



Curves 3



1. Introduction

Curves allows the visualization of the time-current, energy and peak limitation characteristics of ABB low voltage devices. Program features are the guided verifications of the protection of cables, people and discrimination.

2. Use conditions

Warnings and use conditions are available here:

<http://search.abb.com/library/Download.aspx?DocumentID=9AKK106103A2575&LanguageCode=en&DocumentPartId=&Action=Launch>

Curves manual is available clicking on the question mark top right.

3. Menu commands

Menu commands allow a simple management of the features of Curves.

Frequently used commands are proposed also in the toolbar with the icon represented left of the command described in the following paragraphs.

3.1. File menu

- **New:** Creates a new file.
- **Open:** Opens a previously saved Curves file (extension *.crs).
- **Save:** Saves the current project. The program will store the list of chosen objects, their status (visible-not visible), the settings of trip units and the relations between objects (cable protection-discrimination).
- **Save as:** Saves the current project with a different filename and/or path.
- **Print:** Prints a report with the current diagram and the visualized objects and the relays settings.
- **Exit:** Closes Curves.

3.2. Home Menu

- “New”:
 - **New:** Adds a new object.
 - **Delete:** Deletes the selected object.
- “Output”:
 - **Copy values:** Copies the descriptions, the reference voltage and all the other useful data of the visualized objects in the clipboard. The information stored vary depending on the object.
 - **Copy diagram:** Copies the current diagram in the clipboard; the diagram is available for pasting in the wished format.
- “Properties”:
 - **Toggle ID:** Toggles ON – OFF the visualization of a user made ID for the current object.
 - **Color:** Changes the color of the curve of the current object.
 - **Thickness:** Changes the thickness of the curve of the current object.
 - **Pattern:** Changes the pattern of the curve of the current object.
- “Devices and relations”:
 - **Show related:** Shows the objects linked to the current object for protection or discrimination relations.
 - **Relations dialog:** Opens the “Relations” window, where it is possible to assign the protection of a specific cable to a circuit-breaker or fuse or a discrimination link between two circuit breakers
 - **Coordinates:** Opens the “Coordinates” window for the current object. The use of this feature will be presented in paragraph 5.
- “Currents”:
 - **I_B:** Visualizes a vertical line at the I_B of the current object.
 - **I_Z:** Visualizes a vertical line at 1,45xI_Z of the current object.
 - **Min I_k:** Visualizes a vertical line at minimum fault current of the current object.

- **Max Ik:** Visualizes a vertical line at the maximum fault current of the current object.
- “View”:
 - **Zoom window:** Zooms the area selected with the mouse.
 - **Zoom in.**
 - **Zoom out.**
 - **Zoom Extension:** Zoom in/out to automatically fit all the curves displayed in the diagram.
- “Reports”:
 - **Project data:** Enables the user to enter, or change, the data in the project heading (customer, plant, project, board ...).
- “Export”:
 - **Ekip Connect:** exports trip units settings in a format readable by Ekip Connect. Ekip connect user manual is available here:
<https://library.e.abb.com/public/a3a733bfb5884fe1a8bdddc39208a612/1SDH000891R0002.pdf>

3.3. Windows menu

- “Lists”: permits to decide if “Objects” and “Relations” should be visible in the main window.
- “Diagrams”: permits to decide which diagrams should be visible in the main window.

4. Using curves

Example of Curves Workflow:

- 1) Choice of visualized object(s)
- 2) Definition of the verifications to check (cables protection – discrimination between circuit breakers)
- 3) Choice of the curve (Time-current, Energy limitation, Peak limitation)
- 4) Setting of the object(s) (if available)
- 5) Printouts

4.1. Curves main window

The Curves main window is divided into 5 sections:

- 1) Toolbar: Containing menus and toolbars;
- 2) Objects: Showing the list of objects in the current file;
- 3) Diagram: Showing the diagram with the curves of the objects;
- 4) Relations: Showing the list of discrimination and cable protection relations.
- 5) Settings panel: Permits to change settings of the current object.

