RELION® REB500

Distributed busbar protection REB500
Version 8.3 IEC
Engineering manual
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Section 1 Introduction

1.1 This manual

This document contains the description of the REB500 Configurator Tool (HMI500 started under Configurator Mode) and the setfile engineering process. In addition to the theoretical part, the Engineering Manual provides an application example (see Section 8 and Section 9). This part of the documentation can be used for training purposes.

1.2 Intended audience

The engineering manual addresses system and project engineers involved in the engineering process of a project, and installation and commissioning personnel, who change configuration data during engineering, installation and commissioning.

In the Configurator mode, a system configuration can be modified. This mode should be used by selected (trained) users only.

1.3 Product documentation

For an introduction into REB500, it is recommended to study the Product guide and/or the Application manual.

<table>
<thead>
<tr>
<th>REB500 manuals</th>
<th>Document numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product guide</td>
<td>1MRK 505 402-BEN</td>
</tr>
<tr>
<td>Application manual</td>
<td>1MRK 505 399-UEN</td>
</tr>
<tr>
<td>Technical manual</td>
<td>1MRK 505 400-UEN</td>
</tr>
<tr>
<td>Operation manual</td>
<td>1MRK 500 132-UEN</td>
</tr>
<tr>
<td>Engineering manual</td>
<td>1MRK 511 452-UEN</td>
</tr>
<tr>
<td>Commissioning manual</td>
<td>1MRK 505 401-UEN</td>
</tr>
<tr>
<td>Application manual for bay protection functions</td>
<td>1MRK 505 403-UEN</td>
</tr>
<tr>
<td>Technical manual for bay protection functions</td>
<td>1MRK 505 406-UEN</td>
</tr>
<tr>
<td>Cyber security deployment guideline</td>
<td>1MRK 511 453-UEN</td>
</tr>
<tr>
<td>Communication protocol manual IEC61850</td>
<td>1MRK 511 450-UEN</td>
</tr>
<tr>
<td>Communication protocol manual IEC60870-5-103</td>
<td>1MRK 511 451-UEN</td>
</tr>
<tr>
<td>Getting started guide</td>
<td>1MRK 505 404-UEN</td>
</tr>
</tbody>
</table>
1.4 Symbols and conventions

1.4.1 Symbols

The electrical warning icon indicates the presence of a hazard which could result in electrical shock.

The warning icon indicates the presence of a hazard which could result in personal injury.

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 of important 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, it is necessary to understand that under certain operational conditions, operation of damaged equipment may result in degraded process performance leading to personal injury or death. Therefore, comply fully with all warning and caution notices.

The tutor icon points to the tutorial of the REB500 configuration process and vice versa (see Annexure A and Annexure B).

1.4.2 Document conventions

A particular convention may not be used in this manual.

- Abbreviations and acronyms in this manual are spelled out in the glossary. The glossary also contains definitions of important terms.
- Push button navigation in the LHMI menu structure is presented by using the push button icons.
  For example, to navigate the options, use ↑ and ↓.
- HMI menu paths are presented in bold.
  For example, select Main menu/Settings.
- Signal names are presented in bold.
  The signal 21120_EXT_TEST_TRIP can be set and reset via the LHMI Test Trip menu.
- Parameter names and parameter values are presented in italics.
  For example, the default value of the Operation setting is Not Inverted.
- Section references are presented with the respective section numbers.
For example, see Section 1.4.2 for more details about document conventions.
Section 2 Safety information

The busbar protection system REB500 corresponds to the latest practices and guidelines and complies with the recognized safety rules. Nevertheless, care must always be taken to avoid danger.

Only use the busbar protection system when it is in perfect working order and in strict accordance with these operating instructions.

Dangerous situations can arise if the equipment is used improperly, especially if the user changes the configuration.

Live electrical equipment is in the immediate vicinity of the REB500 system. Before working on the system, always ensure that it is impossible to come into contact with, or even close to live parts.

The IEDs of the REB500 system can initiate operation of items of electrical plant (circuit-breakers and isolators). Before working on the equipment, always ensure that unwanted operation is inhibited or has no effect on persons or plant.

Strictly observe all safety precautions (interlocks, locks and blocking devices), especially those issued for the specific station.

Only properly authorized, professionally qualified and correspondingly trained personnel, who have also read and understood the operating instructions, may work on the system.

Dangerous voltages can occur on the connectors, even though the auxiliary voltage has been disconnected.

Non-observance can result in death, personal injury or substantial property damage.

Only a competent electrician is allowed to carry out the electrical installation.

National and local electrical safety regulations must always be followed.
The frame of the IEDs has to be carefully earthed.

Whenever changes are made in the IEDs, measures should be taken to avoid inadvertent tripping.

The IEDs contain components which are sensitive to electrostatic discharge. Unnecessary touching of electronic components must therefore be avoided.

Take care never to open the secondary circuits of CTs conducting current.

There is a danger of contact with live parts when opening REB500 cubicle doors.

Electrostatic discharge can destroy components in the equipment.

Other safety instructions pertaining to particular operations are contained in the respective chapters of the operating instructions.
Section 3  HMI500 modes

HMI500 software is primarily used as a human-machine interface (HMI) for the protection system REB500 (Operator mode). Furthermore, the program can be used for the configuration of the system file (Configurator mode), if a licence key file has been saved under the HMI500-REBWIN installation directory (see HMI500 Licence request description).

The first screen to appear after starting the program is the System log-on dialog box.

![System login dialog box](image)

**Figure 1:** System login dialog box

**Operator** mode (for information only)

The **Operator** mode can be run in a read only mode by appropriately activating the **Read only** check box, that is, the data can be viewed but not changed. Users that want to run the **Operator** mode in a read/write mode must deactivate **Read only**.

When the HMI500 software establishes communication with a REB500 system (only possible in **Operator** mode) initially user must enter a password.

For further information about HMI500-modes, see REB500 Operation Manual, section Starting HMI500.

