Add Points in the Edit menu shows the Add Points dialog as presented in Fig. 4.2.3.3.-1.

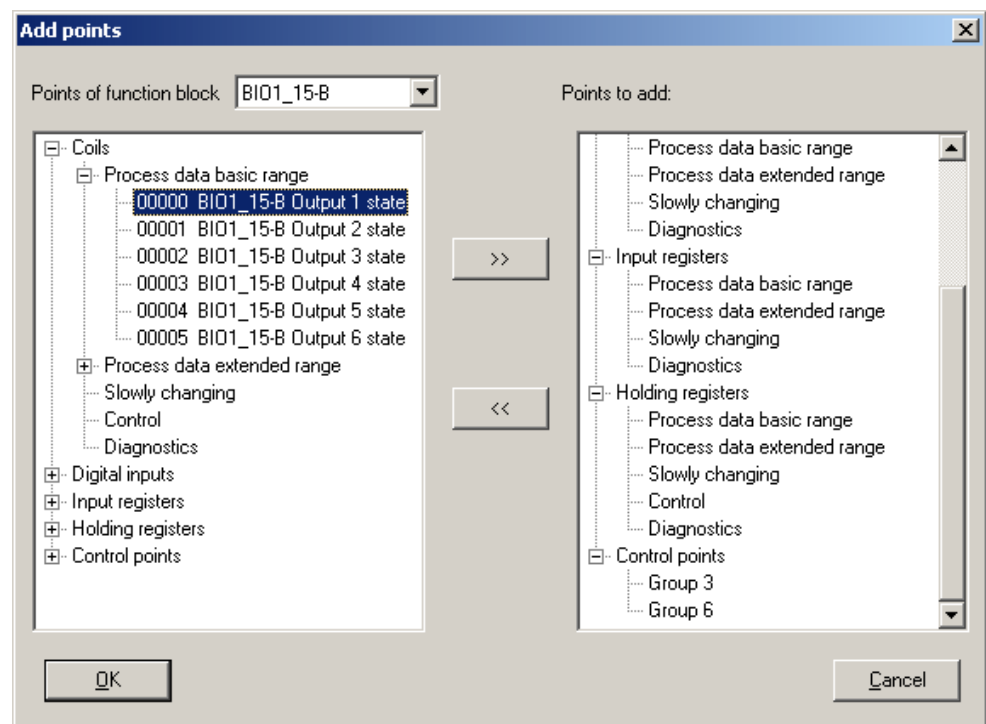


Fig. 4.2.3.3.-1 Add Points dialog

The left tree of the Add Points dialog shows all the points available to be added for the selected pattern. The right tree contains all the points selected by the user.

The user may select required points in the left tree and press the >> button to copy them into the right tree. A particular point can be added more than once.

# Protocol Mapping Tool

## Operation Manual

The user may also select a point and click the << button to remove that point from the right tree. More than one point can be selected.

When the user presses the OK button, all the points stored in the right tree are added to a current mapping at the end of the current point list.

To see the points available for another pattern, the user has to select an appropriate pattern in the top-most combo box called “Points of function block” (see Fig. 4.2.3.3.-1).

### Removing existing points



This option is available in the advanced mode.

If required, unnecessary points can be removed from the mapping. The Protocol Mapping Tool removes the currently selected points.

To start this operation the user should:

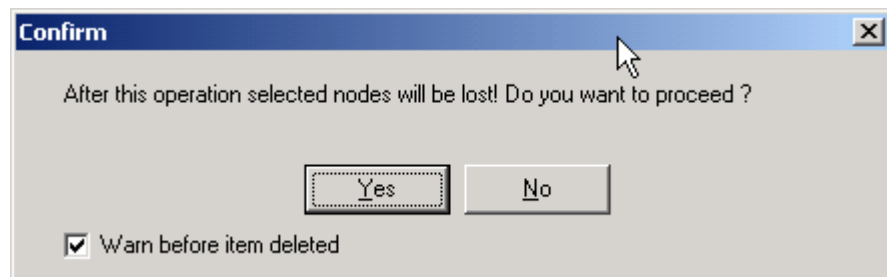
- Select Delete Points from the Edit menu or
- Select the following toolbar button:



minus

- Use <Del> keyboard shortcut

By default, an additional warning is shown when the user tries to remove any point from the current mapping. The warning is skipped when the Warn Before Item Deleted option in the Settings menu is unchecked. The user can also quickly uncheck this option when the warning is shown (see Fig. 4.2.3.3.-2).



delete\_confirm

Fig. 4.2.3.3.-2 Confirmation dialog during point deletion

### Cut and paste operations.



These options are available in the advanced mode.

Cut and paste operations are used to move selected points.

Cut operation is available by:

## Protocol Mapping Tool

### Operation Manual

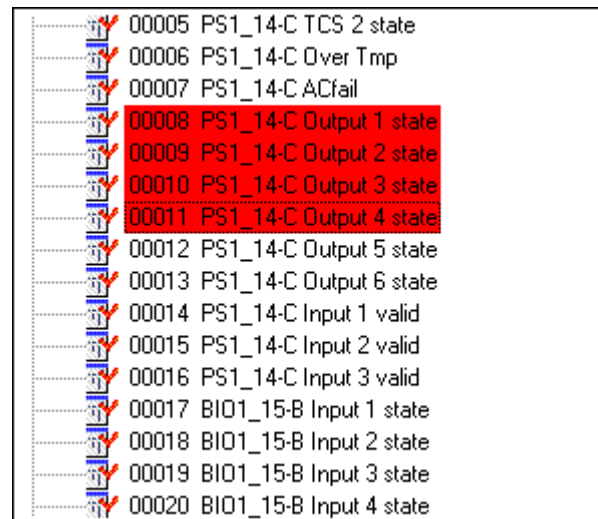
- Selecting Cut points in the Edit menu or
- Selecting Cut points in the pop-up menu or
- Clicking the following toolbar button



sciz

- Using keyboard shortcut: <Ctrl>+<X>

Protocol Mapping Tool cuts the currently selected points. Cut points stay in the same position and wait for the Paste Points operation to be executed.



cut\_points

*Fig. 4.2.3.3.-3 Cut points*

Paste operation is executed when the user:

- Selects paste points in the Edit menu or
- Selects paste points in the pop-up menu or
- Clicks the following toolbar button or



paste

- Uses keyboard shortcut: <Ctrl>+<V>

Cut points are always pasted just behind points being currently selected as a destination location. If the user wants to paste cut points at the beginning of the data category, a data category branch must be selected as a destination location.

The Protocol Mapping Tool does not allow moving points between different data categories.

It is also possible to use drag&drop in order to move selected points within the mapping tree.

Point dragging is started when the user clicks and holds the left mouse button over the area occupied by selected points. During dragging all the dragged points are marked as cut (their background color is red) and the cursor is changed (see Fig. 4.2.3.3.-4):

# Protocol Mapping Tool

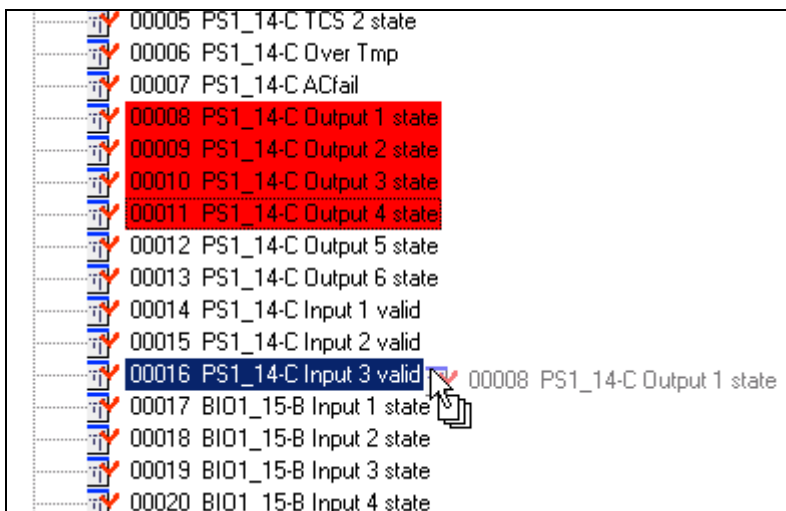
## Operation Manual



drag\_cursor

Fig. 4.2.3.3.-4 A drag&drop cursor

To finish the drag&drop operation, the user has to release the left mouse button. In this case, dragged points are dropped into the location pointed by the cursor (just behind points being currently selected as a destination location).

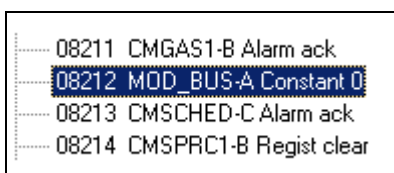


drag\_operation

Fig. 4.2.3.3.-5 A drag&drop operation

### Constant 0 points

A Constant 0 point is a special point that has a conversion factor equal to DUMMY\_0. All Constant 0 points always return 0 and have no special meaning. Therefore, they can be used to fill gaps between two separated sub-ranges of points within the same data category (see Fig. 4.2.3.3.-6).



constant\_0\_reg

Fig. 4.2.3.3.-6 Constant 0 register

### 4.2.3.4.

### Verification against patterns



This option is available in the advanced mode.

Verification against patterns compares existing points in the mapping with the points defined in the current patterns. If differences are found, the user is notified and given a chance to change such points within the mapping.

# Protocol Mapping Tool

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Mapping verification shows differences in the mapping, if any pattern is updated. It is a convenient solution for maintaining mappings, when patterns are revised.

The mapping verification is started by:

- Selecting Verify Against Patterns in the Edit menu or
- Using <Ctrl>+<A> keyboard shortcut

The result of the mapping verification is shown in a separate window as a set of message lines describing individual verification differences (see Fig. 4.2.3.4.-1).

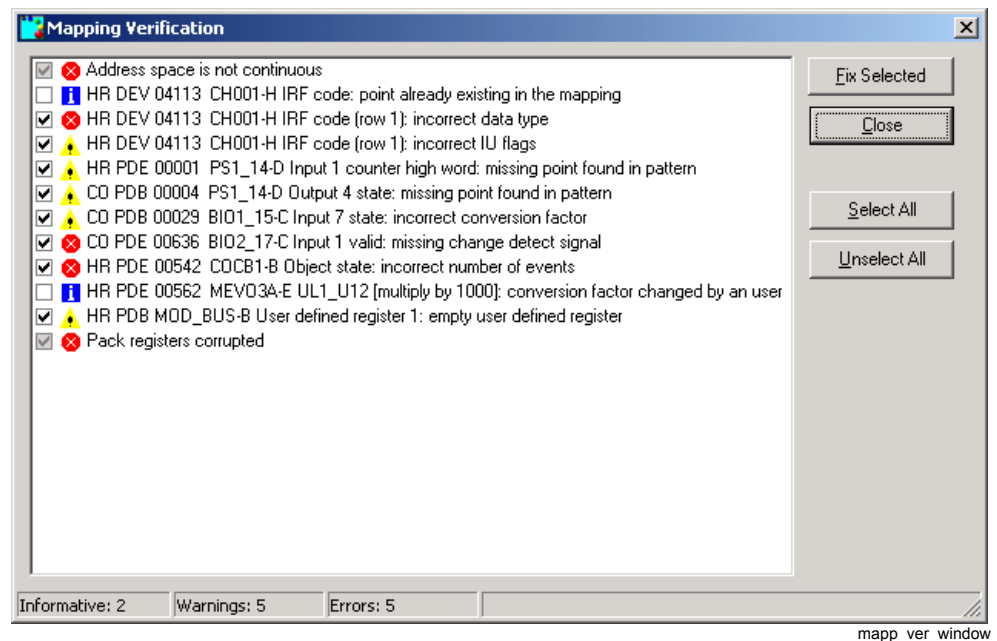


Fig. 4.2.3.4.-1 Results of the mapping verification before fixing

All the messages are shown in three categories distinguished by appropriate icons:

### 1. Errors



msg\_error

### 2. Warnings



msg\_warning

### 3. Informative



msg\_info

To solve the problems shown by the mapping verification, the user has to check the appropriate check boxes and press the Fix Selected button. Errors and warnings have their check boxes selected by default.

# Protocol Mapping Tool

## Operation Manual

The mapping verification is capable of detecting and solving the following problems:

**Table 4.2.3.4-1 Mapping verification messages**

Message/Problem	Message category	Fixing
<b>Common messages:</b>		
Address space is not continuous	Error	Points readdressed
Point already existing in the mapping	Informative	Point removed
Missing point found in pattern	Warning	Point added to the mapping
Point added from not default pattern	Warning	Point removed
Point not existing in pattern	Error	Point removed
Unknown point found in pattern	Error	Point removed
Unknown error detected (Invalid flag active)	Warning	Flag cleared
Incorrect block detected (No block flag active)	Warning	Flag cleared
Incorrect point definition detected (No object flag active)	Warning	Flag cleared
Point updated (Corrected flag active)	Warning	Flag cleared
Incorrect number of events	Error	Events restored
(row #) Incorrect database name	Error	Database name restored
(row #) Incorrect datatype	Error	Datatype restored
(row #) Incorrect IU flags	Warning	IU flags restored
Editable conversion factor changed by a user	Informative	Default conversion factor restored
Point having incorrect conversion factor	Warning	Default conversion factor restored
<b>Modbus specific messages:</b>		
Pack registers corrupted	Error	Pack registers restored
Missing change detect signal	Error	Change detect signal restored
Orphaned change detect signal	Error	Change detect signal removed
·User-defined registers		
Empty user-defined register	Error	User-defined register removed
User register maps an already mapped analog registers	Warning	User-defined register removed
User register in slot # maps an already mapped binary register	Warning	Slot # cleaned up
·Control structures		
Control structure corrupted	Error	Control structure removed
Missing control point found in pattern	Warning	Control point added to the mapping (but not added to a control structure)
Control point added from not default mapping	Warning	Control point removed
Control point not existing in pattern	Error	Control point removed

## Protocol Mapping Tool

## Operation Manual

**Table 4.2.3.4-1 Mapping verification messages**

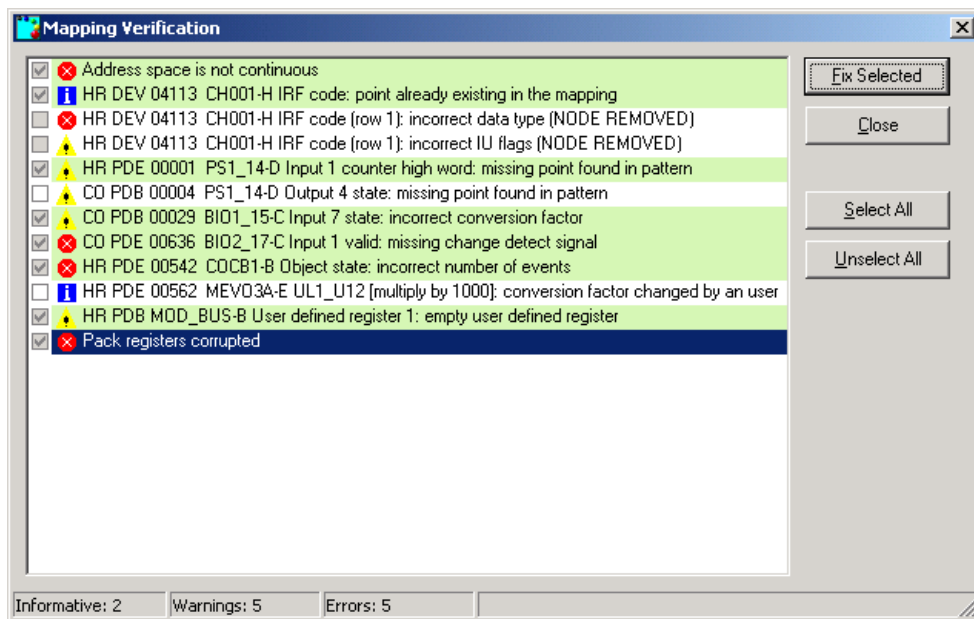
Message/Problem	Message category	Fixing
Unknown control point found in the mapping	Error	Control point removed
<b>DNP specific messages:</b>		
Events removed	Informative	Events restored
(row #) Incorrect default variation mask	Warning	Default variation mask restored
(row #) Incorrect default function mask	Warning	Default function mask restored
Incorrect static point's class	Error	Class 0 restored
Event's class changed by a user	Informative	Default class restored
Incorrect event class	Error	Default class restored
Unsolicited reporting flag deactivated by a user	Informative	Default unsolicited reporting flag restored
Incorrect unsolicited reporting flag	Error	Default unsolicited reporting flag restored
<b>IEC 60870-5-101 specific messages:</b>		
Assignment to general interrogation group changed by the user	Informative	Default interrogation group restored
Incorrect assignment to general interrogation group	Error	Default interrogation group restored
Measurement value format changed by the user	Informative	Default measurement value format restored
Incorrect measurement value format	Error	Default measurement value format restored
Data class changed by the user	Warning	Default data class restored
Incorrect data class	Error	Default data class restored

When the Fix Selected button is clicked, all the verification differences having their check boxes checked are fixed. However, they are not all removed from the list but are distinguished by changing their background color into light green (see Fig. 4.2.3.4.-2).