The screenshot displays the ABB Curves software interface with five numbered sections highlighted in green:

- 1. Toolbar:** Located at the top, it includes menus (FILE, HOME, WINDOWS) and various tool icons for file operations, properties, relations, coordinates, zooming, and reports.
- 2. Objects:** A list on the left showing selected objects, including 'Cable' and 'E6.2V 4000 Ekip G Touch LSI... (Set A)'.
- 3. Diagram:** A central graph titled 'Time-Current curve LLL-LL @ 400V'. The y-axis represents time from 10ms to 10000s, and the x-axis represents current from 100mA to 100kA. A red curve represents the selected object, showing a characteristic time-current protection curve.
- 4. Relations:** A table at the bottom left showing discrimination and cable protection relations. The table has columns for 'Upstream', 'Downstream', 'Verification', and 'Status'. A relation is listed: 'Cb - E6.2V 4000 Ekip G To... Cable' with verification criteria: $IB (10.00[A]) \leq I_{th} (320.00[A]) \leq I_z (419.00[A])$ and $I_f (416.00[A]) \leq 1.45 \cdot I_z (607.55[A])$; $U_{ref}=400V$. The status is 'Ok'.
- 5. Settings panel:** A panel on the right for configuring the selected object 'E6.2V 4000 Ekip G Touch LSI... (Set A)'. It includes settings for In (800 [A]), InN (50%), I (0.400), S (I2t=const, t=const, 0.6, 0.05s), S2 (I2t=const, t=const, 0.6, 0.05s), I (4.0), G (I2t=const, t=const, 0.100, 0.10s), IB (10 [A]), Max Uo (50 [V]), Ik max (10 [kA]), Ra (0.5 [Ω]), and t max (0.4 [s]). A 'Restore' button is at the bottom.

4.2. Objects

Click on “New” button to choose a product. ABB products (circuit breakers, fuses) will be selected through a specific selection window. Once chosen and selected, the wished product will be added to the list of the visualized objects.

The available objects are

- **Cable:** choice of a cable. The default data (I_z , k^2S^2) shown in cable window refers to a cable with 3 conductors loaded, method of installation B2 (installation in cable trunking, standard IEC 60364-5-52). The data are user customizable
- **Cb (Circuit breaker) with electronic trip unit:** ABB Air or Moulded Case circuit breaker equipped with an electronic trip unit.
- **Cb (Circuit breaker) with thermomagnetic trip unit:** ABB Miniature or Moulded Case circuit breaker equipped with a thermomagnetic trip unit.
- **Fuse:** fuses with gG (general purpose) and aM (Motor start-up) fuse-links; sizes from ‘00’ to ‘3’ (NH sizes) and rated current from 2A up to 630A. Also available fuses defined in the standard IEC 60269-2-1.
- **RCD (Residual Current Device):** products with I_{dn} from 0,01A up to 1A; A and AC classes; Instantaneous, Selective and Anti-Perturbance versions.
- **User defined:** definition of a curve per points, supplying abscissa and ordinate.

4.3. Available diagrams

- I-t LLL: time-current devices tripping characteristic for three phase faults.
- I-t LL: time-current devices tripping characteristic for two phase faults.
- I-t LN: time-current devices tripping characteristic for single phase faults.
- I-t LPE: time-current devices tripping characteristic for phase-earth faults.
- I^2t LLL: specific let through energy for three phase faults.
- I^2t LL: specific let through energy for two phase faults.
- I^2t LN: specific let through energy for single phase faults.
- I^2t LPE: specific let through energy for phase-earth faults.
- Peak: current limitation curve.