The following Engineering Manual covers the **Configurator** mode and the REB500 setfile engineering process only.
Section 4  Setfile (REB500 Configuration File)

4.1  File - New...

See Section 9.5.

The configuration of a new protection system (new setfile) is started with **NEW**. First input is the name of the project.

![New configuration file](image)

**Figure 2:** New configuration file

4.1.1  File name

ABB recommends the following guidelines for the naming of a setfile (example):
### 4.1.2 Project directory structure

A REB500 set file configured with the HMI500 Configurator mode has to be saved in a REB500 project structure. For ABB in-house configured systems, the following projects structure is used:

1. **1-File-configuration (draft version)**

   In this directory, the setfile is temporarily stored during the configuration phase. It has to be moved to 2-File-Testing, after setfile configuration has finished.

2. **2-File-testing (test version)**

   While testing/commissioning the system, the setfile is saved under this directory. After the system tests/commissioning have finished, the file has to be moved to 3-File definitive.

3. **3-File-definitive**

   This is the place for a setfile of a REB500 in service. The directories 1-File-configuration and 2-File-Testing should be empty now.

4. **4-File-old-versions**

   If a system (setfile) is modified (re-configured), it is recommended to store the old version(s) of the setfile under this directory. This folder contains the history of all versions, which had been applied during the lifetime of a REB500/REB500sys system.

---

**Remark:** File version index and revision index are automatically added to the file name (see Section 5.1.2).
This directory structure, used for ABB in house configured projects, ensures the transparency about setfile versions used in a REB500 system throughout the engineering process. It is recommended to implement this structure also for client configured systems.

### 4.1.3 Initial windows (default system settings)

See Section 9.6.

After pressing the button **Save** (see Figure 2), three windows containing the basic (default) system settings will appear:

- System Installation (see Section 5.1)
- Plant Data (see Section 5.2)
- Default Values (see Section 7.5)

It is recommended to fill in the system data into these initial menus.

### 4.2 File - Open…

If the HMI500 software is started, the program will load the last used project by default. However, any another configured project can be opened via **Open**.

### 4.3 File - Save as…

An existing project (setfile) can be overwritten with a currently opened project, or a currently opened project can be saved as a new project under a different name with **Save as**.

### 4.4 File - Compare…

This menu item provides facility for comparing the PC database loaded by HMI500 and the database stored in the protection system or a second database file in the PC.

For detailed information about setting and configuration, see *REB500 Operation Manual, section Compare*.

### 4.5 File - Exit

To quit HMI500, choose **Exit**.
Section 5  Configuration

5.1 System installation

See Section 9.7.

Under this dialog box, the general system data, the licensed protection functions and the version/revision control shall be entered.

![System installation dialog box]

Figure 4: System installation

<table>
<thead>
<tr>
<th>Selection</th>
<th>Function</th>
</tr>
</thead>
</table>
| S1        | File version of setfile:  
|           | • preliminary versions → for example, 0.10, 0.20 ….  
|           | • commissioned versions → for example, 1.00, 2.00 ….  
| S2        | Revision index of setfile:  
|           | • setting changes on site → A, B,… up to AY, AZ  |
5.1 System data

Specified data

General system information as well as the type of installation is entered on the left hand side under Specified data.

Licensed data

On the right hand side, the Licensed components (that is, the licensed protection functions) have to be entered. This selection of licensed function in the setfile has to match with the licensed function scope of the ordered Bay Units.

5.1.2 File version management system

The HMI500 tool contains a file version management system which is active under the Configurator mode only. The file version (see Figure 4, selection S1) will be added to the file name by default. During configuration/testing/commissioning phase, it is recommended to use preliminary versions such as 0.1, 0.2. The commissioned file version shall be incremented to 1.0.

For major configuration updates, the first digit shall be incremented (for example, 1.0 to 2.0). For minor updates the second digit of the file version index has to be incremented (for example, 1.0 to 1.1).

Definition major update

- New configuration of primary system (which was not pre-configured)
- Additional Bay Unit (which was not pre-configured)
- Additional functionality as BFP, UMZ etc.
- Setfile migration (software upgrade)

Definition minor update

- New binary I/O configuration (implemented by the setfile engineer)
- New protection settings (implemented by the setfile engineer)

The file revision index A, B, up to AY, AZ (see Figure 4, selection S2) shall be used for setting changes on site (not for configuration changes done under the Configurator mode). This index shall be changed in the HMI500 Operator mode.

5.2 Plant data

See Section 9.8.
Figure 5: Plant data

Under this menu, Rated voltage, Rated frequency, busbar Grounding and the type of Busbar shall be selected. The Rated frequency, can be either 50 Hz or 60 Hz, whereas the range of the Rated voltage, can be from 6 kV to 1000 kV. Pressing Default values button reactivates the default values.

To save the entries, activate the buttons OK or Apply; with Restore and Cancel the entries will be rejected.

5.3 BP Licences...

The menu Configuration/BP Licences... provides an overview of licensed and configured protection function groups for each bay unit.

5.4 Communication

For detailed information about setting and configuration, see REB500 Operation Manual, section Communication.

5.5 Single-line diagram

The single-line diagram editor is the core menu of the HMI500 Configurator tool. Its basic function is the configuration of the bus image (single-line diagram) used for the protection system. For this part of the configuration, tailor-made Bay Models (BM) are copied from a data base to a selected position of the single-line diagram. The Bay Model is not only a graphical layout of a bay, it also contains an image of the hardware, the logical objects and assignments.

Before starting the configuration of the single-line diagram, it is recommended to study the Section 8.
See Section 8.

The Section 9 shows an example for the complete setfile configuration process. The single-line diagram editor is explained in detail.

See Section 9.

5.5.1 Process feeders mode

See Section 9.13.