# Protocol Mapping Tool

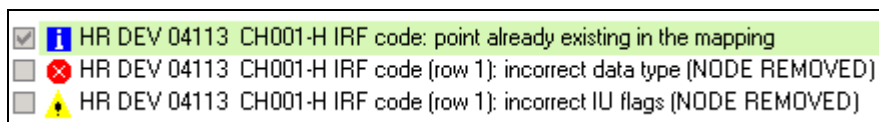
## Operation Manual



mapp\_ver\_wind\_fixed

Fig. 4.2.3.4.-2 Fixed and remaining verification differences available in the mapping verification window.

Any point defined in the verified mapping may have more than one verification difference at the same time. If the fixing of a problem consists of removing the whole point from the mapping (e.g. see Fig. 4.2.3.4.-3 and “Point already existing in the mapping”), a description "(NODE REMOVED)" is added to all the other differences related to the removed point.



mapp\_ver\_wind\_removed

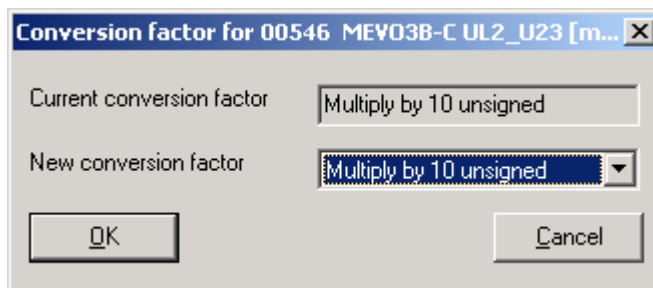
Fig. 4.2.3.4.-3 Maintaining verification differences for removed points

### 4.2.3.5.

#### Conversion factor editing

A Change Conversion Factor menu option is used to edit conversion factors of selected analog registers.

Fig. 4.2.3.5.-1 depicts the conversion factor editor.



conv\_factor\_editor

Fig. 4.2.3.5.-1 The conversion factor editor

## Protocol Mapping Tool

### Operation Manual

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The conversion factor editing is possible only for analog points of data type EV\_REAL and one of the conversion factors listed above set. Other analog points have the operation disabled.



If the operation is executed for more than one register and the selected registers have no common conversion factor, the conversion factor editor will present the "Multiply by 1" value by default (regardless of conversion factors being set within all edited registers).

# Protocol Mapping Tool

## Operation Manual

### 5. Modbus

This chapter provides detailed description of all the Protocol Mapping Tool features supporting the Modbus protocol.

#### 5.1. Protocol Mapping Tool Wizard

The user can decide whether to create a new mapping, open an existing one or import a mapping from a different relay object. It is also possible to delete mappings no longer needed.

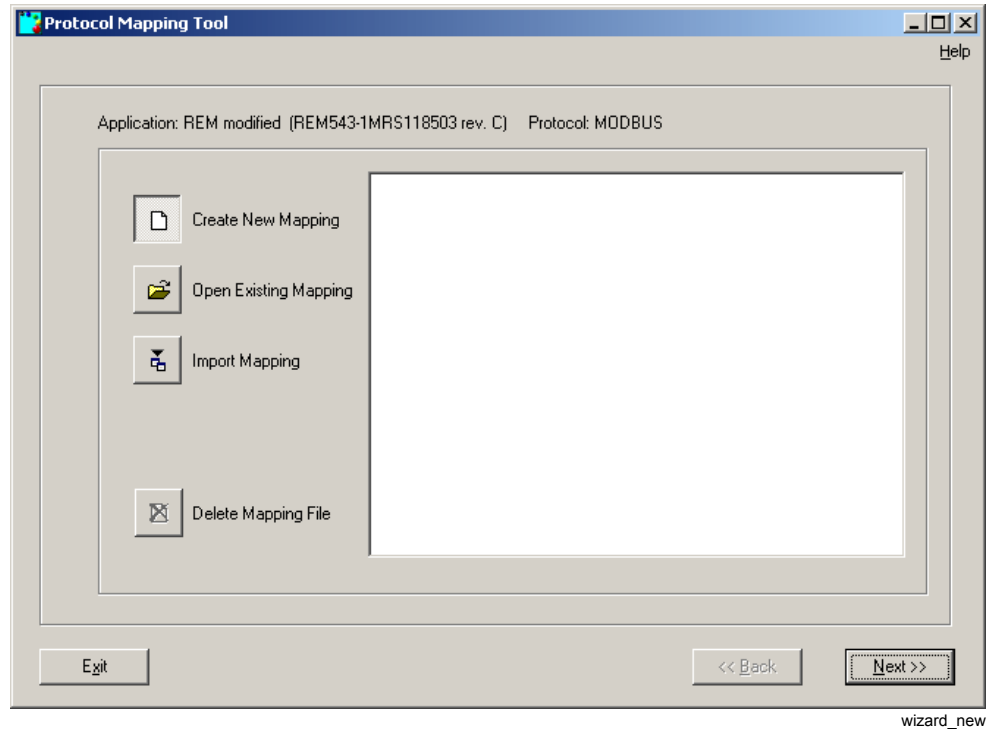


Fig. 5.1.-1 The Protocol Mapping Tool Wizard

#### 5.1.1. Creating a new mapping

Supported categories and their default addresses differ from various terminals. They are presented in Fig. 5.1.1.-1 (REM 54\_) and in Fig. 5.1.1.-2 (REF 54\_ and RET 54\_).

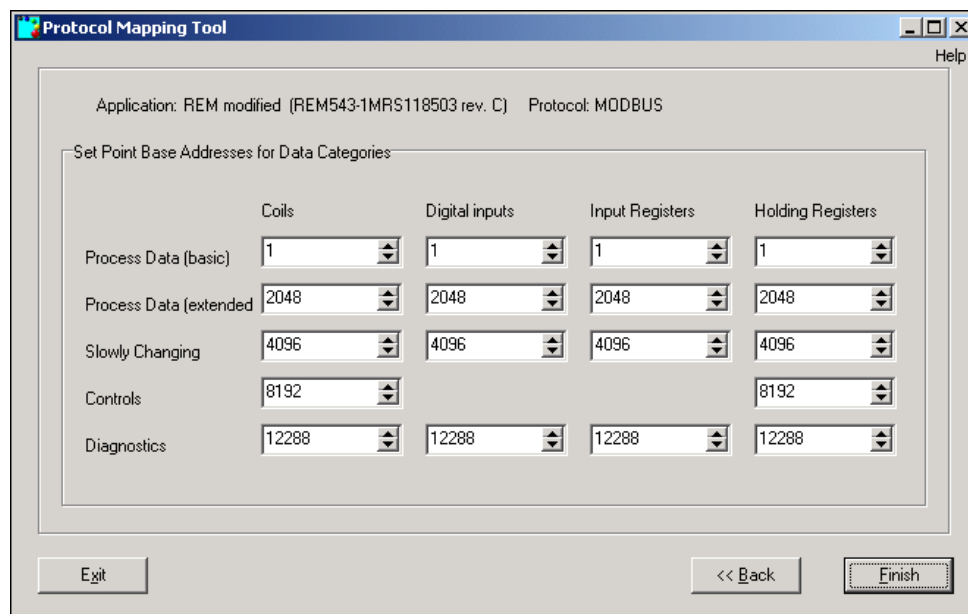
#### Choosing the point base addresses of data categories

Selected addresses can be changed later during the editing. This is described later in this chapter under Base address editing. An Overlapping-check is performed for the Modbus protocol, which is described under Overlapping check.

## Protocol Mapping Tool

## Operation Manual

## REM 54\_terminal



wizard\_iec

Fig. 5.1.1.-1 Choosing the point base addresses of data categories (for the REM 54\_terminal).

#### Supported data types:

- Coils
- Digital Inputs
- Input Registers
- Holding Registers

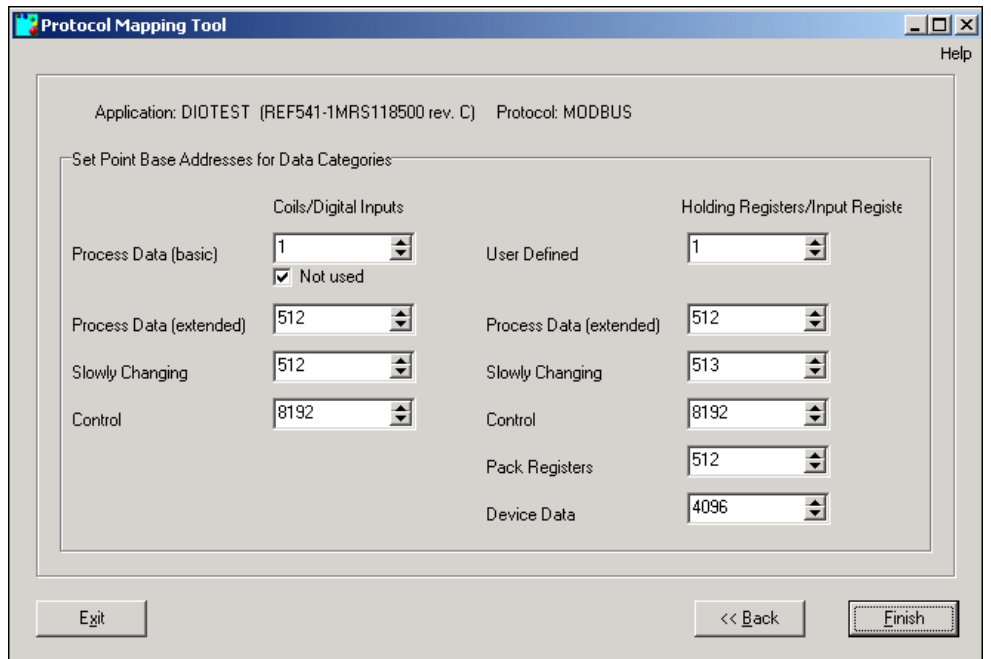
#### Category of data points:

- Process Data (basic): state values mapped to Digital Inputs (basic address range of Digital Inputs)
- Process Data (extended): two Digital Inputs points per signal - state value followed by momentary Change detect bit in the consecutive address (extended address range of Digital Inputs)
- Slowly Changing: Slowly changing binary data (without change events)
- Control: Control parameters
- Diagnostics: Diagnostic parameters

# Protocol Mapping Tool

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### REF 54\_ and RET 54\_ terminals



wizard\_ref

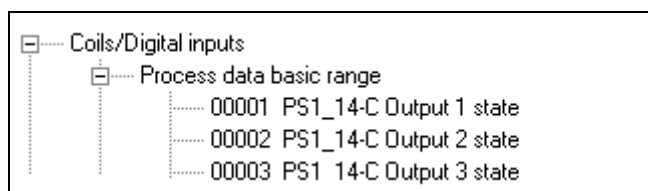
Fig. 5.1.1.-2 Choosing the point base addresses of data categories (for REF 54\_ and RET 54\_ terminals).

After performing this step, the Protocol Mapping Tool will open with a new mapping.

## 5.2.

### Mapping tree

All the points maintained by a mapping are put into several different categories and subcategories. Such categories and subcategories create branches of a mapping tree (see Fig. 5.2.-1):



mapping\_tree

Fig. 5.2.-1 A piece of mapping tree showing its branches and leaves

Table 5.2.-1 Elements visible in Fig. 5.2.-1:

Data category:	Coils/Digital inputs
Data subcategory:	Process data basic range
Point:	00003 PS1_14-C Output 3 state

The number of categories/subcategories and the way points are mapped into those categories depend on the selected application.

# Protocol Mapping Tool

## Operation Manual

**Table 5.2.-2 Mapping tree register elements:**

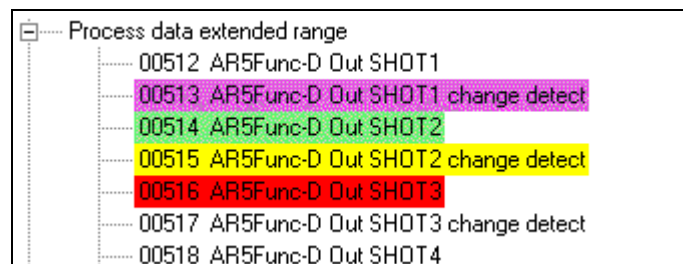
Address	00003 (or 0003H hexadecimal address format is selected)
Function	PS1_14
Function revision	C
Description	Output state 3

If a mapping is read from a device, some points may have warning flags set. There are four warning flags:

1. Invalid (entry for a given point contains invalid information - point removed from the data map)
2. Corrected (the entry for a given point contained incorrect information and was corrected by the device during mapping parsing)
3. No block (the device application does not have a function that contains this data - point removed from the data map)
4. No object (the device application does have a function, but there is no such data item - point removed from the data map)

Tree nodes, which represent registers with warning flags set, have different background colors (see Fig. 5.2.-2):

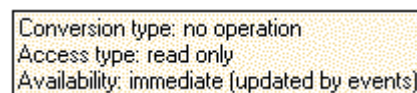
- Purple background color indicates object flag set
- Light green background color indicates no block flag set
- Yellow background color indicates corrected flag set
- Red background color indicates incorrect flag set



warning\_flags\_modbus

*Fig. 5.2.-2 The example of tree nodes indicating active warning flags*

When the user leaves the cursor over a tree node for a while, a tooltip window will be shown (see Fig. 5.2.-3).



tooltip\_modbus

*Fig. 5.2.-3 Tooltips for a Modbus register*

The following tooltip is shown if the user leaves the cursor over an addressed data category or data object, i.e. "Coils\Process data extended range" within the Modbus mapping tree (see Fig. 5.2.-4):

# Protocol Mapping Tool

## Operation Manual

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Starting offset: 02048

tooltip\_datac

*Fig. 5.2.-4 Tooltip window for an addressed data category*

The structure of the mapping tree during the editing of Modbus mapping depends on the selected device.

Each Modbus mapping tree is composed of three kinds of data objects:

1. Data types
2. Data (sub)categories
3. Data points

The former two data objects are tree branches, whereas the latter one is always a leaf.

A Modbus-dependent mapping tree is composed of up to four Modbus data types (main categories) and each Modbus data type is composed of up to five data categories. All Modbus points are mapped into one of the available Modbus data categories.

## 5.3.

### Mapping conventions

#### 5.3.1.

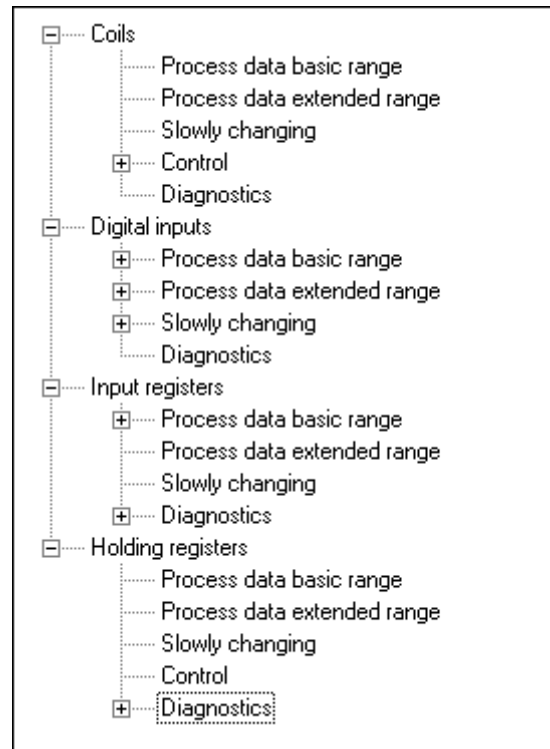
#### Mapping convention of REM 54\_

- Simple (1 to 1) mapping of application data into Modbus types
- All read-only binary data (function block inputs and outputs) are mapped into digital inputs
- Switching device position (2-bit) is mapped into three digital inputs (open/close state on two digital inputs and faulty state indication on the third digital input) and additionally to an input register, containing a switch state encoded on 2 bits (0 - middle, 1 - close, 2 - open, 3 - faulty)
- Control operations are made via coils
- All measurements are mapped into input registers
- Parameters and settings are mapped into holding registers
- Change detect flags are associated with binary inputs and outputs
- User-defined holding registers are used for grouping selected data mapped into digital inputs and coils or input registers

Fig. 5.3.1.-1 shows data categories for REM 54\_.