4.4. Setting the trip units

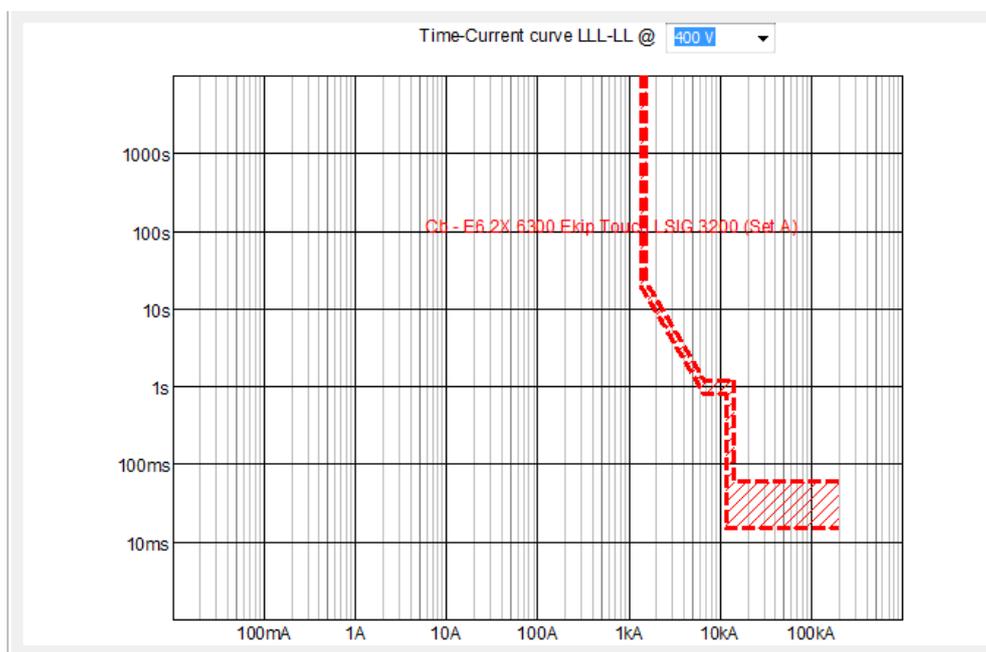


Current object

It is the currently selected object. Selecting an object need to:

- Click on the description in the “Objects” section
- Click on the curve

The curve of the current object is dashed.



Circuit breaker with electronic trip unit

How to set an electronic trip unit?

- **In the control panel:** Click on the description (in objects panel) or on the curve of the breaker to open its control panel on the right. Choose the wished settings in the pop-up menus: the curves are updated in real time. Set ON-OFF functions of the trip units by clicking on the corresponding check box.
- **Dragging the curve directly in the diagram:** Move the mouse cursor on the edge of a curve until it changes its shape into an horizontal double headed arrow \longleftrightarrow for current thresholds, and a vertical double headed arrow \updownarrow for time thresholds. Click and, keeping the left mouse button pressed, drag the curve in the wished position.

E6.2V 4000 Ekip G Touch LSI... ▾ ▹ ×

E6.2V 4000 Ekip G Touch LSIG 800 (Set A)

E6.2V 4000 Ekip G Touch LSIG 800

Electronic ▾

In 800 [A] InN 50% ▾ Enable Set B

L ▾ ▾

S

I2t=const ▾ ▾

t=const

S2

I2t=const ▾ ▾

t=const

I ▾

G

I2t=const ▾ ▾

t=const

IB 10 [A] Max Uo 50 [V]

Ik max 10 [kA] Ra 0.5 [Ω]

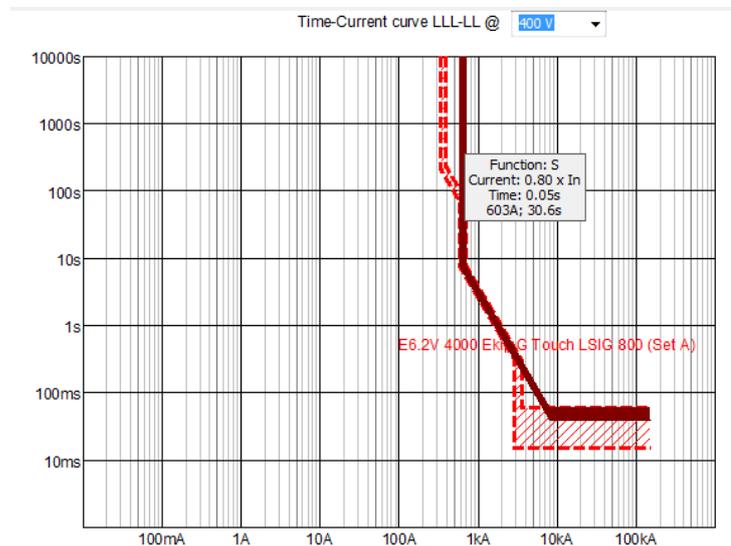
t max 0.4 [s]