Figure 6: Single-line diagram editor
### Table 2: Function of selections

<table>
<thead>
<tr>
<th>Selection</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>The basic single-line editor mode is the ‘Process feeder’ mode. Under this mode, the configuration of the single-line diagram is defined. After the single-line (bus configuration) of the complete station is finished, the (logical) bus zone assignment has to be checked under the ‘Process bus zone’ mode.</td>
</tr>
</tbody>
</table>
| S2        | A Bay Model (BM) or a Bay Figure (BF) can be selected by a left mouse click in the bay area. The selected BM or BF appears marked with a red line rectangle (the BM is marked with a bold rectangle) The single-line editor provides two selection modes:  
  - Figure: In this mode, a single Bay Figure (BF) can be selected and moved to left, or the right side.  
  - Model: In this mode, a complete Bay Model (BM) can be selected and copied to the User model database, or removed from the single-line diagram, or a BM can be copied (imported) from the User model database, the selected position in the single-line diagram.  
  For deleting BM(s) from the single-line diagram, or for the import to the User model database, press SHIFT+left mouse button on the BM. The view of the BM changes to bold framed now. |

### Table 3: Function of buttons

<table>
<thead>
<tr>
<th>Button</th>
<th>Functions</th>
</tr>
</thead>
</table>
| B1     | The (physical) position of the CB and the CT in the single-line diagram can be mutually exchanged (swapped). This button is only active, if a CT object is selected.  
  1. Select (exactly) the center of the CT object with a left mouse click. The CT object appears filled with red color.  
  3. The positions of CB and CT are exchanged now.  
  The single-line diagram including the CB/CT positions configured with the HMIS500 tool has to reflect the substation’s bus configuration exactly. There are bays where an exchange of the CB/CT position is not possible (for example, coupler bays with two CT’s). The swapping function for such bays is blocked by the configurator tool. |
| B2     | Copy a selected Bay Model under a new name into the User Model Database. This button is active only, if the Model Mode (see S2) is selected. |
| B3     | Move the selected Bay Model or Bay Figure one position to the left. This button is active only, if the Figure Mode (see S2) is selected. |
| B4     | Move the selected Bay Model or Bay Figure one position to the right. This button is active only, if the Figure Mode (see S2) is selected. |
| B5     | Import a Bay Model from the Bay Model database to the left side of the selected bay. This button is active only, if the Model Mode (see S2) is selected. |

Table continues on next page
<table>
<thead>
<tr>
<th>Button</th>
<th>Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>B6</td>
<td>Import a Bay Model from the Bay Model database to the right side of the selected bay. This button is active only if the Model Mode (see S2) is selected.</td>
</tr>
<tr>
<td>B7</td>
<td>Import a Bay Model from the Bay Model database to the right end side of the busbar. This button is active only if the Model Mode (see S2) is selected.</td>
</tr>
<tr>
<td>B8</td>
<td>Remove the selected Bay Model or Bay Figure from the single-line diagram. This button is active only if the Model Mode (see S2) is selected.</td>
</tr>
<tr>
<td>B9</td>
<td>Interconnect two selected adjacent busbar-connectors. (for special applications only)</td>
</tr>
<tr>
<td>B10</td>
<td>Interconnect two selected distant busbar-connectors with →← reference. (for special applications only, for example, ring busbars)</td>
</tr>
<tr>
<td>B11</td>
<td>Interconnect two selected distant busbar-connectors with ←→ reference. (for special applications only, for example, ring busbars)</td>
</tr>
<tr>
<td>B12</td>
<td>Remove interconnection between two selected busbar-connectors. (for special applications only)</td>
</tr>
<tr>
<td>B13</td>
<td>Make the invisible caption of one or several selected busbar-connectors visible.</td>
</tr>
<tr>
<td>B14</td>
<td>Make the visible caption of one or several selected busbar-connectors invisible</td>
</tr>
</tbody>
</table>

### 5.5.2 Process bus zones mode

See [Section 9.31](#) and [Section 9.32](#).

![Figure 7: Single-line diagram editor/ Process bus zones mode](image)

**Figure 7:** Single-line diagram editor/ Process bus zones mode
Table 4: Function of buttons

<table>
<thead>
<tr>
<th>Button</th>
<th>Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>B15</td>
<td>After pressing the button B15, the system checks whether all busbar connectors are assigned to a bus zone. At the end of the test, a message box indicates the test result. In most cases, the bus zones are automatically assigned at the moment the Bay Model is inserted into the single-line diagram. For complex bus-configurations or after modifications on an existing Setfile (re-configuration), a reassignment of the bus zones could be necessary. If not all busbar connectors are assigned to a bus zones, the correct function of the REB500 system cannot be guaranteed.</td>
</tr>
<tr>
<td>B16</td>
<td>By pressing the button B16 the complete bus zone arrangement is reassigned. The reassignment might be necessary if an existing setfile has to be extended with new bay models and new bus zones are generated. If the bus zone reassignment process is started with button B16, the configurator tool also performs the reassignment of the bus zone related signals (I/Os) in the background automatically. Re-configuration of a complex system (setfile) can induce a changed signal configuration in comparison to the original setfile. If necessary, these bus-zone related signals have to be worked over under the binary module configuration of the Central Unit (CU).</td>
</tr>
</tbody>
</table>

5.5.3 Select Bay model


This menu appears if one of the buttons Import bay Model (Figure 6 B5-B7) is pressed.