## Protocol Mapping Tool

## Operation Manual



mt\_modbus\_rem

Fig. 5.3.1.-1 Data categories within a mapping tree for REM 54\_

## 5.3.2.

### Mapping convention of REF 54\_ and RET 54\_

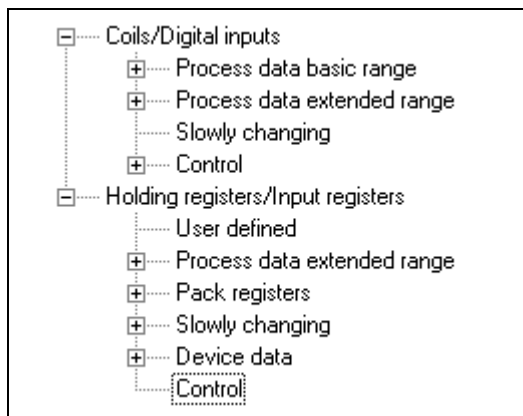
- Digital data points are readable Coils or Digital Inputs
- Analog data points are readable Holding Registers or Input Registers
- Points defined as basic range process data Coils/Digital Inputs are created optionally
- Switching device position (2-bit) is mapped into three digital inputs (open/close state on two digital inputs and faulty state indication on the third digital input) and additionally to an input register, containing a switch state encoded on 2 bits (0 - middle, 1 - close, 2 - open, 3 - faulty)
- Pack Registers is a data category composed of automatically created 16-bit read-only registers containing basic range and extended range process data Coils
- Device Data is a data category
- Basic range process data category in Holding Registers/Input Registers is used to store user-defined registers, which are provided for grouping selected data mapped into digital inputs and coils or holding registers
- Measurement data points are placed in Extended range Holding Registers/Input Registers
- Diagnostic data category is not supported (Diagnostic points are converted into Slowly Changing signals)
- Control structures and user-defined registers are not supported (these points are dropped)

Fig. 5.3.2.-1 shows data categories for REF 54\_ and RET 54\_.



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mt\_modbus\_ref

Fig. 5.3.2.-1 Data categories within a mapping tree for the REF 54\_ and RET 54\_

## 5.4.

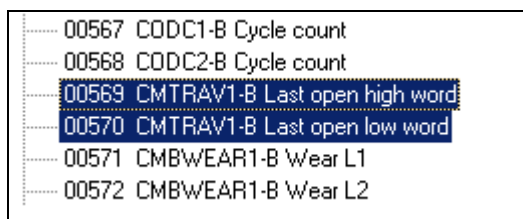
### Complex structures

Modbus mappings support complex structures. In some cases such structures are composed of many registers presented as a compact undividable set of nodes within a mapping tree.

### Low Word/High Word Analog Registers

Low Word Analog Register and High Word Analog Register forms a structure of two compact registers and are used to map 32-bit values (2 x 16-bit registers).

Fig. 5.4.-1 presents an example of a Low/High Word structure:



lowhigh\_word\_reg

Fig. 5.4.-1 Low and High Word Analog Registers

Appropriate Low and High Word Analog Registers cannot be split. These are always next to each other and is treated as a single structure.

### Analog points having an editable conversion factor

Some analog points have a conversion factor, which can be changed by using the appropriate menu option. The editable conversion factors are:

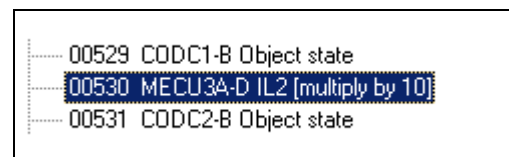
- Multiply by 1 (no operation)
- Multiply by 10 unsigned
- Multiply by 100 unsigned
- Multiply by 1000 unsigned
- Divide by 10 unsigned

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- Divide by 100 unsigned
- Divide by 1000 unsigned
- Multiply by 10 signed
- Multiply by 100 signed
- Multiply by 1000 signed
- Divide by 10 signed
- Divide by 100 signed
- Divide by 1000 signed

Analog registers having editable conversion factors are presented as single registers with an additional description of the current conversion factor inside square brackets (see Fig. 5.4.-2).



analog\_reg\_conv\_factor

Fig. 5.4.-2 Example of an analog register having an editable conversion factor

### User Registers (User-Defined Registers)

User-defined registers are used to map the different already existing data points into a shared data category (user registers are mapped as Holding Registers within Process data basic range/User-Defined data category).

A single user-defined register is able to load:

- One analog register (Holding Register or Input Register)
- Up to 16 binary points (Coils or/and Digital Inputs)

A User Register containing an analog register is called a user analog register, whereas a user register containing up to 16 binary points is called a user bit-field register.

Fig. 5.4.-3 below depicts the user registers within a mapping tree:

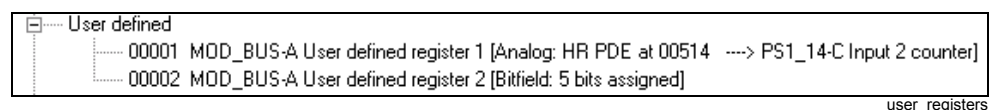


Fig. 5.4.-3 Analog user register and bit-field user register

User registers are created as Holding Registers within the Process Data Basic Range (alias User Defined Registers) data category. The user register's identification number and its address are assigned automatically.

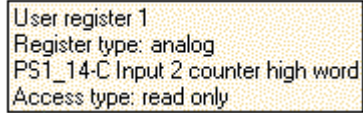
The user register's identification number is seen as a part of the name in the mapping tree, i.e. the following description 'User defined register 3 [Bit field: 10 bits assigned]' refers to the user register no. 3.

The description of a user register presented in the mapping tree contains an additional section (bounded by square brackets), which describes the type and content of the user register.

# Protocol Mapping Tool

## Operation Manual

The information presented in a tooltip window contains an even more detailed description of the user register: an identification number (i.e. User register 2), register's type (i.e. Register type: bitfield) and a list of mapped registers (see Fig. 5.4.-4 and Fig. 5.4.-5):

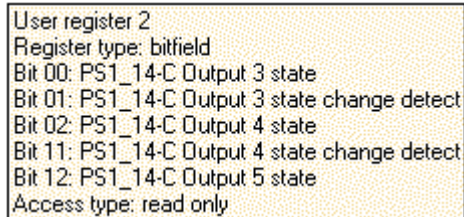


```

User register 1
Register type: analog
PS1_14-C Input 2 counter high word
Access type: read only
  
```

tooltip\_modbus\_ura

Fig. 5.4.-4 Tooltips for an analog user register



```

User register 2
Register type: bitfield
Bit 00: PS1_14-C Output 3 state
Bit 01: PS1_14-C Output 3 state change detect
Bit 02: PS1_14-C Output 4 state
Bit 11: PS1_14-C Output 4 state change detect
Bit 12: PS1_14-C Output 5 state
Access type: read only
  
```

tooltip\_modbus\_urb

Fig. 5.4.-5 Tooltips for a bit-field user register

The Protocol Mapping Tool is able to manage up to 256 user defined registers in a single mapping.

## Pack Registers



Pack registers are supported only in Modbus-dependent mappings created for REF 54\_ and RET 54\_ devices.

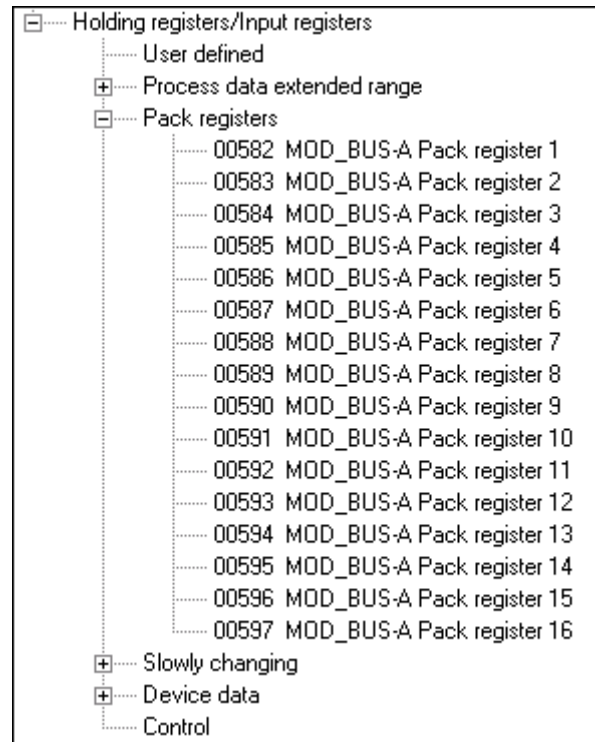
Pack registers are provided for packing a sequence of digital signals in the order determined by the order of coils on the Modbus map. Each pack register contains up to 16 binary points mapped from basic and extended process data ranges of coils.

Pack registers are read-only registers, which are created automatically when a mapping is created and updated any time a mapping is changed.

Pack registers are stored as holding registers in a separate data category (see Fig. 5.4.-6).

## Protocol Mapping Tool

## Operation Manual



pack\_registers

Fig. 5.4.-6 Pack registers

Tooltip information presented for pack registers allows the user to check which coils are mapped.

Tooltip information is composed of a source data category and a list of mapped binary registers.

```

MOD_BUS-A Pack register 6
Source data category: CO.PDE
Register type: bitfield
Bit 01: Freq1St1-F Output START1
Bit 02: Freq1St1-F Output START1 change detect
Bit 03: Freq1St1-F Output TRIP1
Bit 04: Freq1St1-F Output TRIP1 change detect
Bit 05: Freq1St1-F Output START2
Bit 06: Freq1St1-F Output START2 change detect
Bit 07: Freq1St1-F Output TRIP2
Bit 08: Freq1St1-F Output TRIP2 change detect
Bit 09: Freq1St2-F Input BS1
Bit 10: Freq1St2-F Input BS1 change detect
Bit 11: Freq1St2-F Input BS2
Bit 12: Freq1St2-F Input BS2 change detect
Bit 13: Freq1St2-F Output START1
Bit 14: Freq1St2-F Output START1 change detect
Bit 15: Freq1St2-F Output TRIP1
Bit 16: Freq1St2-F Output TRIP1 change detect
Access type: read only
  
```

tooltip\_modbus\_pr

Fig. 5.4.-7 A tooltip for a certain pack register

# Protocol Mapping Tool

## Operation Manual

### Creation of Constant 0 points



This option is available in the advanced mode.

The user can insert a Constant 0 point by selecting the "Insert Constant 0" option:

- In the Edit menu or
- From the Edit window's pop-up menu

A Constant 0 point is always put just behind points selected as a destination location. If the user wants to put a Constant 0 point at the beginning of the data category, the data category branch must be selected as a destination location.

Constant 0 points are also used to replace not supported points during the mapping file import.



Add 15 constant 0 points to the end of the data category. That makes it possible to define the polling topic easier. The topic needs to be a number of full 16 bits words. If the topic contains more bits than exists in the relay's data category, the relay answers nothing to the poll.

### Base address editing

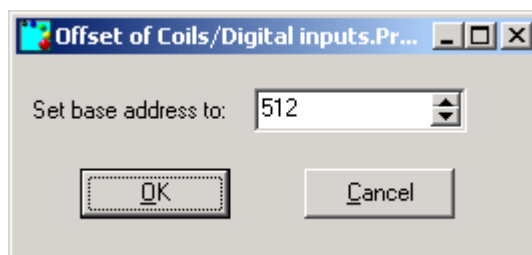


This option is available in the advanced mode.

The "Change base address" pop-up menu item allows the user to change the base address of the selected data category.

As a result, all the registers within such a data category are readdressed.

A dialog box is used to enter a new base address (see Fig. 5.4.-8).



base\_address\_edition

Fig. 5.4.-8 Base address editor

The format of an edited address (either decimal or hexadecimal value) presented in the base address editor depends on the format of the addresses presented in the mapping tree.

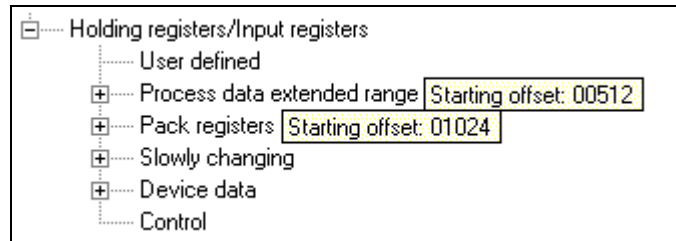
## Protocol Mapping Tool

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#### The order of data categories within Modbus mapping



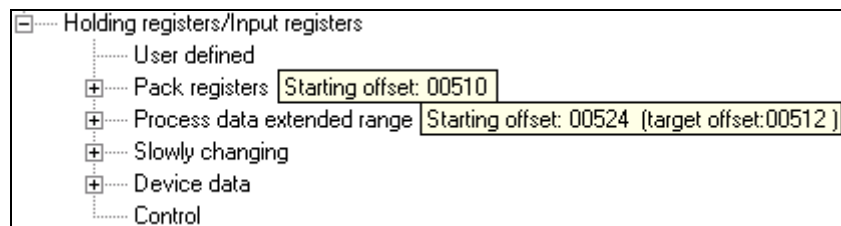
For Modbus mappings, readdressing is often connected with the changing of the location of Modbus data categories to preserve their correct order in the mapping tree, i.e. the given five data categories within the "Holding registers/Input registers" data type (see Fig. 5.4.-9).



modbus\_addr\_ed1

Fig. 5.4.-9 The order of Modbus data categories before the base address change

Changing the base address of the "Pack registers" data category (from address 1024 to address 510) will change the sequence of data categories as well - "Pack registers" category is ahead of "Process data extended range" category (see Fig. 5.4.-10).



modbus\_addr\_ed2

Fig. 5.4.-10 The order of Modbus data categories after the base address of "Pack registers" category was changed to address 510.

Apart from that, the overlapping check operation proceeded (it is active by default) and moved the overtaken category (from address 512 to address 524) to avoid the address conflicts.

#### Overlapping check



This option is available in the advanced mode.

The Overlapping check can be started by selecting Check Overlapping in the Overlapping submenu within the Edit menu.

This menu feature starts the procedure of the data category address range checking within Modbus data types to determine whether any data category begins at a memory address, which is reserved by registers belonging to other data category. When that kind of memory arrangement occurs the overlapping check procedure will change the base address of the latter data category (and move its registers into a new location).

# Protocol Mapping Tool

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The Auto Check menu toggle in the Overlapping submenu within the Edit menu is also available. It is used to enable/disable the automatic start of the Overlapping check procedure each time the mapping has been changed during the editing.

By default, auto check is enabled.

### User registers editing



This option is available in the advanced mode.

The creation of a new user-defined register is started by:

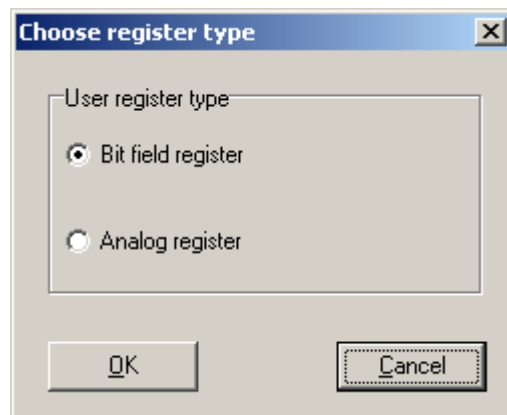
- Selecting the User Register menu item in the Create submenu in the Edit menu or
- Selecting the following toolbar button or



create\_ur

- Using <Ctrl>+<U> keyboard shortcut

Since the Protocol Mapping Tool supports two kinds of user registers, the user has to select the type for a new user register (see Fig. 5.4.-11).



ur\_create

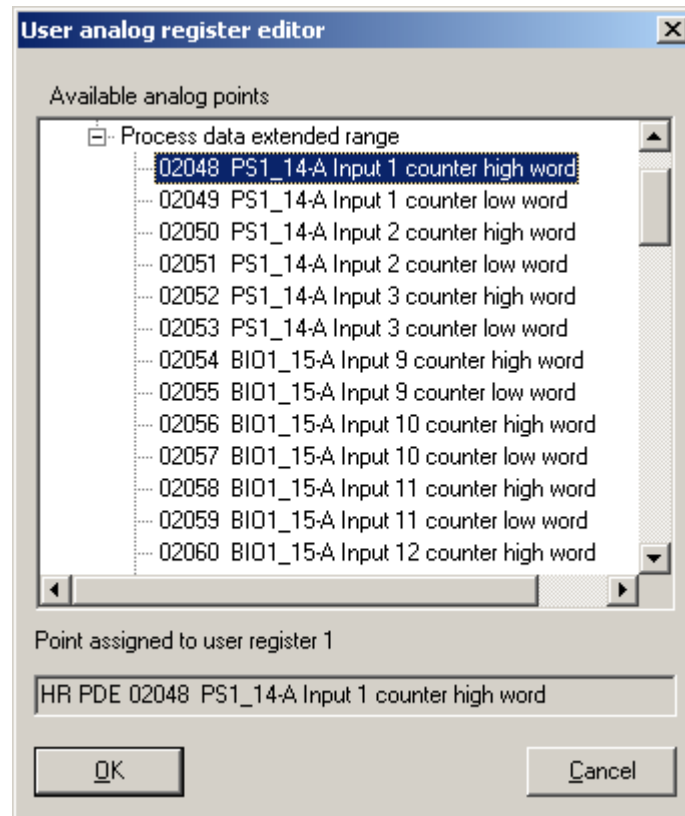
Fig. 5.4.-11 User register type selection

### Analog User Register

Selected analog data and data with integer values (measurements, counters, diagnostic data, settings) mapped to holding registers can be replicated to the user-defined holding registers by using the User Analog Register Editor (see Fig. 5.4.-12).