 Restore



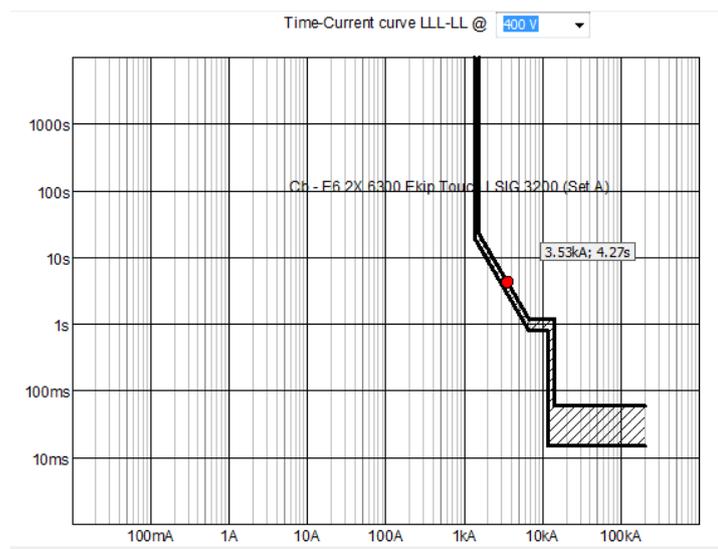
Function highlighting

Passing with the mouse on the curve, the part of the curve corresponding to the function on which the mouse is passing will be highlighted. A tooltip will give information about the function, the current settings and the coordinates on which the mouse cursor is.



Magnetic cursor

When the mouse cursor is next to a curve, the cursor is “magnetically attracted” by the curve: this function permits to slide the curve and read the curves coordinates with high precision.





WARNING

The program verifies in real time the coherency of the settings. Therefore it is not possible to set thresholds which do not satisfy the condition:

$$I1 < I2 < (I2-S2) < I3$$

Circuit breaker with thermomagnetic trip unit

When a thermomagnetic trip unit has adjustable thresholds it can be set by dragging its curve or in its specific window. When the threshold are fixed this features will be disabled.

Cb

Cb - XT4V 250 TMA 225-2250

XT4V 250 TMA 225-2250

In 225 [A]

L

157.5 191.25 225

I

1125 1687.50 2250

IB 10 [A] Max Uo 50 [V]

Ik max 10 [kA] Ra 5 [Ω]

t max 0.4 [s]

Changing the breaker I_B (the load current of the breaker), it is possible to appreciate the curve variation due to it.

Cable

The cable control panel contains the data used in the verifications. It is possible to customize all the default values.

The data used in the verifications are:

- I_z : current carrying capacity.
- $K2S2$: max withstandable energy during short circuit.
- I_k min: min. fault current at line end.
- I_k max: max. fault current at line beginning.

Cable

400 V LLLN TT

Fire danger place
 K2S2 at working temperature

Cable

Phases
1 x 150 mm²
Cu I_z 419 [A]
PVC K²S² 2.98e+008 [A²S]

Neutral
1 x 95 mm²
Cu I_z 341 [A]
PVC K²S² 1.19e+008 [A²S]

PE
1 x 95 mm²
Cu I_z 341 [A]
PVC K²S² 1.19e+008 [A²S]

I_k min 1 [kA] 
 I_k max 10 [kA]