Under the Select Bay Model window, a Bay Model (BM) can either be selected from the Base Bay Models database (models created by ABB) or from the User Bay Models database (models created by the user).
Table 5: Function of selections

<table>
<thead>
<tr>
<th>Selection</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>Activates the Base Model Database. The table of Bay Models (S4) containing the BM’s created by ABB can be selected.</td>
</tr>
<tr>
<td>S2</td>
<td>Activates the User Model Database. The table of Bay Models (S4) containing the BM’s created by the user (client) can be selected.</td>
</tr>
<tr>
<td>S3</td>
<td>If the option Filter Selection by Bay Model type is selected, the table of Bay Models (S4) is filtered according to the BM type. The filter criteria (number of busbars) is automatically derived from the Plant data settings (see Figure 5). If this option is not selected, all models of the respective database are visible.</td>
</tr>
<tr>
<td>S4</td>
<td>Table of bay models. The content of this table is controlled by the buttons S1-S3. By selecting one of the table lines with a left mouse click, a BM is selected (highlighted in blue colour) for import to the single-line diagram. After pressing the button OK or Apply, the menu Import options appears for the selected BM (see Section 5.5.4).</td>
</tr>
</tbody>
</table>

Table 6: Indications

<table>
<thead>
<tr>
<th>Selection</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1</td>
<td>Single-line diagram of the selected BM → Selection made under S4</td>
</tr>
<tr>
<td>V2</td>
<td>Description of the selected BM → Selection made under S4 Example: 2SSF5A1BBP,BFP double busbar, F5A1 BM identifier Station protection functions contained in the BM 2 x single Pole Tripping outputs configured in the BM → two sets of single pole trip-ping contacts (2 x 3)</td>
</tr>
</tbody>
</table>
5.5.4 Import options

See Section 9.16.

This menu appears, if under the menu Select bay Model (see Section 5.5.3), the button OK or Apply is pressed. Now, the import-options of the BM can be selected by the user.

**Figure 9: BM import options**

<table>
<thead>
<tr>
<th>Selection</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>If the Voltage transformer option is selected, after pressing the button OK, the imported BM includes the voltage transform configuration (VT is visible under the single-line diagram). If the BM selected under Select Bay Model (see Section 5.5.3) does not contain a voltage transformer, this option is inactive (grey colored). If the Voltage transformer option is not selected, the BM will in any case be imported without voltage transformer. Resulting from this, no voltage protection function and no disturbance recording for voltage channels is available for this bay.</td>
</tr>
<tr>
<td>S2/ S5</td>
<td>For details about the import options of bay protection and the corresponding Variant (L-V2), see Application Manual for bay protection functions REB500, section Configuring bay protection using HMI500/ Integration of bay protection</td>
</tr>
<tr>
<td>S3</td>
<td>If the LMI LED configuration option is selected, after pressing the button OK, the imported BM includes a pre-defined LMI-LED configuration. If the LMI LED configuration option is not selected, the BM will be imported without LMI-LED configuration and configuration table of LED’s on the LMI will be empty. This table can be manually edited later (see Section 5.11).</td>
</tr>
<tr>
<td>S4</td>
<td>If the BU with PIO’s option is selected, additional 12 inputs and 6 precision outputs are available as a Bay Unit variant. The precision outputs are based on MOSFET technology and offer an improved tripping time performance.</td>
</tr>
</tbody>
</table>

5.6 Device structure

See Section 9.37.
Under the menu item **Device structure**, the system generated hardware device labels of the CU and the BUs (so called ABB-References) can be edited with client specific labels.

![Device structure](image)

**Figure 10: Device structure**

**Table 7: Function of selections**

<table>
<thead>
<tr>
<th>Selection</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>One of the hardware devices can be selected from the device table</td>
</tr>
</tbody>
</table>

**Table 8: Function of buttons**

<table>
<thead>
<tr>
<th>Button</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1</td>
<td>After all Bay Models are placed in the single-line diagram and the CU device creator process is completed, the device labels and the associated network in the background is automatically sorted from BU01 to BUxx → Bay Unit on the left end side to Bay Unit on the right end side of the single-line diagram in the correct order. After modifications (extensions) to an existing setfile, this sequence (label) of devices might be unsorted. By pressing the button B1, the reassignment of the ABB-References is started from left to right side of the single-line diagram (ABB-Reference = logical device containing label, node Id, device Id of a Bay Unit). If the reassignment of the ABB-References is started, the node-Id and device-Id of the Bay Units and the Central Unit may change compared to the original setfile.</td>
</tr>
<tr>
<td>B2</td>
<td>The button B2 opens the <strong>Edit device</strong> menu for the selected device. The user can fill in a device label which is in accordance with the client system labeling conventions. If one label is changed, the labelling shall be worked over for all devices. If necessary, the hardware type of the Bay Units can also be exchanged under this menu item.</td>
</tr>
</tbody>
</table>
5.7 **CU device creator**

See Section 9.34.

After completion of the basic setfile configuration, the single-line diagram and the bay configuration, the design wizard of the Central Unit shall be started by the button **Next**.

**Figure 11: CU Hardware wizard**

After pressing the button **Next**, a window containing the settings of the hardware options on the Central Unit will appear:

**Figure 12: CU Hardware wizard/ Options**

**Table 9: Function of selections**

<table>
<thead>
<tr>
<th>Selection</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>Redundant Power Supply on CU If this option is selected, the CU rack contains a second DC/DC converter for redundant power supply.</td>
</tr>
<tr>
<td>S2</td>
<td>Power supply (voltage) type Type 1: 48-125VDC Type 2: 125-250VDC</td>
</tr>
<tr>
<td>S3</td>
<td>Set the number of BIO boards 1 BIO Board → 9 Inputs, 19 outputs 2 BIO Boards → 18 Inputs, 29 outputs</td>
</tr>
</tbody>
</table>
After pressing the buttons **Next** and **Finish**, the **Hardware Wizard** starts the build-process and creates a hardware device for the Central Unit.

![Hardware Wizard](image)

**Figure 13:** CU Hardware wizard/ finish HW build process

Once the build process of the CU device creator is completed, it can be repeated again (for example, to reflect subsequent corrections resulting from system configuration changes).

### 5.8 Network

See **Section 9.36**.

This menu contains an overview of the BU device Id's. Since the CU device creator process (see **Section 5.7**) performs the complete network assignment (physically and logically), manual changes are usually not necessary. If required (for example, for reordering the bays after initial engineering), the ID can be adjusted manually, taking care that IDs have to be unique and can only be used once.
Figure 14: Network

5.9 Binary inputs/outputs

For detailed information about setting and configuration, see *REB500 Operating Manual*, section *Binary inputs/outputs*.