## Protocol Mapping Tool

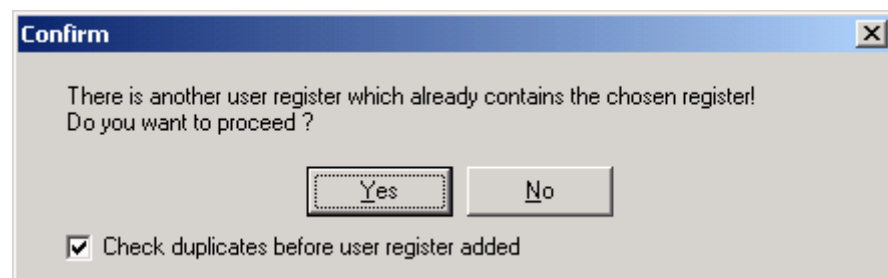
## Operation Manual



an\_ur

Fig. 5.4.-12 User Analog Register Editor

When the user selects the OK button, the Protocol Mapping Tool checks other analog user defined registers to ensure that the selected register is not mapped yet. If a duplicate is found, Fig. 5.4.-13 will be shown:



duplicates\_analog

Fig. 5.4.-13 Warning message seen, when a duplicate of an analog register is found.

The warning is skipped when the Check Duplicates Before User Register Added option in the Settings menu is unchecked. The user can also quickly uncheck this option when the warning is shown (see Fig. 5.4.-13 above).



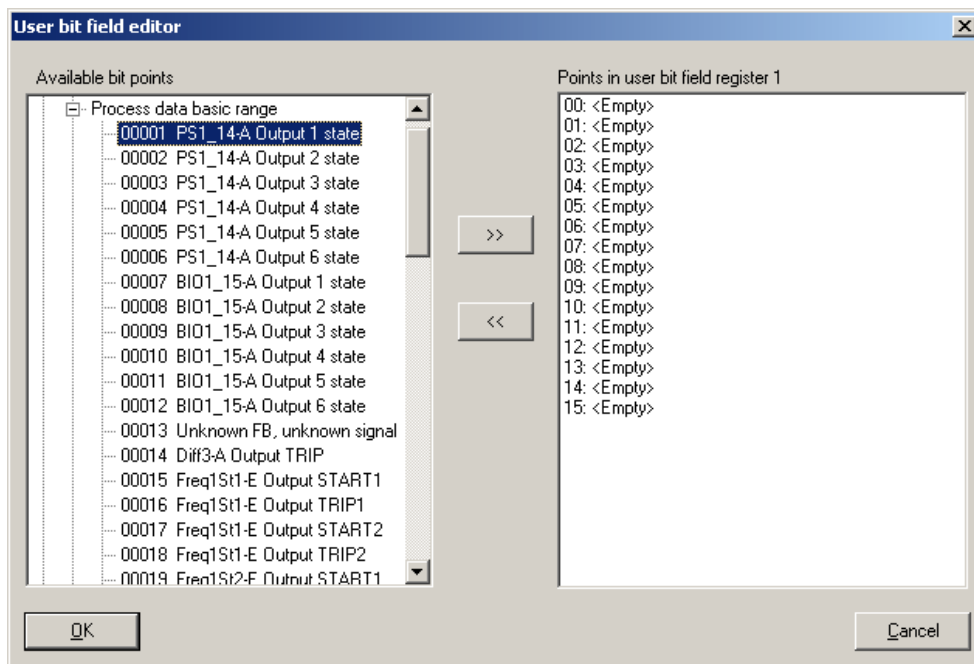
# Protocol Mapping Tool

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### Bit Field User Register

Selected binary signals, with or without their momentary change detect flags represented by coils or digital inputs, can be mapped to bit positions in user-defined holding registers. In this way holding registers can contain groups of binary signal data. This grouping of binary signals enables more efficient data scanning in the Modbus protocol.

Bit field user registers are created by using the User Bit Field Editor (see Fig. 5.4.-14).

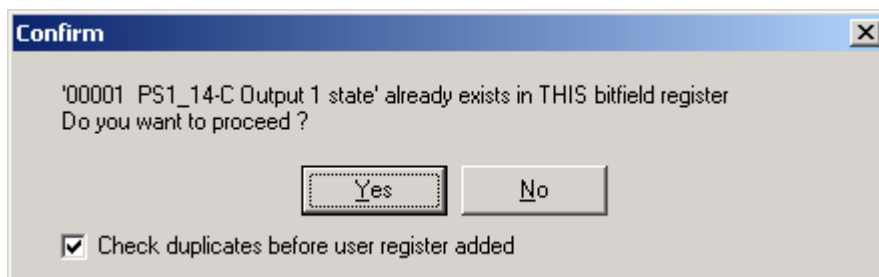


bf\_ur

Fig. 5.4.-14 User Bit Field Editor

To add a new binary register to the edited bit field, select the required register in the left tree and press the >> button. The added binary register is put into the first empty slot presented in the right tree.

When the >> button is selected, the Protocol Mapping Tool checks the already existing bit-field user defined registers to ensure that the selected binary registers are not yet mapped. If a duplicate is found, a warning message as in Fig. 5.4.-15 will be shown:



duplicates\_binary

Fig. 5.4.-15 Warning message seen, when a duplicate of a binary register is found

## Protocol Mapping Tool

### Operation Manual

If the *Check duplicates before user register added* option in the Settings menu is unchecked, the PMT does not show any warning. The user can also quickly uncheck this option when the warning is shown (see Fig. 5.4.-15 above).

To remove already added binary register, the user has to select such an item in the right tree and press the << button.

The order of added binary registers can always be changed by using the drag&drop operation.

The user is able to change any of the existing user registers:

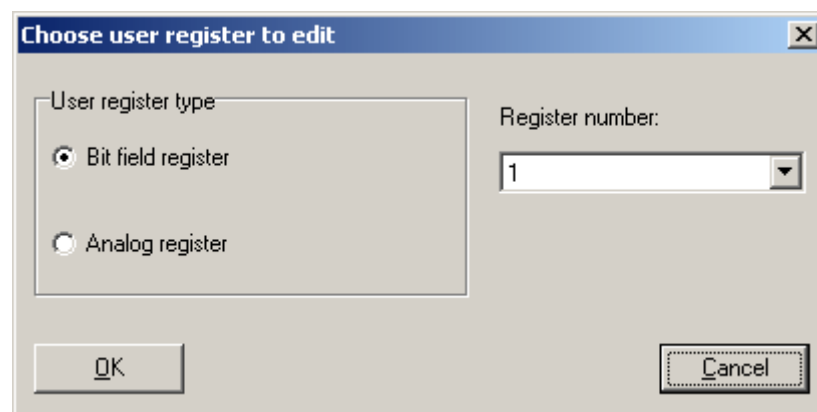
- By selecting User Register in the Change submenu in the Edit menu or
- By selecting the following toolbar button:



change\_ur

- by selecting Change User Register in the Protocol Mapping Tool window's pop-up menu

First of all, the user has to select which user register must be edited. Fig. 5.4.-16 allows the user to set the identification number of the required user register:



ur\_edit

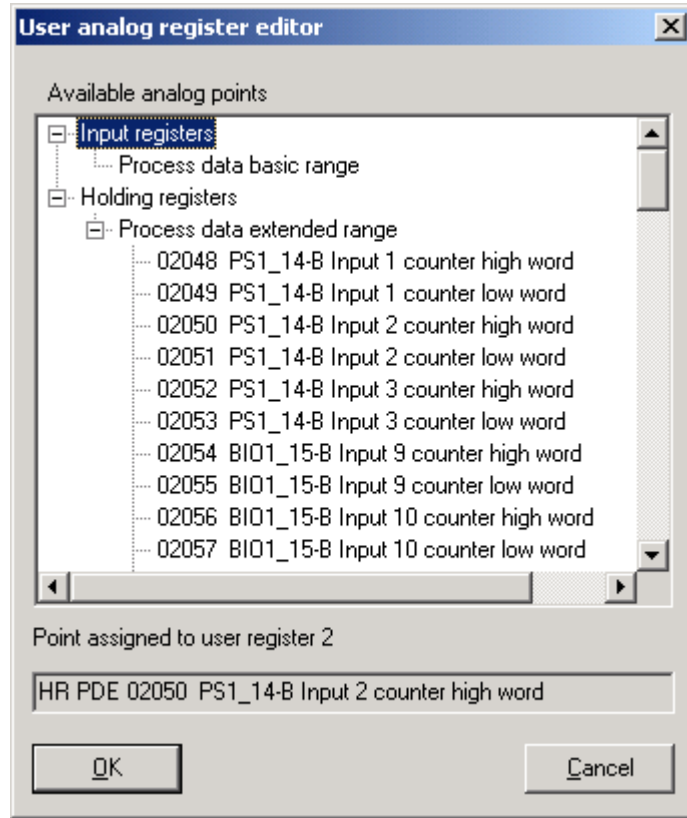
Fig. 5.4.-16 Selection of a user register's identification number

There is no need to select a user register's identification number, if user the editing of the register is started by using the Protocol Mapping Tool window's pop-up menu.

In the second step, the appropriate editor is presented depending on the type of selected user register (see Fig. 5.4.-17 and Fig. 5.4.-18 below).

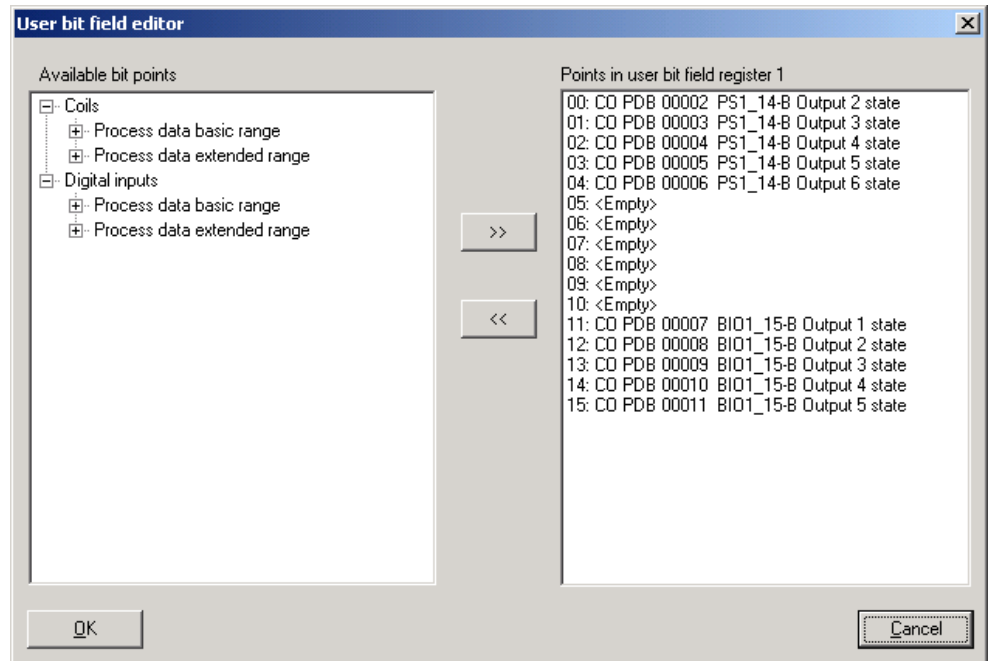
# Protocol Mapping Tool

## Operation Manual



an\_ur\_edit

Fig. 5.4.-17 The user analog register editor



bf\_ur\_edit

Fig. 5.4.-18 The user bit field register editor

## Protocol Mapping Tool

### Operation Manual

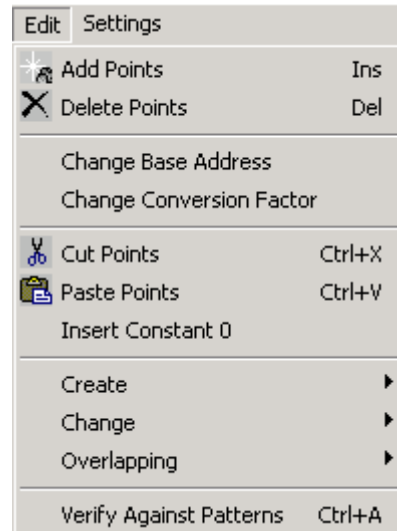
The editing of user register proceeds in the same manner as if the user register has only just been created.

For details on user registers see Section 5.4. Complex structures under User Registers (User-Defined Registers).

## 5.5. Modbus specific menu items and submenus

### 5.5.1. Edit menu

Fig. 5.5.1.-1 shows the components of the Edit menu of the Protocol Mapping Tool.

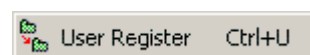


menu\_edit\_rem

Fig. 5.5.1.-1 The Edit menu for Modbus mapping

#### 5.5.1.1. Create submenu

Fig. 5.5.1.1.-1 shows the components of the Create submenu of the Protocol Mapping Tool.



menu\_edit\_create\_ref

Fig. 5.5.1.1.-1 Create submenu

#### (Create) User Register



This option is available in the advanced mode.

By selecting the User Register menu item in the Create submenu of the Edit menu, the creation of a new user register is started. This feature is described in Section 5.4. Complex structures under User registers editing.

More information can be found in Section 5.4. Complex structures under User Registers (User-Defined Registers).

# Protocol Mapping Tool

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Toolbar button:



create\_ur

Keyboard shortcut: <Ctrl>+<U>

### 5.5.1.2.

## Change submenu

Fig. 5.5.1.2.-1 shows the components of the Change submenu of the Protocol Mapping Tool.



menu\_edit\_change\_ref

*Fig. 5.5.1.2.-1 Change submenu*

### (Change) User Register



This option is available in the advanced mode.

By selecting this feature, the user is able to change any of already existing user registers within the mapping. The description of the feature is available in Section 5.4. Complex structures under User registers editing.

Toolbar button:

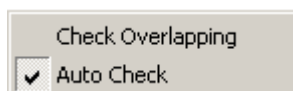


change\_ur

### 5.5.1.3.

## Overlapping submenu

This section covers menu items within the Overlapping submenu placed in the Edit menu. The Overlapping submenu is shown in Fig. 5.5.1.3.-1:



menu\_edit\_overlapping

*Fig. 5.5.1.3.-1 Overlapping submenu*

### Check overlapping



This option is available in the advanced mode.

This menu option starts the procedure of the data category address range checking within Modbus data types to determine whether any data category begins at a memory address, which is reserved by registers belonging to another data category. The Overlapping check is described in detail in Section 5.4. Complex structures under Overlapping check.

# Protocol Mapping Tool

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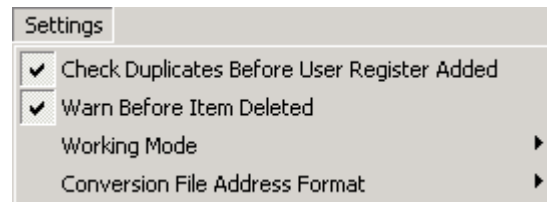
### Auto check

Auto check is a menu toggle used to enable/disable the automatic start of the overlapping check procedure each time the mapping has been changed during the editing. The "Overlapping check" is described in detail in Section 5.4. Complex structures under Overlapping check.