 Restore



Ik min calculator

The calculator in the cable control panel allows a quick assessment of the minimum short circuit current at line end, given the upstream contribution and the cable length. Following the formulas and hypothesis used in the calculation:

$$I_{cc \text{ min}} = \frac{0.95 \cdot V}{A \cdot \sqrt{(R_{ph} + R_{pe} + R_s + R_a)^2 + (X_{ph} + X_{pe} + X_s)^2}}$$

Legenda:

- V = Rated Voltage.
- A = Phase coefficient = 1 for single-phase cables, or when PE and Neutral are not distributed; $\sqrt{3}$ in all the other cases.
- R_{ph} = Phase Resistance at T_{max}. Resistance of the phase conductor at the maximum working temperature (70°C for PVC; 90°C for EPR).
- R_{pe} = PE Resistance at T_{max}. Resistance of the PE conductor (or Neutral, if the PE is not available) at the maximum working temperature.
- X_{ph} = Phase Reactance. The reactance calculation considers conductors in flat disposition, spaced.
- X_{pe} = PE Reactance.
- R_s = Resistance of the upstream circuit = $0.6 \cdot V / \sqrt{3} \cdot I_{ccmax}$.
- X_s = Reactance of the upstream circuit = $0.8 \cdot V / \sqrt{3} \cdot I_{ccmax}$.
- R_a = Earthing resistance of the network (only for TT systems).

The screenshot shows a dialog box titled "Ik min calculator" with a close button (X) in the top right corner. It contains four input fields with their respective units: Length (1 [m]), Ra (1 [Ω]), Ik max (10 [kA]), and Ik min (0.216 [kA]). At the bottom, there are two buttons: "OK" and "Cancel".

Fuse

The data used to select and verify a fuse (Fuse-link type, Size, In) are displayed in the fuse control panel. It is possible to select ABB fuses as well as fuses defined in the standard IEC 60269-2-1.

Fuse

Fuse, OFAF0AM6

400 V LLLN TT

Fuse

Icu 120 [kA]

Fuse-link aM

Size 0

In 6 [A]

IB 10 [A]

Max Uo 50 [V]

Ra 5 [Ω]

t max 0.4 [s]

Restore

Residual current device

The data used to select and verify a residual current circuit breaker (poles, Id, class, version) are displayed in its control panel.

RCD

Cb

400 V LLLN TT

Poles 4P Class AC

Id 0.30 [mA] Version Instantaneous

F204 AC-100/0.3
F204 AC-125/0.3
F204 AC-25/0.3
F204 AC-40/0.3
F204 AC-63/0.3
F204 AC-80/0.3
F204-SX AC-25/0.3
F204-SX AC-40/0.3
F204-SX AC-63/0.3
F364 25A 300mA AC 4P
F364 40A 300mA AC 4P
F364 63A 300mA AC 4P

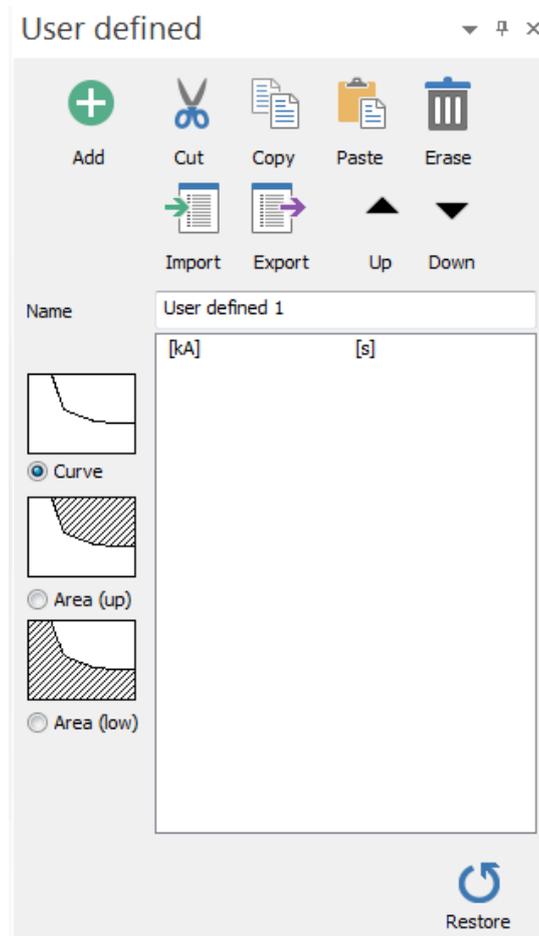
OK Cancel

User defined

It is possible to define a curve by points, connected each other by a straight line. This object can be used to draw, for instance, a MV relay.