5.10 Event text configuration

For detailed information about setting and configuration, see *REB500 Operating Manual*, section *Event text configuration*.

5.11 LMI LED...

For detailed information about setting and configuration, see *REB500 Operating Manual*, section *HMI LEDs*.

5.12 Disturbance recorder

For detailed information about setting and configuration, see *REB500 Operating Manual*, section *Disturbance recorder*.
Section 6  Settings

6.1  Breaker failure protection

For detailed information about setting and configuration, see *REB500 Technical Manual*, section Breaker failure protection.

6.2  Time overcurrent protection

For detailed information about setting and configuration, see *REB500 Technical Manual*, section Time overcurrent protection.

6.3  End fault protection

For detailed information about setting and configuration, see *REB500 Technical Manual*, section End fault protection.

6.4  CB pole discrepancy

For detailed information about setting and configuration, see *REB500 Technical Manual*, section CB pole discrepancy.

6.5  Overcurrent release

For detailed information about setting and configuration, see *REB500 Technical Manual*, section Overcurrent release.

6.6  Voltage release

For detailed information about setting and configuration, see *REB500 Technical Manual*, section Voltage release.

6.7  Bay protection

For detailed information about bay protection functions, configuration and technical data see, *REB500 Application Manual for Bay protection functions.*

6.8  Circuit breakers

For detailed information about setting and configuration, see *REB500 Technical Manual*, section Circuit breakers.
6.9 Isolators

For detailed information about setting and configuration, see REB500 Technical Manual, section Isolators.

6.10 Current transformers

For detailed information about setting and configuration, see REB500 Technical Manual, section Current transformers.

6.11 Voltage transformers

For detailed information about setting and configuration, see REB500 Technical Manual, section Voltage transformers.

6.12 Voltage/ external release

For detailed information about setting and configuration, see REB500 Technical Manual, section Voltage/ external release.

Supplementary information necessary for configuration

The under voltage release criteria is performed with the normalized voltage amplitudes. The voltage limit UL is in relation to the defined nominal voltage UN of the corresponding voltage transformer.

Abbreviations

- UL Voltage limit
- UN Nominal voltage (phase-phase)

The scaling of 1/√3 in case of phase to earth configuration (3-phase star, 1-phase to earth) is done internally by the algorithm.

For more information about settings and calculations, refer to the document Ground fault protection for high voltage busbars, 1KHL 020319-Aen.

The number of activated measurements depends on the setting of the Bay Unit input voltage scaling and on the setting of the network grounding:

Input scaling: 3-Phase Delta (independent of network grounding):

\[ U \leq \text{Min}(U''_{L1-L2}, U''_{L2-L3}, U''_{L3-L1}) < U_L \]

Input scaling: 3-Phase Star (solidly grounded or impedance grounded):

\[ U \leq \text{Min}(U''_{L1-E}, U''_{L2-E}, U''_{L3-E}, U''_{L1-L2}, U''_{L1-L3}, U''_{L2-L3}) < U_L \]

Ungrounded or Petersen coil:

\[ U \leq \text{Min}(U''_{L1-L2}, U''_{L2-L3}) < U_L \]
Input scaling: 1-Phase to Phase (independent of network grounding):

\[ U \leq U''_{L1,L2} < U_L, \] only one voltage measured

Input scaling: 1-Phase to Earth (independent of network grounding):

\[ U \leq U''_{L1,E} < U_L, \] only one voltage measured

**Voltage transformer connections for \( U < \) measurement**

![Diagram of 3-phase VT connections](image.png)

*Figure 15: 3-phase VT connections*
6.13 **System response**

For detailed information about setting and configuration, see *REB500 Technical Manual*, section System response.

6.14 **Activate/ deactivate device**

For detailed information about setting and configuration, see *REB500 Commissioning Manual*.

6.15 **CB inspection**

For detailed information about setting and configuration, see *REB500 Commissioning Manual*.

6.16 **Event memory**

For detailed information about setting and configuration, see *REB500 Technical Manual*, section Event memory.

6.17 **Time**

For detailed information about setting and configuration, see *REB500 Technical Manual*, section Time synchronization and the specific subsection Additional settings.
Section 7  Tools

7.1  File verification

After starting the File verification tool, the content, structure and completeness of the REB500 setfile is checked.

This test routine shall be started after the setfile configuration has been completed. Once the test run is finished, the HMI500 menu shows the test result. For a successful test run, the system provides the information Number of errors: 0, Number of warnings: 0.

![File verification](image)

Figure 17: File verification — no errors

If the test procedure locates a setfile inconsistency, then an error level and a short description of the problem is given:

- **Error level 1 (minor error)**
  Such errors are caused by incomplete settings and configurations in the setfile (for example, CU device creator not started). An error level 1 is mostly accompanied by errors level 2 and 3. These error messages (side effect) should be cleared, after the errors level 1 are fixed. The repetition of the file verification shall prove the setfile again.

- **Error level > 1 (major error)**
  If errors level >1 should remain after the errors level 1 are fixed, the setfile has an important inconsistency, which cannot be solved by the user (engineer) of the HMI500 Tool, please contact your HMI500 supplier for clarification.

It is mandatory, to start the test run after the setfile configuration has been finished.

7.2  Reports

For detailed information about setting and configuration, see *REB500 Operation Manual, section Reports*.

7.3  Export SCS data

For detailed information about setting and configuration, see *REB500 Operation Manual, section Export SCS data*. 
7.4 Export Bay Model catalogues

The setfile engineer can save (export) a Bay Model catalogue in the PDF file format at any time. Depending on a selection, this catalogue contains Bay Models from the Base model database, or the User model database. The catalogue comprises the selected models filter criteria: busbar type(s) or all models.