### 5.5.2.

### Settings menu

The Settings menu of the Protocol Mapping Tool is presented in Fig. 5.5.2.-1:



menu\_settings\_rem

Fig. 5.5.2.-1 The Settings menu

### Check Duplicates Before User Register Added

This menu toggle enables/disables the looking for duplicated entries within user defined registers. Section 5.4. Complex structures under Analog User Register and Bit Field User Register describes how this setting is used.

### Warn Before Item Deleted

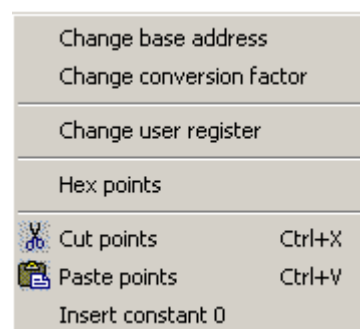
This menu toggle enables/disables the warning shown each time the user tries to remove any register from a mapping tree. See Section 4.2.3.3. Mapping editing under Removing existing points for more details on the using of the setting.

### 5.6.

### Modbus specific pop-up menu

The section describes the Modbus specific pop-up menu available for the mapping tree in the Protocol Mapping Tool.

Fig. 5.6.-1 shows the components of the pop-up menu shown for the mapping tree in the main window:



menu\_popup\_ref

Fig. 5.6.-1 Pop-up menu for Modbus mapping editing

# Protocol Mapping Tool

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---

All pop-up menu items make sense only for certain types of tree nodes and each pop-up menu item is enabled only when the user selects the appropriate type of tree node within the mapping tree.

### **Change User Register**

This pop-up menu item enables the editing of the selected user register. See Section 5.4. Complex structures under User registers editing for more details.





# Protocol Mapping Tool

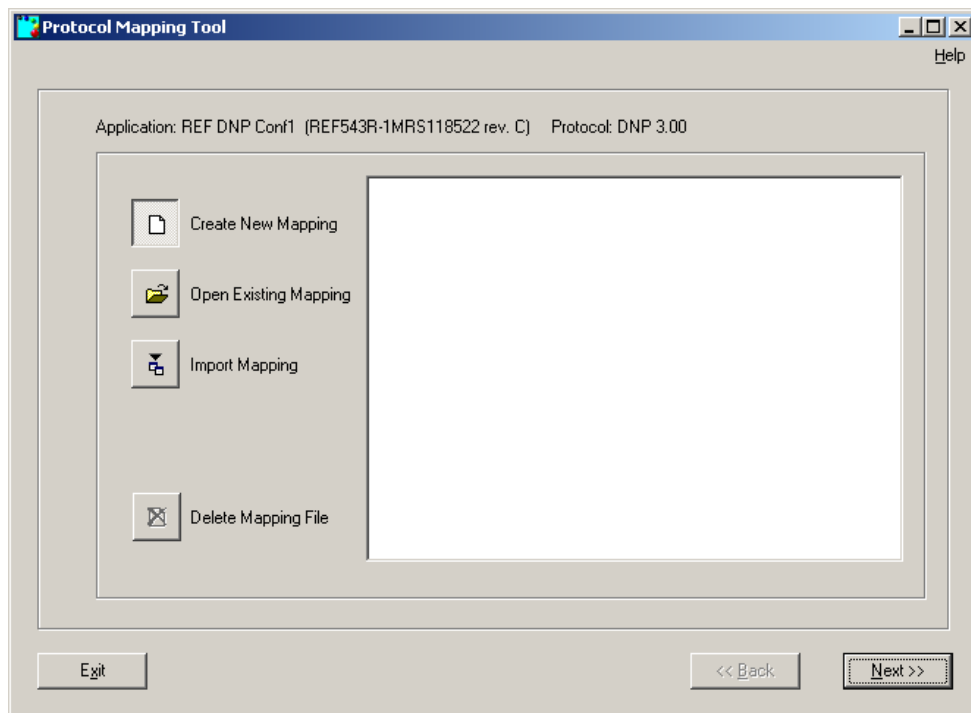
## Operation Manual

### 6. DNP 3.0

This chapter provides a detailed description of all the Protocol Mapping Tool features supporting the DNP 3.0 protocol.

#### 6.1. Protocol Mapping Tool Wizard

Fig. 6.1.-1 shows the Protocol Mapping Tool Wizard. First the user decides whether to create a new mapping, open an existing one or import a mapping from a different CAP project. It is also possible to delete mappings no longer needed.



wizard2\_new

Fig. 6.1.-1 The Protocol Mapping Tool Wizard

#### 6.1.1. Creating a new mapping

The user needs to choose the way of processing events and the point base addresses of data categories.

##### Choosing the way of processing events

Some protocol points contain events and the user can decide how to process these points (see Fig. 6.1.1.-1). Events can be removed later during editing, which is described in Section 6.5. Mapping editing features.

# Protocol Mapping Tool

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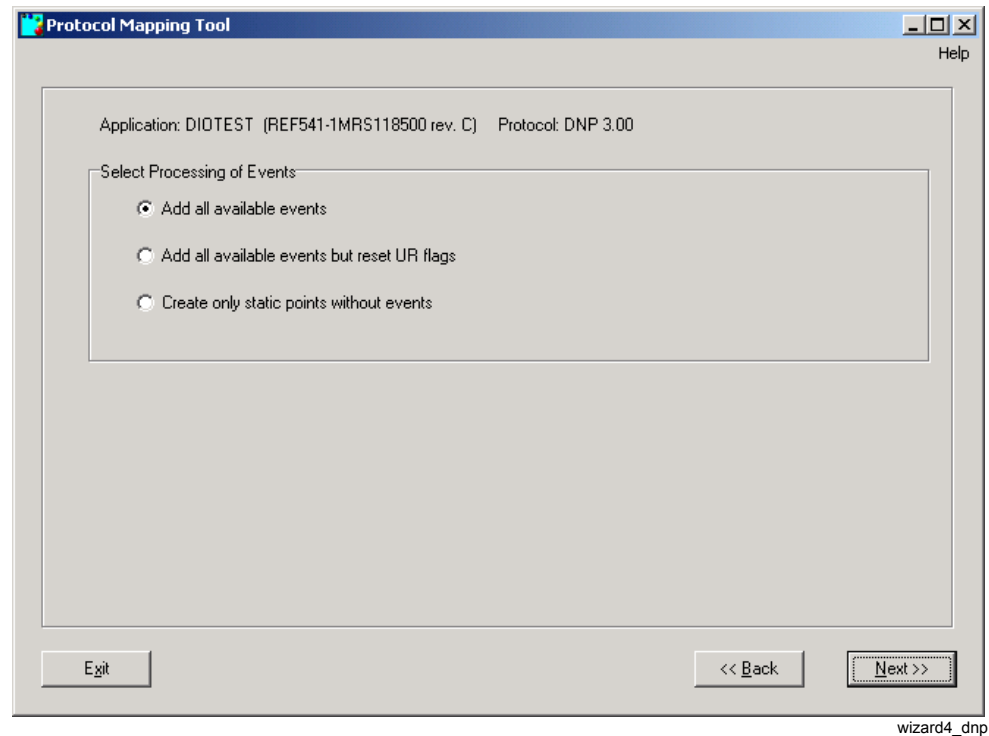


Fig. 6.1.1.-1 Choosing the way of processing events

### **Add all available events**

Unsolicited reporting flag is set the same way as in patterns (by default, set to enabled = 1)

### **Add all available events but reset UR flags**

Unsolicited reporting flag is reset for every event. Selecting this option causes the device NOT to send any events spontaneously. This option should be used in installation where communication is half duplex and there is no common system-wide collision avoidance/detection procedure.

### **Create only static points without events**

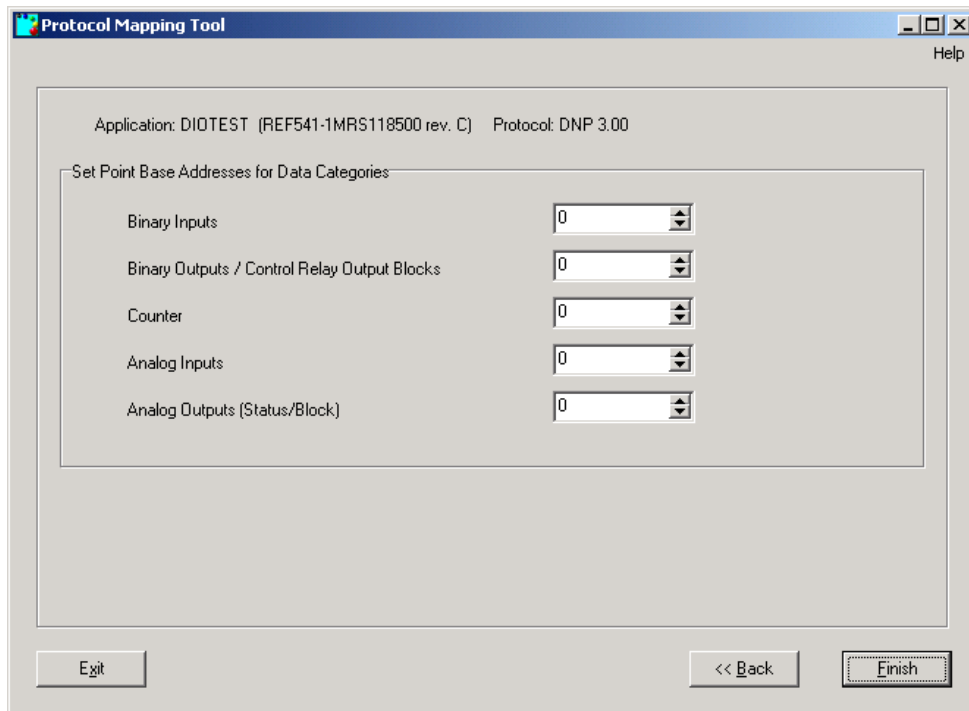
Events will be removed totally from the mapping. Instead, all the points will be updated via background scan. This option should be used ONLY if the master station does not understand events and does not perform class 1,2,3 scans at all. Using this option will prevent event buffer overflows.

### **Choosing the point base addresses of data categories**

Supported categories and their default addresses are presented in Fig. 6.1.1.-2 below. Selected addresses can be changed later during the editing, which is described in Section 6.5. Mapping editing features

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wizard5\_dnp

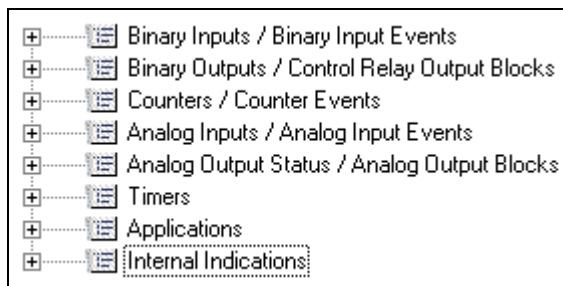
Fig. 6.1.1.-2 Choosing the point base addresses of data categories (for DNP 3.0 protocol).

After performing this step, the Protocol Mapping Tool will open with a new mapping.

## 6.2.

### Mapping tree

The structure of a mapping tree is fixed during the editing of the DNP 3.0 mapping (see Fig. 6.2.-1).



mapping\_tree\_dnp

Fig. 6.2.-1 Data objects within the DNP 3.0 mapping tree

Data objects are represented by branches with the following icon:



gategory

DNP 3.0 points can produce both static and dynamic (event) information. It can be determined by a tree node icon set for a tree node representing a single register:

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1. Node containing only static points



points3

2. Node containing only events (static information is also available, but is based on the value of the last triggered event)



events3

3. Node containing both static points and events



points\_events3

**Table 6.2.-1 Mapping tree register elements**

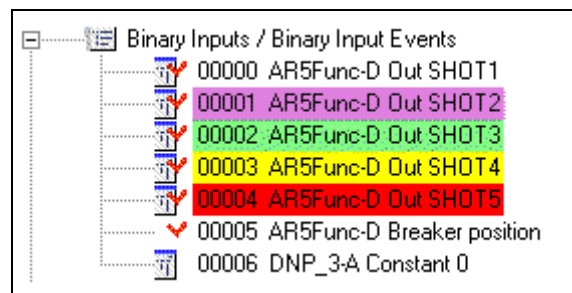
Address	00005 (or 0005H hexadecimal address format is selected)
Function	AR5Func
Function revision	D
Description	Breaker position

If a mapping is read from a device with the Relay Download Tool, some points may have warning flags set. There are four warning flags:

- Invalid (the entry for a given point contains invalid information - point removed from data map)
- Corrected (the entry for a given point contained incorrect information and was corrected by the device during mapping parsing)
- No block (the device application does not have a function that contains this data - point removed from the data map)
- No object (the device application does have a function, but there is no such data item - point removed from the data map)

Tree nodes representing registers with warning flags set have different background colors (see Fig. 6.2.-2):

- Purple background color indicates object flag set
- Light green background color indicates no block flag set
- Yellow background color indicates corrected flag set
- Red background color indicates incorrect flag set



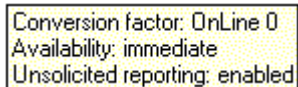
warning\_flags

*Fig. 6.2.-2 Example of tree nodes indicating the active warning flags*

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When the user leaves the cursor over a tree node for a while, a tooltip window will be shown (see Fig. 6.2.-3).



tooltip\_dnp

Fig. 6.2.-3 Tooltips for a DNP 3.0 register

The following tooltip will be shown if the user leaves the cursor over an addressed data category or data object, i.e. Binary Inputs/Binary Input Events within the DNP 3.0 mapping tree (see Fig. 6.2.-4).



tooltip\_dataac

Fig. 6.2.-4 Tooltip window for an addressed data category

### 6.3. Mapping conventions

The DNP 3.0 protocol supports the following mapping convention:

- Binary input objects are used to represent the state of the digital input points (hardware or software).
- Binary output objects are used to represent the state of controllable binary points (hardware or software).
- Control relay output block information objects are used to make control commands on binary output points.
- Binary counters represent accumulated values. They can be accumulated pulses or transitions from hardware or software points.
- Analog inputs are information objects used to represent hardware or software analog points. Their values can represent digitized signals or calculated values.
- Analog output status information objects represent the actual values of analog output points and associated statuses.
- Analog output block information objects are used to set a new value for analog output points.
- Time and date objects are the objects that represent the time of day and date used to perform time synchronization.
- Internal indications are information elements used to convey internal states and diagnostic results of a responding station.

Points from Timers and Internal Indications must always be present in mapping and cannot be altered by the user. The user can change the content of Applications category, but its base address cannot be changed.

### 6.4. Complex structures

DNP 3.0 mappings support:

- Analog points having an editable conversion factor
- Internal indications

## Protocol Mapping Tool

### Operation Manual

#### Analog points having an editable conversion factor

Some analog points have a conversion factor, which can be changed by using the appropriate menu option. The editable conversion factors are:

- Multiply by 1 (no operation)
- Multiply by 10 (signed)
- Multiply by 100 (signed)
- Multiply by 1000 (signed)
- Divide by 10 (signed)
- Divide by 100 (signed)
- Divide by 1000 (signed)

#### Internal indications

Internal indication are information elements used to convey internal states and diagnostic results of a responding station. This information can be used by a receiving station to perform error recovery or other functions.

The definitions of internal indications are stored in a separate data category called Internal Indications within DNP 3.0 mapping. The Internal Indication data category is not editable and is composed of 16 binary points.

The meaning of 16 internal indications is specified in Table 6.4.-1 below:

**Table 6.4.-1 The meaning of 16 internal indications:**

Internal indication	Meaning
Bit 0	All stations message received
Bit 1	Class 1 data available
Bit 2	Class 2 data available
Bit 3	Class 3 data available
Bit 4	Time-synchronization required from the master
Bit 5	Set when some or all of the Outstation's digital output points are in the Local state
Bit 6	Device trouble
Bit 7	Device restart
Bit 8	Function code not implemented
Bit 9	Requested object(s) unknown
Bit 10	Parameters in the qualifier, range or data fields are not valid or out of range
Bit 11	Event buffer(s), or other application buffers have overflowed
Bit 12	Request understood but requested operation is already executing
Bit 13	Set to indicate that the current configuration in the Outstation is corrupt
Bit 14	Reserved for use by agreement, currently always returned as zero (0)
Bit 15	Reserved for use by agreement, currently always returned as zero (0)

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## Operation Manual

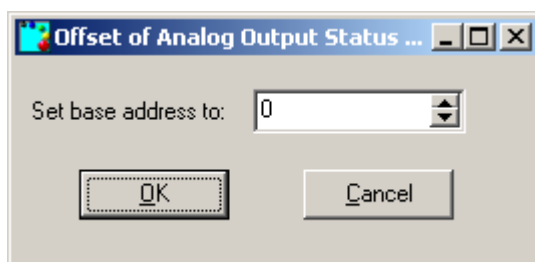
### 6.5. Mapping editing features

#### Base address editing



This option is available in the advanced mode.