It is possible to export (Export command) and import (Import command) the curves in .csv, .xls, .xlsx format.

The object “Area” works like the user defined curve, with the adding of a pattern which will fill in the area above or below the curve, according to user choice.



5. Advanced features

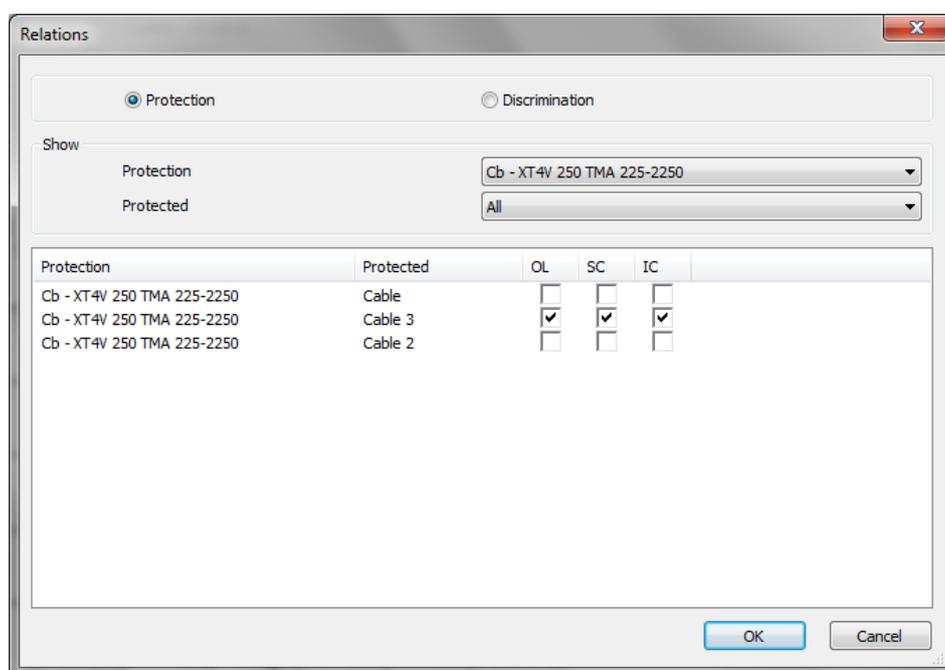
The chapter will describe the advanced features of the program:

- The verifications of the protection of a cable;
- The verification of discrimination;
- The coordinates command;
- The views creation;
- The reference voltage of the diagram.

5.1. Relations

Cables protection and discriminations links are defined in the dialog window “Relations”.

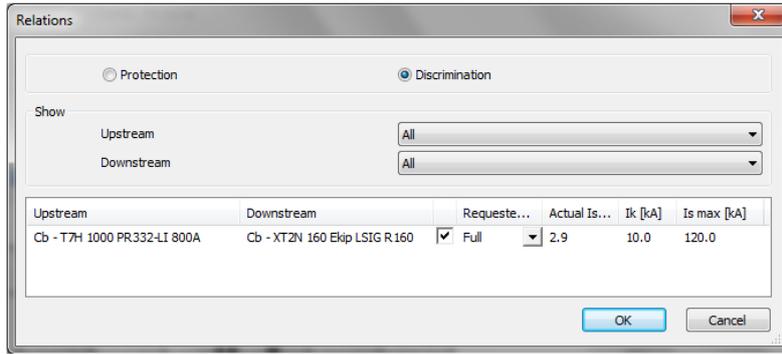
Protection: links a cable to a device able to protect it against OverLoad (OL), Short Circuit (SC), Indirect Contacts (IC). Combo boxes filter the list of protecting devices and protected cables.