![Export bay model catalogs](image)

**Figure 18:** Export bay models

7.5 Default values

See Section 9.9.
Figure 19: Default values

In this window, the default values common for all bays can be adjusted (the adjustment has a system global validity). If the entries are made during the initial setfile configuration phase (prior to the Bay Model engineering under the window single-line diagram), they are active for the further configuration process.

If the entries are made at a later stage (after the Bay Model engineering phase), the settings have to be confirmed with Change value of all (group individually).

Of course, these values can also be locally adjusted (individually) for each bay.

7.6 Bay model viewer

During the configuration phase of the single-line diagram, the user can select pre-configured Bay Models (see Section 5.5.3). The menu item BM Mode viewer, provides a preview of the available Bay Models (library).
**Figure 20: Bay model viewer**

**Table 10: Function of selections**

<table>
<thead>
<tr>
<th>Selection</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>Preview of <strong>Base bay models</strong> (created by ABB)</td>
</tr>
<tr>
<td>S2</td>
<td>Preview of <strong>User bay models</strong> (created by users)</td>
</tr>
<tr>
<td>S3</td>
<td>Table of bay models: The content of this table depends on the selection S1/S2. By selecting one table row (one Bay Model) with a left mouse click, the Bay Model viewer provides a preview of the single-line diagram as well as a short description.</td>
</tr>
</tbody>
</table>

**Table 11: Indications**

<table>
<thead>
<tr>
<th>Selection</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1</td>
<td>Single-line diagram of the selected BM → Selection made under S3</td>
</tr>
<tr>
<td>V2</td>
<td>Description of the selected BM → Selection made under S3 Example: 2SSF5A1 → double busbar, F5A1 → BM identifier, BBP, BFP → Station protection functions contained in the BM, 2 x single Pole → Tripping outputs configured in the BM → two sets of single pole trip-ping contacts (2 x 3)</td>
</tr>
</tbody>
</table>

**7.7 Operator mode**

If the HMI500 software is started under the **Configurator Mode**, the user can change over to the **Operator Mode** at any time. The login process is described under **Section 3**.
Figure 21: Change over from Configurator mode to Operator mode

7.8 Settings

For detailed information about setting and configuration, see *REB500 Operation Manual, section Settings.*
Section 8  
Annexure A | Configurator mode - Definitions
8.1 Setfile

See Section 4.
8.2 Configuration models (1)

Bay Model \(\rightarrow\) (BM)
The Bay Model is a logical image representing the complete configuration of a bay in a REB500 setfile. It contains the Bay Figure and the Bay Unit Model.

Bay Figure \(\rightarrow\) (BF)
The Bay Figure contains the bus image of a bay (including the switchgear objects, connections and the busbar connectors)

Bay Unit Model \(\rightarrow\) (UM)
The Bay Unit Model contains:
- the device type of the Bay Unit
- the image of the switchgear objects (derived from the Bay Figure)
- the licensed functions (pre-configured with basic settings \(\rightarrow\) to be worked over)
- the basic I/O configuration settings \(\rightarrow\) to be worked over
8.3 Configuration models (2)

Bay Model containing more than one Bay Figure
A Bay Model can contain more than one Bay Figure (for example, a feeder bay + bus section isolators), while only one Bay Unit Model (one Bay Unit) is used. This under the condition, that the following limitations are not exceeded.

Maximum per bay unit:
- 1 CB object
- 1 CT object (represents 4I-inputs → for example, I_{3ph} + I_{ground})
- 1 VT object (represents 5U-inputs → for example, U_{3ph} + U_{BB1} + U_{BB2})

From the Bay Model side, the number of isolators is not limited, if the number of binary inputs is sufficient.
8.4 Configuration models (3)

**Bay Model containing more than one Bay Figure AND more than one Bay Unit Model**

This type of Bay Model, is called Multiple Bay Model (MBM).

➢ For example, a Multiple Bay Model for a complete 1 ½ - breaker bay

Multiple Bay Models are allowed, if following limitations are not exceeded:

- Number of CB objects   number of bay units
- Number of CT objects   number of bay units
- Number of VT objects   number of bay units
- From the Bay Model side, the number of isolators is not limited, if the number of binary inputs is sufficient.
8.5 Bay Figure (BF)

Bay Figure BF
The bay figure is a part of the single-line diagram. It contains the Bay Objects (BO) as well as the Bay Topology (BT).

Bay Topology BT
- **Busbar Connectors**
  - Connection points between the Bay Figures
- **Bay internal connect**
  - Topological connections in a BF
- **Bay Node**
  - Place holder for the (logical) bay label

Bay Objects BO
- **Isolators**
  - two state objects → Open/ Closed
- **Circuit Breaker (CB)**
  - two state objects → Open/ Closed (inclusive CB close command)
- **Current Transformer (CT)**
  - analogue object → \( I_{L1}, I_{L2}, I_{L3}, I_{L0} \)
- **Voltage Transformer (VT)**
  - analogue object → \( U_{L1}, U_{L2}, U_{L3}, U_{L0} \)
8.6 Bus interconnections (1)

**Bus Interconnections**

The (logical) connections between adjacent Bay Models (adjacent Busbar Connectors).

If the number of bus connectors of adjacent Bay Models is identical, these interconnects are automatically added by the tool.
8.7 Bus interconnections (2)

If the number of Bus Connectors of adjacent Bay Models is not identical (for example, single bus and double bus Bay Models within the same single-line diagram), Bus Interconnections have to be added manually.

For manual insertion of a Bus Interconnection, select two Busbar Connectors and use the Connect button.
Data acquisition

Before starting the setfile configuration, the relevant system data shall be collected and the Bay Unit / Central Unit hardware as well as their functional scope shall be defined (evaluation of the order codes).

For the evaluation of the order codes, the tables attached to the REB500 Product Guide shall be used.
9.2 Preparations (2)

Single-line Diagram

It is mandatory for the configuration of a setfile to have a binding single-line diagram of the substation (latest version). The bus image implemented in the REB500 system will be based on this diagram.
9.3 Start HMI500

Starting HMI500 → Configurator mode
For the setfile configuration, the HMI500 has to be started under the Configurator mode.