The "Change base address" pop-up menu item allows to change the base address of the selected data category. As a result, all registers within such a data category will be readdressed. A dialog box is used to enter a new base address (see Fig. 6.5.-1 below).



base\_address\_dnp

Fig. 6.5.-1 Base address editor

The format of an edited address (either decimal or hexadecimal value) presented in the base address editor depends on the format of the addresses presented in mapping tree.

#### Removing events



This option is available in the advanced mode.

This operation removes the event definitions from points defined within the mapping.

The Protocol Mapping Tool provides two ways of removing events:

1. Removing all events within all the defined points either by selecting Remove All Events in the Edit menu or by selecting the following toolbar button:



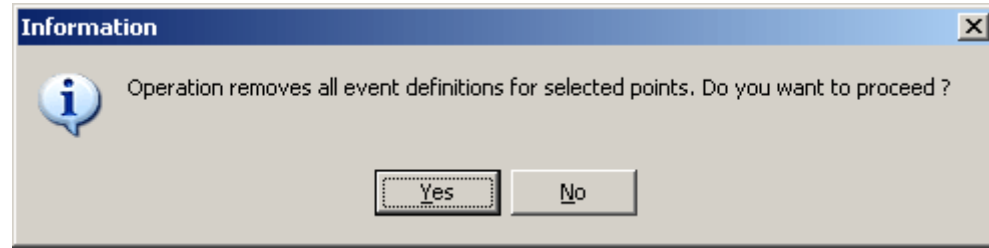
remove\_events

2. Removing events within the currently selected points by selecting Remove Events in a pop-up menu.

Such an action must be confirmed (see Fig. 6.5.-2).

# Protocol Mapping Tool

## Operation Manual



remove\_events\_confirm

Fig. 6.5.-2 Operation confirmation



The Removing events operation is irreversible.

### Unsolicited reporting management

All DNP 3.0 events defined within static points have associated unsolicited reporting flag (UR flag). The Protocol Mapping Tool allows the editing of this flag.

The user can enable all UR flags within events defined in all static points either by using Enable All UR Flags in the Edit menu or by selecting the following toolbar button:



urep1

To enable UR flags only for currently selected points, the user has to choose Enable UR flags in a pop-up menu.

Similarly, the following ways can be used to disable all unsolicited reporting flags for events within all defined static points:

- By selecting Disable All UR Flags in the Edit menu or
- By selecting the following toolbar button:



urep0

To disable UR flags only for selected points, the user needs to choose Disable UR Flags within a pop-up menu.

### Class assignment

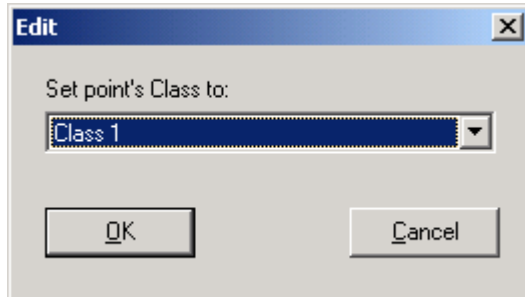
Class assignment is used to set an appropriate class to events provided by currently selected points.

Fig. 6.5.-3 is used to assign class (see below):



# Protocol Mapping Tool

## Operation Manual



class\_editor

Fig. 6.5.-3 The class editor

The following values are available during class editing:

- Class 1
- Class 2
- Class 3
- Not assigned



If operation is executed for more than one point, the class editor will present a "Not assigned" value by default (regardless of class values being currently set within all edited points).

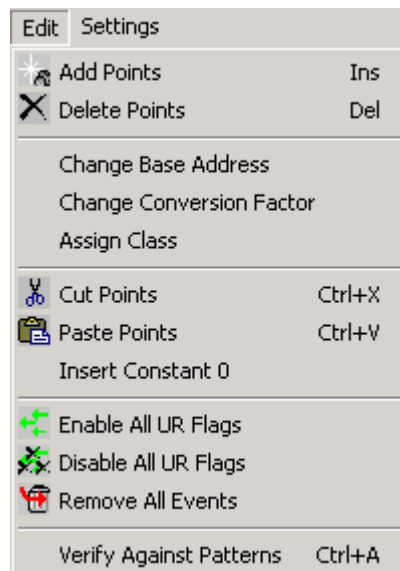
## 6.6.

### DNP 3.0 specific menu items

#### 6.6.1.

#### Edit menu

Fig. 6.6.1.-1 shows the components of the Edit menu of the Protocol Mapping Tool.



menu\_edit\_dnp

Fig. 6.6.1.-1 The Edit menu for DNP 3.0 mapping

## Protocol Mapping Tool

### Operation Manual

#### Assign Class

This menu option is used to set the appropriate class to events produced by the currently selected points. More information is provided in Section 6.5. Mapping editing features under Class assignment.

#### Enable All UR Flags

This menu option enables the unsolicited reporting flag for events mapped within all registers defined in the mapping. More information is provided in Section 6.5. Mapping editing features under Unsolicited reporting management.

Toolbar button:



urep1

#### Disable All UR Flags

This menu option disables the unsolicited reporting flag for events mapped within all registers defined in the mapping. More information is provided in Section 6.6. DNP 3.0 specific menu items under Unsolicited reporting management.

Toolbar button:



urep0

#### Remove All Events



This option is available in the advanced mode.

This operation removes the event definitions from all registers defined within the mapping. More information is provided in Section 6.5. Mapping editing features under Removing events.

Toolbar button:



remove\_events

## 6.7.

### DNP 3.0 specific pop-up menu

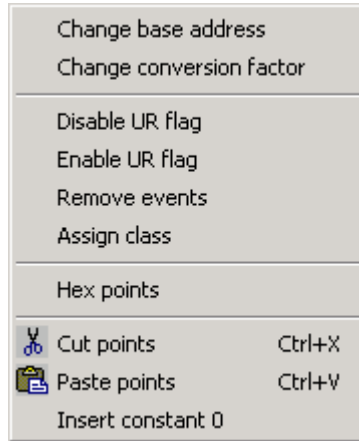
This section describes the DNP 3.0 specific pop-up menu available for the mapping tree in the Protocol Mapping Tool.

Fig. 6.7.-1 shows the components of the pop-up menu shown for the mapping tree in the main window:

# Protocol Mapping Tool

## Operation Manual

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menu\_popup\_dnp

*Fig. 6.7.-1 Pop-up menu for DNP 3.0 mapping editing*

Pop-up menu items are available only for certain types of tree nodes and each pop-up menu item is enabled only when the user selects the appropriate type of tree node within mapping tree.

### **Disable UR Flag**

This menu option disables the unsolicited reporting flags of all currently selected points. Section 6.5. Mapping editing features under Unsolicited reporting management provides more information.

### **Enable UR Flag**

This menu option enables the unsolicited reporting flags of all currently selected points. Section 6.5. Mapping editing features under Unsolicited reporting management provides more information.

### **Remove Events**

This menu item deletes event definitions from all currently selected points. Section 6.5. Mapping editing features under Removing events provides more information.

### **Assign Class**

Assign Class menu option is used to set the appropriate class to events produced by currently selected points. Section 6.5. Mapping editing features under Class assignment provides more information.



# Protocol Mapping Tool

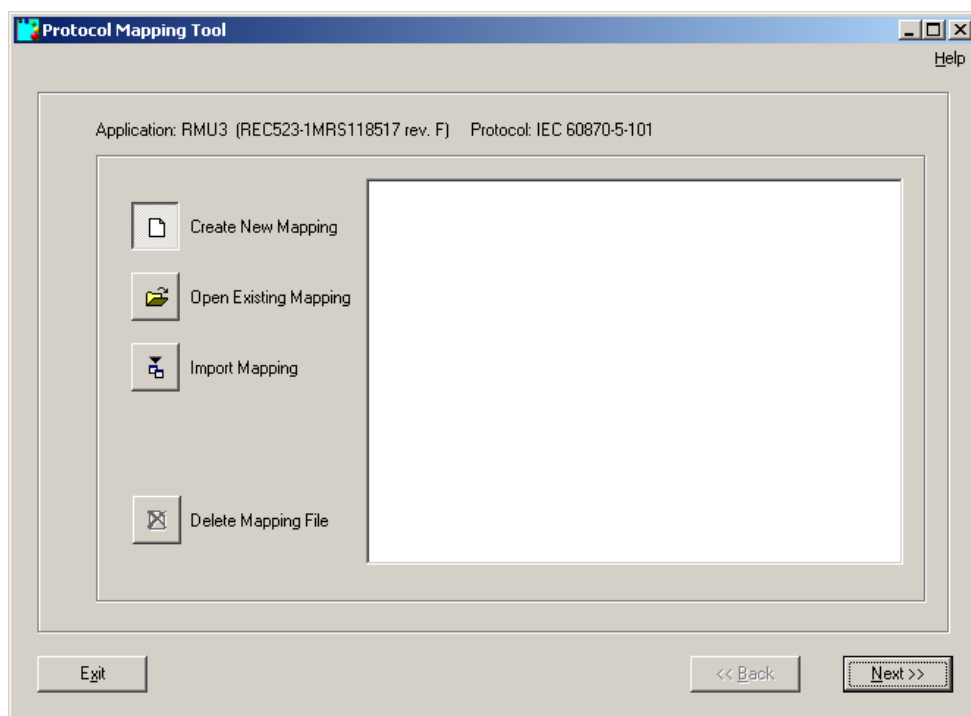
## Operation Manual

## 7. IEC 60870-5-101

This chapter provides detailed description of the Protocol Mapping Tool features supporting the IEC 60870-5-101 protocol.

### 7.1. Protocol Mapping Tool Wizard

Fig. 7.1.-1 shows the Protocol Mapping Tool Wizard. First the user decides whether to create a new mapping, open an existing one or import a mapping from a different CAP project. It is also possible to delete mappings no longer needed.



A050092

Fig. 7.1.-1 The Protocol Mapping Tool Wizard

#### 7.1.1. Creating a new mapping

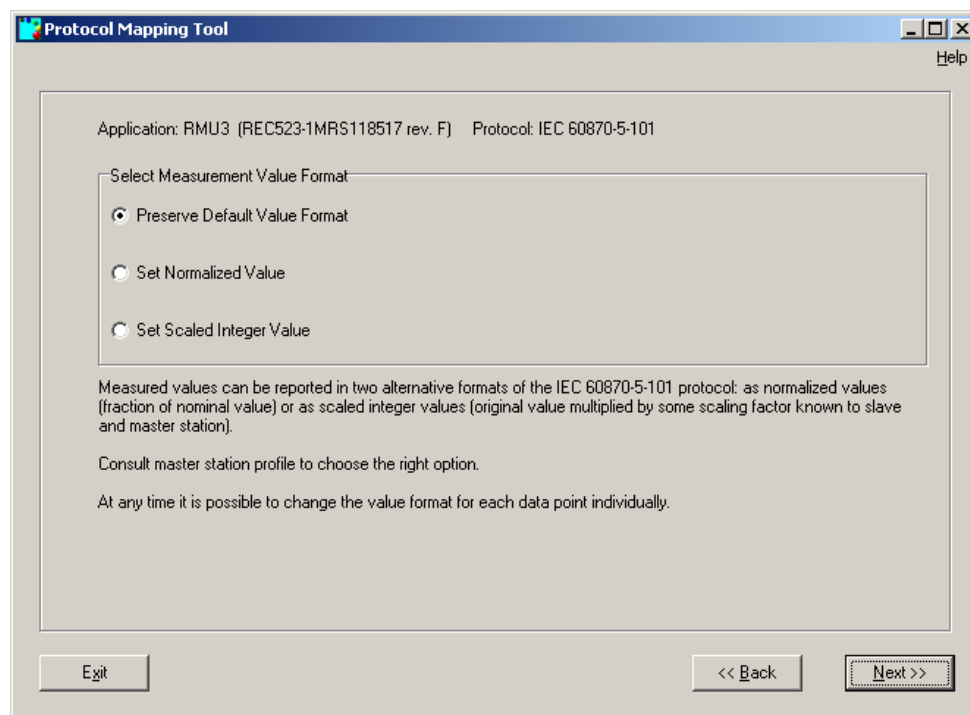
The user needs to choose the desired format of measured values, control command type, addressing mode and, if continuous addressing mode was chosen, the base addresses for data categories.

#### Choosing the format of measured values

In the IEC 60870-5101 protocol, measured values can be transferred as normalized values (fraction of nominal value) or scaled integer values (original value multiplied by some scaling factor known to the slave and master station). The user can decide which format should be used (see Fig. 7.1.1.-1). The measurement format can later be changed individually.

# Protocol Mapping Tool

## Operation Manual



A050093

*Fig. 7.1.1.-1 Choosing the format of measured values*

### **Preserve Default Value Format**

Measurements will be sent by using the format designed in patterns.

### **Set Normalized Value**

Measurements will be sent by using the normalized format.

### **Set Scaled Integer Value**

Measurements will be sent by using the scaled integer format.

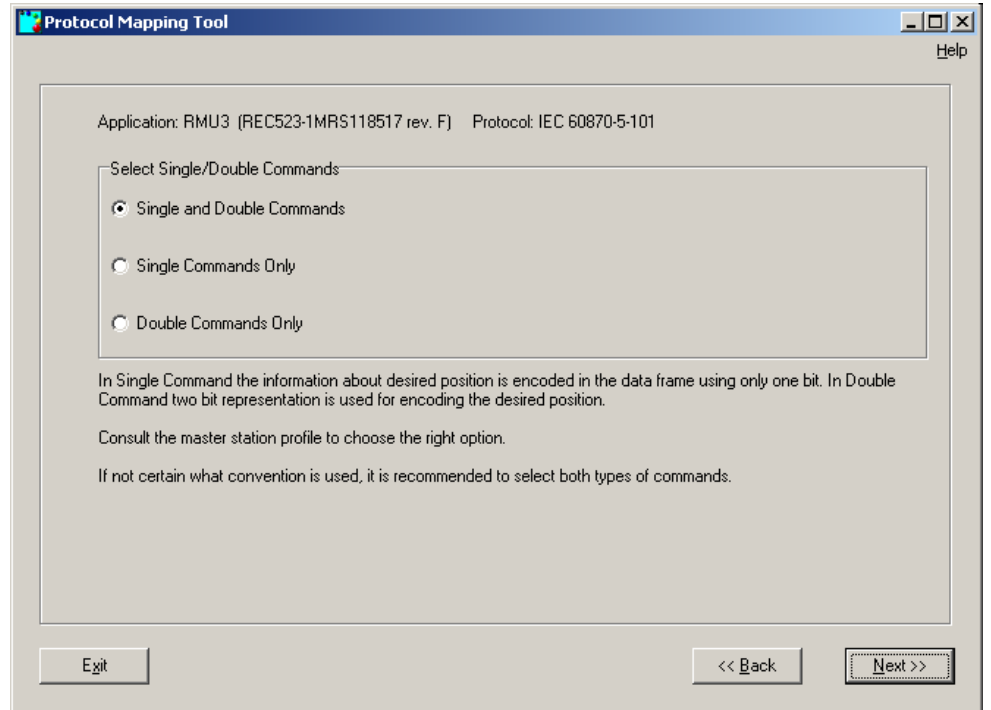
### **Choosing the control command type**

Two types of control commands are defined in the IEC 60870-5101 protocol. In Single Command the information about the desired position is encoded in the data frame by using only one bit. In Double Command, two bit representation is used for encoding the desired position.

The user can decide what type should be used (see Fig. 7.1.1.-2).

# Protocol Mapping Tool

## Operation Manual



A050094

Fig. 7.1.1.-2 Choosing the control command type



The master station profile should be checked to choose the right option. If you are not sure what convention is used, it is recommended to select both types of commands.

### Single and Double Commands

Both command types will be supported in the device.

### Single Commands Only

Only single command type will be supported in the device.

### Double Commands Only

Only double command type will be supported in the device.