Discrimination: creates a discrimination link between two circuit breakers. Verifications are made according to QT1.

The dialog window shows the following values:

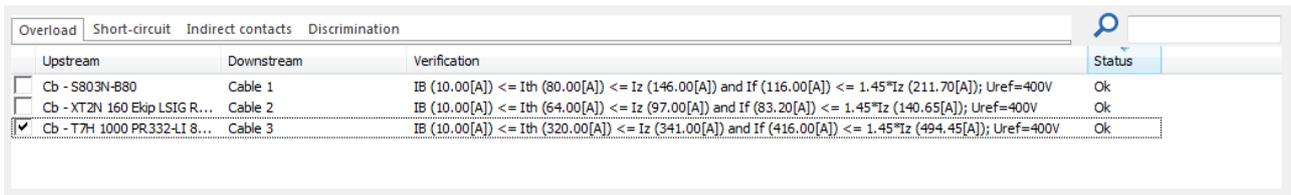
- **Requested Is:** requested discrimination value in [kA]. “Full” means discrimination up to the **Ik**.
- **Actual Is:** discrimination value with current settings.
- **Ik:** max. short circuit current in the downstream circuit breaker; it is the discrimination value to reach to achieve full discrimination.
- **Is max:** max discrimination value achievable by the couple of circuit breakers when the rules defined in QT1 are accomplished. This value is read from the coordination tables (energy discrimination).



Once assigned, the relations are shown in the lowest section of the main window (see section 4 of Figure 1) and their status is updated in real-time, when changing the settings.

The program shows the curves of the objects linked in the selected relation, automatically switching to the diagram used in the verification.

Relations



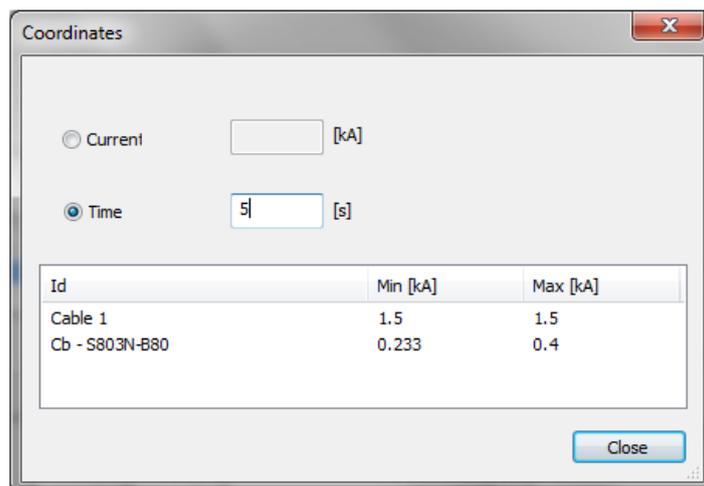
Relations are split through tabs in “Overload”, “Short circuit”, “Indirect contacts” and “Discrimination”. Moreover, it is possible to filter relations through the search box.

Red color is used to highlight not verified relations.

5.2. Coordinates

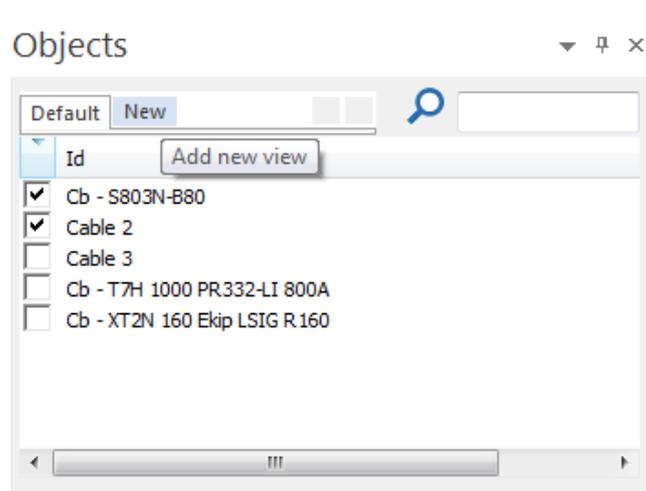
This feature allows calculating the abscissa of a curve given a specific coordinate and viceversa.