HMI500 Setfile Editor
Under the setfile editor, the complete system configuration (setfile) can be configured.

See Section 3.
9.4 Sequence of configuration

As a guideline for the sequence of work items, the setfile engineer can follow the sequence of menu items.

(1) System configuration
The system configuration includes the global system data. The related inputs have to be made once per system (× 1).

(2) Bay configuration
The bay configuration includes the bay (Bay Model) individual data. The related inputs have to be made 'n' times per system (× n).

n = number of different Bay Models per system
9.5 Start configuration - File-New (1)

(1) File New…
Create a new setfile

(2) File name
Save the new setfile under a new file name. The ABB System Number shall be used for the file name (5221 in this example).

See Section 4.1 and Section 4.1.1.
### 9.6 Start configuration - File-New (2)

After pressing the Save button, three windows containing the basic (default) system settings will appear:

1. System Installation
2. Plant Data
3. Default Values

The default system data shall be worked over before starting any further detail configuration.

See [Section 4.1.3](#).

**Default system settings**

- Specified data
- Station name
- System name
- Plant data
- Impedance
- Voltage
- Grounding
- Type of installation
- Central
- Disturbance recorder
- Overcurrent release
- Voltage release
- Embedded Volts Server
9.7 Initial (default) settings (1)

Licensed components
- The licensed components (protection functions) shall be activated under this section.
- After the OK, or Apply button is pressed, the sub-menu items of the selected (licensed) protection functions become visible under the main menu Settings.

Revision information
- The revision index information is not used during the configuration phase. It has to be filled in for changes during the service phase of the system (for example, setting changes in the protection).

Version information
- The first version of the setfile shall get a preliminary index, for example, 0.10.
- To confirm a new index, press OK, or Apply button. Now, the HMI500 tool saves a new version of the setfile under a new name. The original file name (for example, 5221.mdb) is extended by the version part (for example, 01 → 522101.mdb).

See Section 5.1.
9.8 Initial (default) settings (2)

The busbar specific data shall be entered under this window:

1. Rate voltage ' Busbar voltage ph-ph
2. Rated frequency
3. Grounding ' Network grounding
4. Busbar ' Busbar configuration
   - single up to quadruple busbar
   - optional transfer bus
   - 1 ½ breaker system

See Section 5.2.
9.9 Initial (default) settings (3)

**Battery voltage**
This setting is valid for:
- Aux. DC voltage of BU/CU voltage supply
- Aux. DC voltage of BU/CU binary inputs

**General**
The default values are valid for the complete protection system. If the entries are made during the initial setfile configuration phase (prior to the Bay Model engineering under the window Single-line diagram), they are valid for the further configuration process. If the entries are made at a later stage, they have to be confirmed with Change value of all (group individually) to get a system-wide validity.

**Recovery time**
For detailed information, see REB500 Application Manual section Breaker reclaim time.

**CT (VT) ratio**
Secondary values of current and voltage transformers (if VTs are used for protection system)

See Section 7.5.
9.10 Initial (default) settings (4)

**Max. recording time**
This disturbance recorder provides two options for the setting of the recording time → standard and extended.

For detailed information, see REB500 Product Guide, table Disturbance recorder.

**Voltage channels**
As an option, the voltage channels can be implemented to disturbance recording (for bay units only).

**Disturbance recorder licence**
The default values are valid for the complete protection system.

See Section 7.5.
9.11 Communication (1)

SCS Configuration

The default setting is no interface. Under this setting, no protocol specific settings are visible.

If an inter-bay bus (IBB) is selected, the particular protocol specific settings are visible.

Max. two IBB configurations (connections) can be realized per system.

→ IBB1/IBB2

For detailed information about IBB settings, see REB500 Communication Protocol manuals.
9.12 Communication (2)

SCS Diff Current Parameters

The settings shall be worked over only after the configuration of single-line diagram has finished.

For detailed information about SCS Diff Current Parameters setting, see *REB500 Communication Protocol Manual, IEC 61850.*
9.13 SLD-CONF - Start

(1) Model Mode
Before starting SLD-CONF, select Model mode.

(2) Import model from database (DB)
First model to be inserted into the single-line diagram (SLD) with the button Copy Bay Model.

See Section 5.5.1.
9.14 SLD-CONF Select BM (1)

Now, the Select Bay Model window appears.

See Section 5.5.3.
9.15 SLD-CONF — Select BM (2)

(1) Bay Model DB
Use Base Bay Models (Models created by ABB) for the BM selection.

(2) Filter selection...
This selection filters the Base Bay Models according to the number of busbars (see settings made under Plant data → Busbar data).

(3) Select BM from table
Select the BM, suitable for the first bay of the single-line diagram.

(4) Press OK.
9.16  SLD-CONF — Select BM (3)

(1) Select BM from table
The 'Bay model import options' menu appears now, providing the following selection items:
- BM to be imported with or without voltage transformer
  (If a disturbance recorder with voltage option, or any voltage function is used, this item must be selected)
- BM to be imported with or without PIO's
  (6 precision outputs per BU)
- BM to be imported with a set of bay protection functions (Variant available 'L-V2')
- BM to be imported with or without LMI LED configuration
  (If the default LED configuration shall be applied for the local HMI, this item has to be selected)

(2) Press OK.

See Section 5.5.4.
Now, the first Bay Figure is imported into the single-line diagram.
9.18 SLD-CONF — adjust BM (1)

Setting menus of the protection functions and switchgear objects.

Note: While inserting the Bay Figure into the single-line diagram, the HM1500 tool has implemented the complete Bay Model under the related Menus automatically.

Menu Configuration-Device structure (hardware object)
Menu Configuration-Binary module (I/O signals/configuration)
Menu Configuration-LMI LED configuration
Menu Configuration-Disturbance recorder
9.19 SLD-CONF — adjust BM (2)

**Note:** Before duplicating the (first) Bay Model, it is recommended to work over the bay specific configuration and settings (menus) with the user (client) setting values (if different from ABB default setting).