### Choosing the addressing mode

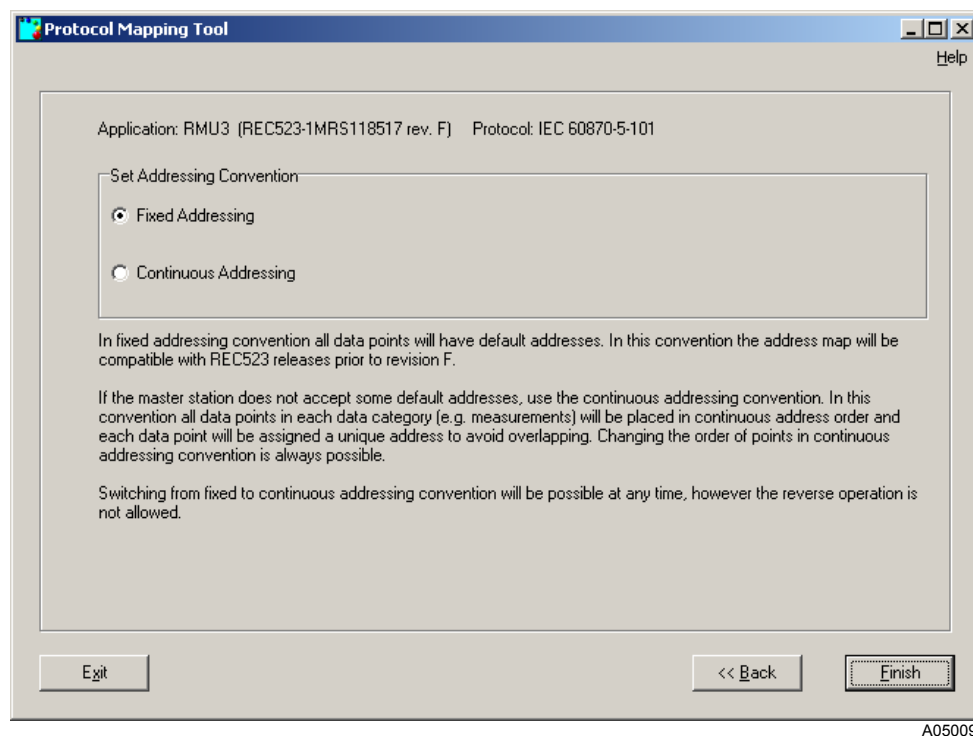
In fixed addressing convention all the data points will have default addresses. In this convention, the address map will be compatible with REC 523 releases prior to revision F.

If the master station does not accept some default addresses, continuous addressing convention can be used. In this convention all the data points in each data category (e.g. measurements) will be placed in continuous address order and each data point will be assigned a unique address to avoid overlapping. Changing the order of points in continuous addressing convention will always be possible.

# Protocol Mapping Tool

## Operation Manual

The user can decide what type should be used (see Fig. 7.1.1.-3).



A050095

*Fig. 7.1.1.-3 Choosing the addressing mode*



Switching from fixed to continuous addressing convention is possible at any time (see Section 7.5.1. under "Set continuous address space"). However, the reverse operation is not allowed.

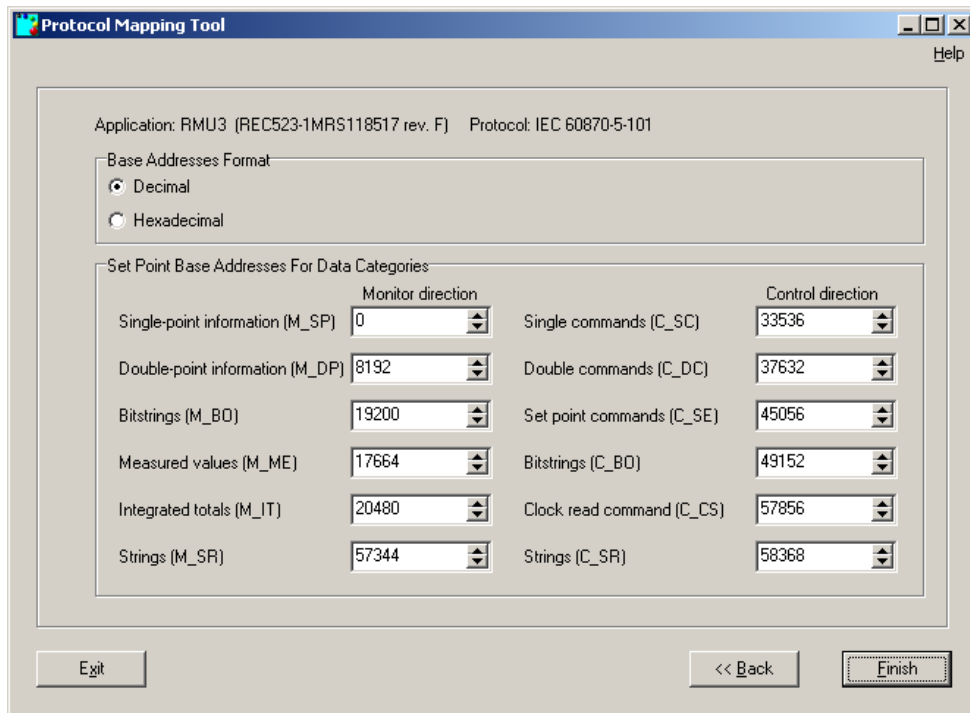
### Choosing the point base addresses of data categories

Starting offsets can be adjusted for each ASDU type. For convenience, addresses can be given as decimal or hexadecimal values (depending on convention used by the master station). See Fig. 7.1.1.-4 and Fig. 7.1.1.-5.



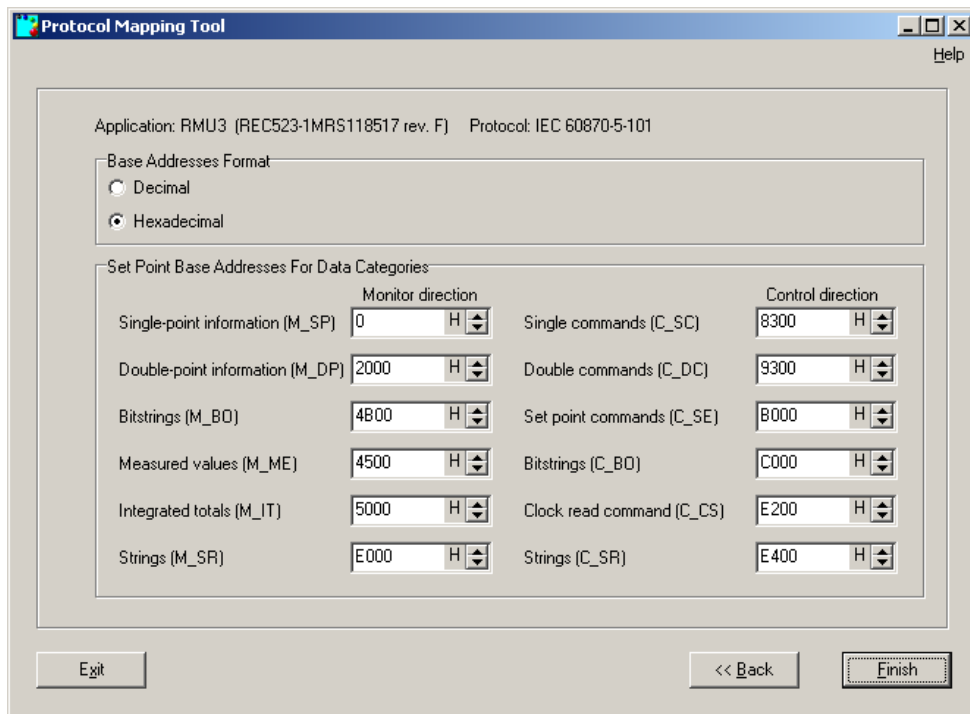
# Protocol Mapping Tool

## Operation Manual



A050096

Fig. 7.1.1.-4 Choosing the point base addresses of data categories (decimal values).



A050097

Fig. 7.1.1.-5 Choosing the point base addresses of data categories (hexadecimal values).

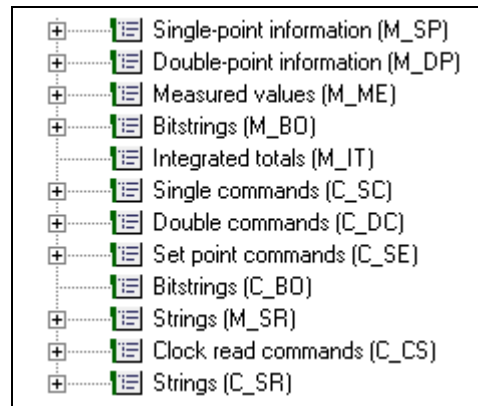
# Protocol Mapping Tool

## Operation Manual

### 7.2.

### Mapping tree

The structure of a mapping tree is fixed during the editing of the IEC 60870-5-101 mapping (see Fig. 7.2.-1).



A050098

*Fig. 7.2.-1 Data objects within the IEC 60870-5-101 mapping tree*

The root node indicates the current addressing convention (fixed or continuous).

Data categories (ASDU types) are represented by branches with the following icon:



A050099

Tree nodes can contain both static and dynamic (event) information. It can be determined by a node icon set for a tree node representing a single point:

1. Node containing only static points



A050100

2. Node containing only events



A050101

3. Node containing both static points and events



A050102

**Table 7.2.-1 Mapping tree point elements:**

Address:	00002 (or 0002H if hexadecimal address format is selected)
Function:	NOC3Low
Function revision:	D
Description:	Output TRIP

# Protocol Mapping Tool

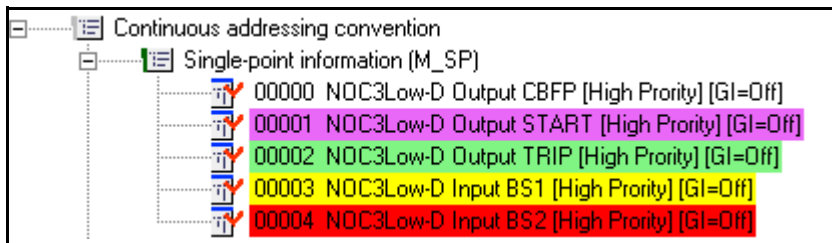
## Operation Manual

If a mapping is read from a device with the Relay Download Tool, some points may have warning flags set. There are four warning flags:

- Invalid (the entry for a given point contains invalid information - point removed from data map)
- Corrected (the entry for a given point contained incorrect information and was corrected by the device during mapping parsing)
- No block (the device application does not have a function that contains this data - point removed from the data map)
- No object (the device application does have a function, but there is no such data item - point removed from the data map)

Tree nodes representing points with warning flags set have different background colors (see Fig. 7.2.-2):

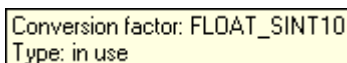
- Purple background color indicates object flag set
- Light green background color indicates no block flag set
- Yellow background color indicates corrected flag set
- Red background color indicates incorrect flag set



A050103

Fig. 7.2.-2 Example of tree nodes indicating the active warning flags

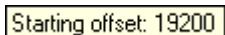
When the user leaves the cursor over the tree node for a while, a tooltip window will be shown (see Fig. 7.2.-3).



A050104

Fig. 7.2.-3 Tooltips for IEC 60870-5-101 point

The following tooltip will be shown if the user leaves the cursor over an addressed data category, i.e. Measured values (M\_ME) within the IEC 60870-5-101 mapping tree (see Fig. 7.2.-4).



A050105

Fig. 7.2.-4 Tooltip window for IEC 60870-5-101 data category

### 7.3.

#### Mapping convention

IEC 60870-5-101 protocol supports the following mapping convention:

- Single point information (M\_SP) nodes are used to represent the state of the digital input points (hardware or software).

## Protocol Mapping Tool

### Operation Manual

- Double point information (M\_DP) nodes are used to represent state of two bit encodes binary points (hardware or software) such as breaker position.
- Measured values (M\_ME) nodes are information objects used to represent hardware or software analog points. Their values can represent digitized signals or calculated values.
- Integrated totals (M\_IT) represent the accumulated values. They can be accumulated pulses or transitions from hardware or software points.
- Bit strings in monitoring direction (M\_BO) nodes represent values for reading that can be treated as bit masks.
- Strings in monitoring direction (M\_SR) nodes represent strings of characters that can be read from the device.
- Single command (C\_SC) nodes are used to make control commands on relays by using one bit convention for encoding desired position.
- Double command (C\_DC) nodes are used to make control commands on relays by using two bit convention for encoding desired position.
- Set point commands (C\_SE) nodes are used to set new value of analog output points.
- Bit strings in control direction (C\_BO) nodes represent values for writing that can be treated as bit masks.
- Strings in control direction (C\_SR) nodes represent strings of characters that can be written.
- Clock read command (C\_CS) nodes represent devices current time of day and date.

## 7.4.

### Mapping editing features

#### Base address editing



This option is available in the advanced mode and when the continuous addressing convention is selected.

The "Change base address" menu item (in Edit menu and pop-up menu) allows to change the base address for the selected data category. As a result, all the points within such a data category will be readdressed. The following dialog is used to enter a new base address (see Fig. 7.4.-1).

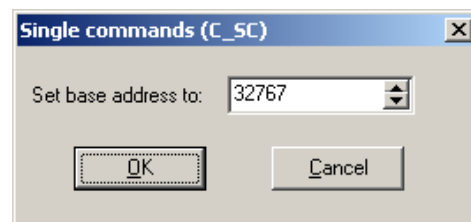


Fig. 7.4.-1 Base address editor

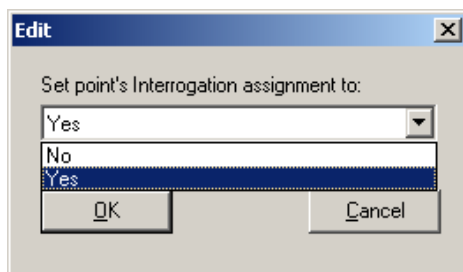
A050106

## Protocol Mapping Tool

### Operation Manual

#### General interrogation assignment

The Assign General Interrogation Group menu item (in Edit menu and pop-up menu) allows to change the GI assignment flag value for the selected data points. As a result, all the selected points will or will not be assigned to general interrogation group. The following dialog is used to select GI assignment (see Fig. 7.4.-2).

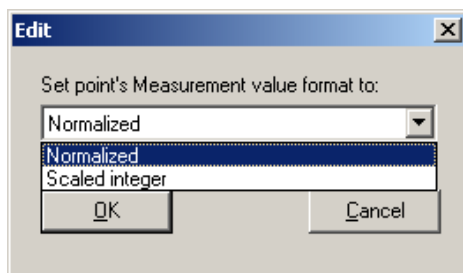


A050107

Fig. 7.4.-2 GI assignment editor

#### Measurement value format change

The Change Measurement Value Format menu item (in Edit menu and pop-up menu) allows to change the measurement format for the selected data points. As a result, all the selected points will have selected measurement format (normalized or scaled). The following dialog is used to enter a new measurement format (see Fig. 7.4.-3).



A050108

Fig. 7.4.-3 Measurement value format editor

#### Data class (priority) assignment

The Change Data Class menu item (in Edit menu and pop-up menu) allows to change the data class (priority) for the selected data points. As a result, all the selected points will have selected priority (high or low). The following dialog is used to select a new priority (see Fig. 7.4.-4).

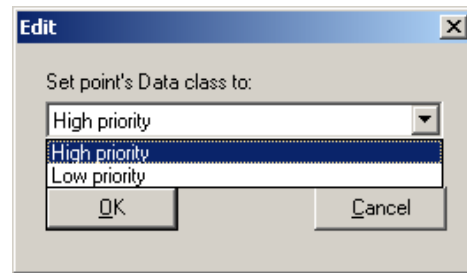
Description of the data class priorities:

High priority = Class 1

Low priority = Class 2

# Protocol Mapping Tool

## Operation Manual



A050109

Fig. 7.4.-4 Data class (priority) assignment editor

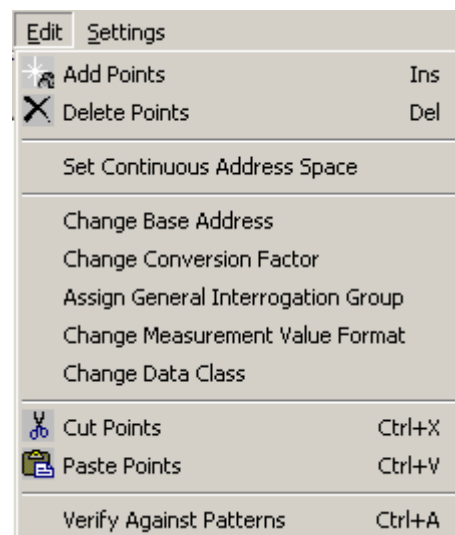
## 7.5.

### IEC 60870-5-101 specific menu items

#### 7.5.1.

#### Edit menu

Fig. 7.5.1.-1 shows the components of the Edit menu of the Protocol Mapping Tool for the IEC 60870-5-101 protocol.



A050110

Fig. 7.5.1.-1 Edit menu for IEC 60870-5-101 mapping

#### Set continuous address space

This menu option is used to switch to continuous addressing convention.