The icon is active only when a curve is selected.



5.3. Views creation

In the “Objects” panel, it is possible to create views in which visualize only the desired objects.



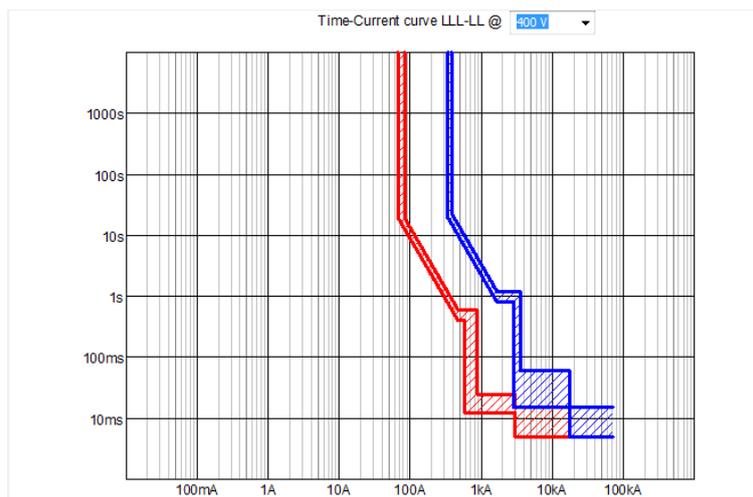
Clicking on “New”, the view is created, and it can be renamed. Checking the desired objects, they are inserted in the new view. Views remain memorized, and changing settings in a view, they are automatically changed in all the views. Objects, in each view, can be sorted by alphabetical order in each column clicking on the column header, and can be filtered using the search box.

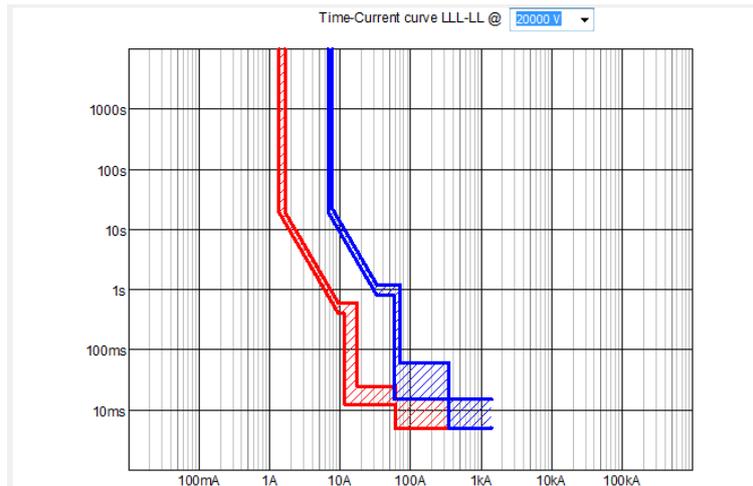
5.4. Diagram reference voltage

This feature permits to change the reference voltage of the diagram. **This is not related to the breakers behavior at different voltage levels.**

This functionality enables the user to visualize breakers, whose curves are valid at different voltage levels, in the same diagram at the same time; it can be particularly useful in case of different voltages in the same plant.

In the following pictures, the same diagram is shown with two different reference voltages. In essence, the change of the reference voltage of the graph moves the curves horizontally.





6. Print commands

6.1. Print

The print report created by Curves is a document with:

- Project data
- Current diagram
- Reference voltage
- Drawn objects and related characteristics (Trip units settings; current carrying capacity of cables, etc.)
- Current relation (verification and status)