### Setting menus
- Breaker failure protection
- Time overcurrent protection
- Undervolt protection
- CB pole discrepancy
- Overcurrent release
- Voltage release
- Bay Protection
- Circuit breaker
- Isolation
- Current transformers
- Voltage transformers
- Busbar protection
- Voltage external release
- System impedance
- System parameters
  - Activate/deactivate device
  - CB inspection
  - Event memory
  - Time
9.20 SLD-CONF — export BM (1)

Now, the BM, which is custom made for a line bay can be copied to the user model database (template database).

(1) Select the rectangular box of the Bay Figure with a left mouse click.

(2) Press the Copy selected BM to user model database button.
9.21 SLD-CONF — export BM (2)

1. Define a BM name.

2. Provide a BM description.

3. Press OK to write the BM to the user model database.
9.22 SLD-CONF — export BM (3)

Now, the typical Bay Model My Line 380kV, which is saved under the user model database is finished.

Note: The user model database and consequentially the Bay Model My Line 380kV can also be used for other stations.
9.23 SLD-CONF — typical bays (1)

Configuration steps from 8.14 SLD-CONF → Select BM (1) to 8.22 SLD-CONF → Export BM (3) are ready.

Repeat the configuration steps done for the typical line feeder My line 380kV for each typical bay of the station.

Typical bays of this station are:
- Line 380 kV
- Trafo 380 kV
- Buscoupler 380kV
- Line 380 kV including section isolator
The User Bay Model database contains each typical bay of the station now.
Now, the single-line diagram shall be completed step by step by importing the typical Bay Models from the User Bay Model database.

Import buttons to be used.
In case of Multiple Bay Models, change over to Figure mode, select the relevant Bay Figure (for example, bus section isolator figure) and move it to the appropriate position of the single-line diagram.
9.27 SLD-CONF — Bus labels (1)

After all Bay models have been imported to the SLD, the busbar labels shall be made visible.

(1) Select a Busbar Connector
After a left mouse click the connector point is highlighted in red colour.

(2) Make labels visible
Now, the button Bus label visible shall be pressed.
Now, the Bus Label is visible.

It is recommended to make all necessary Bus Labels visible now.

**Note:** At least one Bus Label should be visible at the end of each zone.
9.29 SLD-CONF — Labels (1)

Each text (caption) of the single-line diagram can be worked over by the user.

(1) Select a label
With a right mouse click, the button Change label appears. Press Change label, now.

(2) Change label
Now, the Change label dialog box appears.

(3) New label
Write a new label (client label) and press OK.
9.30 SLD-CNF — Labels (2)

Note: The single-line diagram configured in the REB500 setfile should now reflect the single-line diagram of the station.
9.31 SLD-CONF — Bus zone assignment (1)

After the configuration of the single-line diagram is finished, switch over to the process bus zones mode. Under this mode, the user can check whether the system has (automatically) assigned each busbar connector to a bus zone.

See Section 5.5.2.
9.32 SLD-CONF - Bus zone assignment (2)

Check Bus zone assignment
After pressing this button, the software checks whether the bus zone assignment is completed or not.
→ The result of the check is indicated in a separate window.

Note: For the initial configuration of a standard bus (single-line diagram), the bus zone assignment is performed completely by the configurator tool.
For complex bus configurations, or for reconfiguration (extension) of existing setfiles, it might be necessary to Reassign Buszones.

See Section 5.5.2.
9.33 SLD-CONF — Bus zone assignment (3)

**Warning:** If the bus zones reassignment process is started with the button “Reassign Buszones”, the configurator tool also performs the reassignment of the bus zone related signals (I/Os) in the background. The reconfiguration of a complex system (setfile) can induce a changed signal configuration compared to the original setfile. These (bus zone related) signals have to be worked over under the binary module configuration of the central unit (CU) now.
9.34 CU device creator (1)

The hardware design wizard starts the configuration process of a Central Unit suited for the bays (Bay Units) configured under the single-line diagram. In addition the CU specific hardware (settings) shall be defined:

- Redundant power supply on CU (or not)
- Power supply type (voltage range)
- Set the number of BIO boards (number of I/O's)

→ Press Next.

After the basic setfile configuration, the single-line diagram and the bay configuration are completed, the design wizard for the Central Unit (CU) shall be started.

→ Press Next.

See Section 5.7.
The Build Process completes now the configuration of the CU. The Build Process creates a new CU including the specified hardware options:

- Redundant power supply on CU (or not)
- Power supply type (voltage range)
- Set the number of BIO boards (number of I/O’s)

→ Press Finish.

After the build process of the CU device creator was started once, it can be repeated again (for example, to reflect subsequent corrections resulting from system configuration changes).
Additionally to the CU device, the Build Process defines the device allocation of the REB500 process bus (network) including the Device IDs of the Bay Units.

See Section 5.8.
9.37 Device structure

Under the menu item Device Structure, the system generated device labels of the CU and the Bus can be worked over with client specific labels.

(1) Select device line and press Edit.

(2) Edit device
Fill in a device label which is in accordance with the client system labelling conventions.
→ Work over devices line by line and press OK.

See Section 5.6.
9.38 File verification

After the configuration of the setfile has been completed, it must be verified. The File verification tool checks the plausibility and completeness of the bus configuration, hardware-configuration and the assignments.

Warning: Of course, the file verification tool can check the setfile internal configuration only. It is the responsibility of the user to check that the REB500 configuration is in accordance with the configuration of the protected station.
9.39 Final settings

Final adjustment of the setting menus
The settings shall be changed, if the default values generated by the configurator tool are not in accordance with the station parameters.

See Section 6.
9.40 Completed setfile

The setfile is now ready for a download to the protection system REB500 (target).
A download can be realized under the HMI500 Operator mode only.