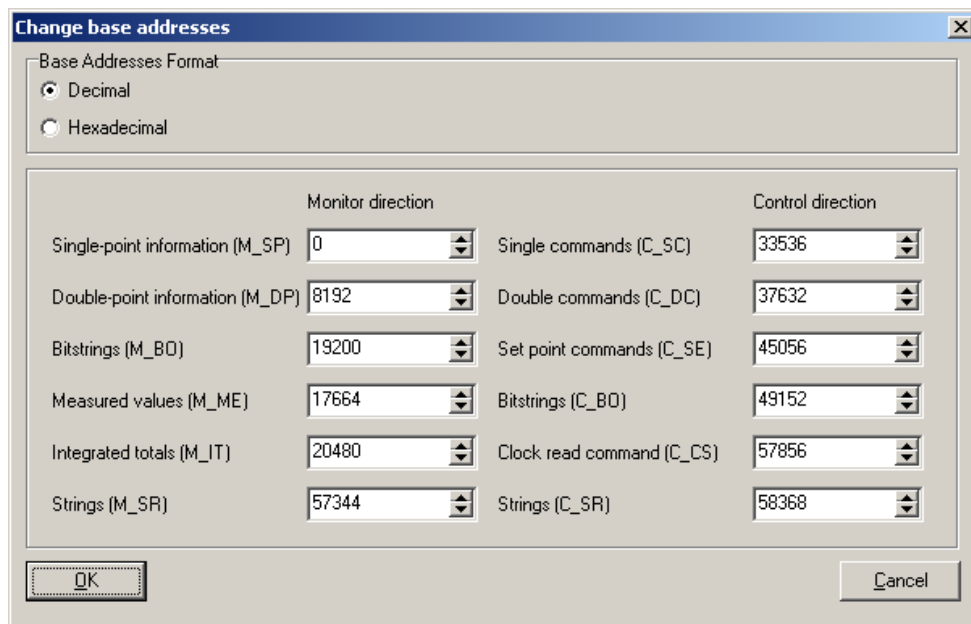


This option is available in the advanced mode, when the fixed addressing convention is currently used.

The following dialog is used to set new base addresses for all data categories (see Fig. 7.5.1.-2).

# Protocol Mapping Tool

## Operation Manual



A050111

Fig. 7.5.1.-2 Selection dialog of base addresses



Continuous addressing convention is possible only when the reverse operation is not allowed.

### Assign General Interrogation Group

This menu item allows to change the GI assignment flag value for the selected data points. More information is provided in Section 7.4. under "General interrogation assignment".

### Change Measurement Value Format

This menu item allows to change the measurement format for the selected data points. More information is provided in Section 7.4. under "Measurement value format change".

### Change Data Class

This menu item allows to change the data class (priority) for the selected data points. More information is provided in Section 7.4. under "Data class (priority) assignment".

## 7.6.

### IEC 60870-5-101 specific pop-up menu

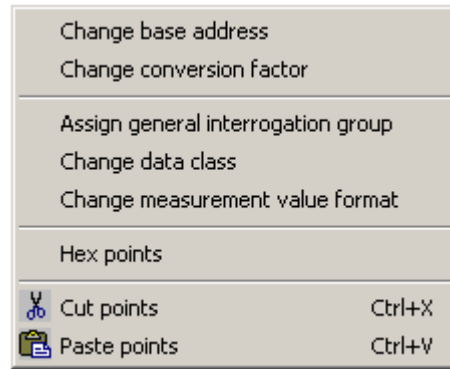
This section describes the IEC 60870-5-101 specific pop-up menu available for the mapping tree in the Protocol Mapping Tool.

Fig. 7.6.-1 shows the components of the pop-up menu shown for the mapping tree in the main window:

# Protocol Mapping Tool

## Operation Manual

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A050112

*Fig. 7.6.-1 Pop-up menu for IEC 60870-5-101 mapping editing*

Pop-up menu items are available only for certain types of tree nodes. Each pop-up menu item is enabled only when the user selects the appropriate type of tree node within the mapping tree.

### **Assign General Interrogation Group**

This menu item allows to change the GI assignment flag value for the selected data points. More information is provided in Section 7.4. under "General interrogation assignment".

### **Change Data Class**

This menu item allows to change the data class (priority) for the selected data points. More information is provided in Section 7.4. under "Data class (priority) assignment".

### **Change Measurement Value Format**

This menu item allows to change the measurement format for the selected data points. More information is provided in Section 7.4. under "Measurement value format change".



# Protocol Mapping Tool

## Operation Manual

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### 8. Troubleshooting

This chapter provides answers to some frequently asked questions.

#### **Some menu and pop-up items are disabled all the time. How to activate them?**

Some menu and pop-up items are enabled only if the appropriate nodes are selected in the mapping tree (the pop-up menu's "Change base address" operation is enabled when a data category node is selected).

The second reason why a menu/pop-up item is not available all the time is incorrect working mode. The Protocol Mapping Tool provides two working modes: basic and advanced. Some editing features can be used only in the advanced working mode. If you need more information about working modes, see Section 2.2.1. Working modes The switching between working modes is described in Section 4.2.1.3. Settings menu under Working Mode submenu.

#### **Why does the Protocol Mapping Tool allow saving an edited mapping in two types of files: mapping file and/or binary mapping file?**

The mapping file is a text file containing complete information about a certain mapping, whereas the binary mapping file is a binary file having only a binary representation of mapping without additional information (i.e. information on the protocol mode required in Modbus dependent mappings for REM 54\_ terminal is lost).

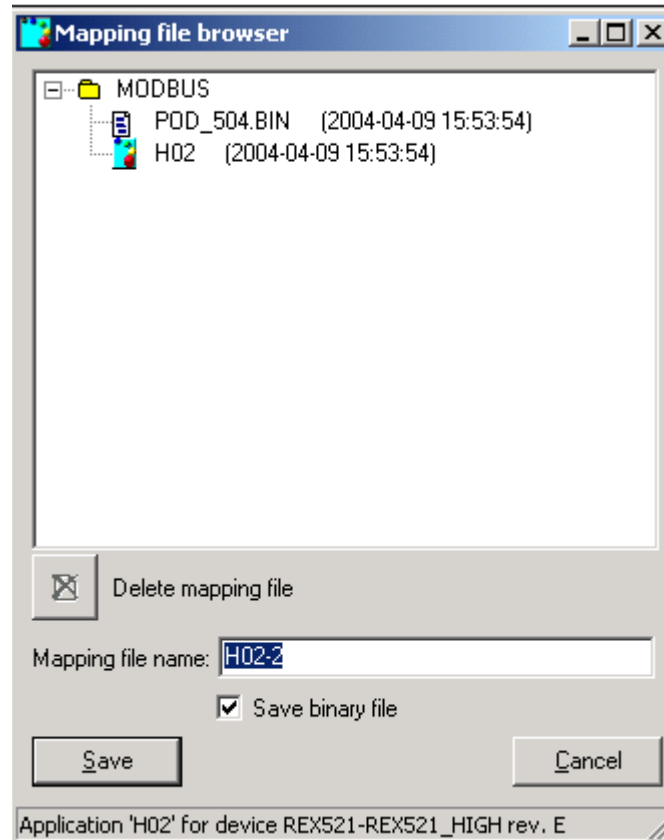
The binary mapping files are still in use because only such files can be downloaded into and uploaded from a terminal by the Relay Download Tool.

#### **How to create a binary mapping file for the Relay Download Tool?**

The only way to create a binary file is to save the mapping file. The "Save binary file" attribute must be checked in the Save dialog (see Fig. 8.-1):

## Protocol Mapping Tool

## Operation Manual



save

Fig. 8.-1 Save mapping dialog

Saving a mapping file is described in detail Section 4.2.2.5. Selecting address format (Hex/Decimal Points) under Saving an edited mapping.

### What does it mean if "Cannot open file XXX.dat" messages are shown when loading or creating a mapping?

Such messages are shown when the Protocol Mapping Tool's resources are incomplete and the names of certain signals (maintained within loaded/created mapping) are unrecognized. In this case all unrecognized signals are described by the "Unknown signal" label.

The problem has no influence on how a mapping is processed by the Protocol Mapping Tool.

### What is the overlapping check operation and how does it work?

The overlapping check operation is provided only for Modbus mappings. It checks the data category address range within Modbus data types, to determine whether any data category begins at a memory address reserved by registers belonging to another data category.

# Protocol Mapping Tool

## Operation Manual

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The overlapping check is also capable of moving all points belonging to one of the data categories into the nearest unallocated location. Such an operation allows to avoid possible conflicts between points having the same Modbus address. The overlapping check is described in Section 5.4. Complex structures under Overlapping check.

More information concerning the data category moving is available in Section 5.4. Complex structures under Base address editing. If you need more information about Modbus data types and categories, see Section 5.2. Mapping tree



## Protocol Mapping Tool

## Appendix A

## 9. Appendix

### Export Conversion File format

The export file format is composed of columns (fields), which are separated by using a tabulator (as an unique character not used in signal descriptions).

Each point is exported as a single row entry. The number and name of the fields in the export file differ depending on the selected protocol. The following tables present the order and names of the fields used in the export file:

**Table 1: Fields in the export file for Modbus:**

No.	Modbus
1	Address
2	DB name
3	Explanation
4	Read only flag
5	SPA event names
6	Scaling factor
7	Value range
8	Unit

**Table 2: Fields in the export file for DNP 3.0:**

No.	DNP 3.0
1	Address
2	DB name
3	Explanation
4	Event class
5	Unsolicited reporting flag
6	SPA event names
7	Scaling factor
8	Value range
9	Unit

**Table 3: Fields in the export file for IEC 60870-5-101:**

No.	IEC 60870-5-101
1	Address
2	DB name
3	Explanation
4	SPA Event class
5	Data class
6	GI assignment
7	Measurement value format
8	Scaling factor
9	Value range
10	Unit

An empty field (carrying no information) is always marked by a dash "-".

# Protocol Mapping Tool

## Operation Manual

### Address

#### Descriptive address format:

The format of this column depends on the provided protocol:

1. In case of a MODBUS Address=<Data Type> <Offset> (<Data Category>) where all the elements are separated by a space character and <Data Type> = CO | DI | IR | HR {CO-coils, DI-digital inputs, IR-input registers, HR-holding registers}

<Offset> = {a decimal address within the data type}

e.g.

HR 0123 (PDE)

CO 1856 (SCH)

The content of pack registers/binary user-defined registers is addressed by using the binary position indicator.

e.g.

HR 0001 (PBD).01bit

HR 0764 (PRG).15bit

<Data Category> = PDB | PDE | SCH | CTL | DGN | PRG | DDE {PDB-process data basic, PDE-process data extend., SCH-slowly changing, CTL-control, DGN-diagnostics, PRG-pack registers, DDE-device data}

#### Example rows:

```
CO 0001 (PDB)    F0140001    PS1_14-D: Output 1 state   Y    F014E014/ F014E015
-              0/1      -
HR 0002 (PDE)    F200I001    MECU3A-D: IL1      Y    -    MUL_100  0.0...20000.0 [A]
HR 2368 (PRG).09bit  F014I003    PS1_14-D: Input 3 state   Y    F014E004/
F014E005      -      0/1      -
```

2. In case of a DNP 3.00 Address = <Object Type> <Point> where all the elements are separated by a space character and

<Object Type> = BI | BO | AI | AO | CT | TM | AP | II {BI-binary input, BO-binary output/control relay output block, AI-analog input, AO-analog output/analog output block, CT-counter, TM-timers, AP-application, II-internal indication}

<Point>= {a decimal address within the data type identified by <Object Type>}

e.g.

BI 0127

AP 0001

#### Example rows:

```
BI 0007    F0140001    PS1_14-D: Output 1 state   1    Y    F014E014/F014E015
-          0/1      -
AI 0001    F0160001    RTD1_16-D: Output 1 value  -    -    -    MUL_1000
-10000.00000 ...10000.00 [mA]
```

# Protocol Mapping Tool

## Appendix A

3. In case of IEC 60870-5-101 Address = <ASDU type><Point> where all the elements are separated by a space character and

<ASDU Type> = M\_SP | M\_DP | M\_BO | M\_ME | M\_IT | M\_SR | C\_SC | C\_DC | C\_SE | C\_BO | C\_CS }

<Offset> = {decimal address within data type}

i.e.

M\_IT 08762

M\_SP 01856

### Example rows:

M_SP 00000	F0310001	NOC3Low-D: Output START
F031E000/F031E001	1	0 -0..1-
M_ME 20226	F017I011	PSC1_17-C: Minimum battery-2
0	N	- 18.0 ...
33.0	[V]	

### SCADA address format:

Other offset format containing a word number and bit number is possible:

<Offset>=<Word Number>^<Bit number>

where

<Word Number>=integer of (<Offset> / 16)

<Bit Number>=remainder of (<Offset> / 16)

<Word Number> and <Bit Number> are 0-based counters.

<Bit Number> matters only for binary signals.

e.g.

BI 0007^14

AP 0001

### Example rows:

CO 0000^00	F0140001	PS1_14-D: Output 1 state	Y	F014E014/ F014E015
- 0/1	-			
HR 0001	F200I001	MECU3A-D: IL1	Y -	MUL_100 0.0...20000.0 [A]
HR 2367^09	F014I003	PS1_14-D: Input 3 state	Y	F014E004/ F014E005 -
0/1	-			
BI 0000^07	F0140001	PS1_14-D: Output 1 state	1	Y F014E014/
F014E015	- 0/1	-		
AI 0001	F0160001	RTD1_16-D: Output 1 value	- - -	MUL_1000
-10000.00000	...10000.00	[mA]		



The format is selected in the Settings menu.

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#### DB name

DB name is the signal identifier in the terminal. When so-called shadow points are reported, the exported DB name will be composed of several identifiers separated by a backslash "/".

e.g.

BI 0183 F200E20/F200E21 MECU3A-D: IL2 low alarm reset - - F200E20/  
F200E21 - 0/1

#### Explanation

Description of the signal.

#### SPA event names

This field provides information concerning SPA events, which are associated with an appropriate static point and are composed of event identifiers separated by a backslash "/".

#### Scaling factor

This field describes the conversion factor applied for the appropriate static point.

##### For MODBUS protocol:

MUL\_1000\_SIGNED, MUL\_100\_SIGNED, MUL\_10\_SIGNED,  
MUL\_1\_SIGNED, MUL\_1000, MUL\_100, MUL\_10, NO\_OPERATION, DIV\_10,  
DIV\_100, DIV\_1000, DIV\_10\_SIGNED, DIV\_100\_SIGNED,  
DIV\_1000\_SIGNED

##### For DNP protocol:

MUL\_1000, MUL\_100, MUL\_10, NO\_OPERATION, DIV\_10, DIV\_100,  
DIV\_1000

##### For IEC 60870-5-101 protocol:

FLOAT\_UINT, FLOAT\_SINT10, FLOAT\_SINT100, FLOAT\_SINT1000,  
FLOAT\_SINT01, FLOAT\_SINT001, FLOAT\_SINT0001,

#### Read only

Marks whether a static signal is writable. Field may be equal to:

Y - readable only

N - writable/readable



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## Appendix A

### Event class

The event class column describes the class set for events associated with an exported static signal.

The following single characters are used:

**Table 4: Event class field values:**

Value in event class field	Explanation
1	Class 1
2	Class 2
3	Class 3
N	Not assigned

### Unsolicited reporting

Marks whether unsolicited reporting is activated. Field may be equal to:

Y - unsolicited reporting activated

N - unsolicited reporting turned off

### Value range

This column provides a value range of the exported static point.

The field provides the real range of values possible for the static point (the value carried by a protocol may be different because the appropriate scaling factor is taken into account).

In case of binary signals the value range is always equal to 0/1.

### Unit

This field provides the unit of measure of the exported point.

The field matters for analog static points only.

### Data class

This column describes the data class priority set for the exported signals.

The following values are allowed:

1 - High Priority

2 - Low Priority

### General interrogation group

Shows the general interrogation group assignment of the exported static points.

The field may be equal to:

0 - Not assigned to general interrogation

1 - Assigned to general interrogation

- - Undetermined (i.e. no static signal defined for this protocol point)

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#### Measurement value format

Shows the scaling format of M\_ME and C\_SE analog values.

The field may be equal to:

N - Normalized (M\_ME\_NA, C\_SE\_NA)

S - Scaled integer (M\_ME\_NB, C\_SE\_NB)

For other data types, the field is always equal to "-".



Containers (such as pack registers and user-defined registers used in MODBUS) are not specified, but their content is listed instead.

Contained points are described as common signals having appropriate bit position within the container and its address.

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