DOC

User Manual

1. Introduction

1.1. General information

This chapter describes:

- the list of DOC functionalities;
- the applications which can be made with DOC.

1.2. Presentation of the program

DOC is the ABB SACE program for drawing and calculating single-line diagrams of low and medium voltage electrical plants, for selecting the switching and protection devices and for verifying coordination of the protections.
DOC is dedicated to all professionals in the electrical sector looking for a precise but simple and rapid tool, which helps them to do their work.

The main functionalities of the program are:

- Drawing single-line electric diagrams.
- Drawing the key diagram of the auxiliary circuits.
- Drawing and configuring the switchboard front (only for Italy).
- Calculating line current and voltage drops.
- Calculating short-circuit currents.
- Dimensioning low and medium voltage cables.
- Dimensioning switching and protection devices.
- Calculating the temperature rise in ABB modular switchboards.
- Setting and coordinating protection devices.
- Verifying cable protection.
- Printing single-line diagrams and project documentation

The program can calculate electric networks with the following characteristics:

- Medium voltage: $Vn \leq 36kV$ 50/60Hz
  State of the neutral: Insulated / Compensated
- Low voltage: $Vn \leq 1kV$ 50/60Hz
  Three-phase power supplies with and without neutral, two-phase and single-phase
  Distribution system : TT – TN-S – TN-C – IT

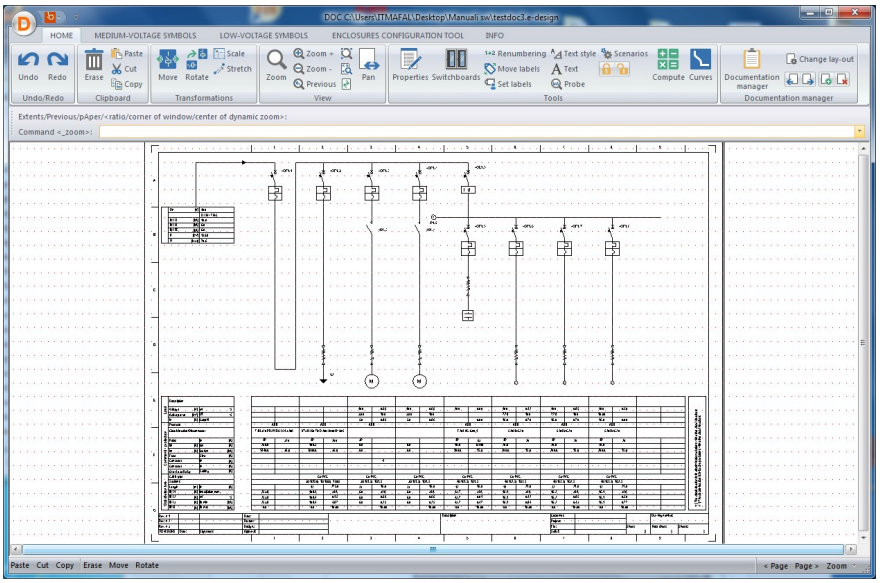
- Unlimited number of levels and feeders.
- Several distribution systems in the same network
- Three-phase networks with single-phase and two-phase loads
- Plants with service generator.
- Plants in cogeneration.
- Plants with back-up transformers.
- Island operation, without restrictions to the number of generators

Colors of the single line diagram

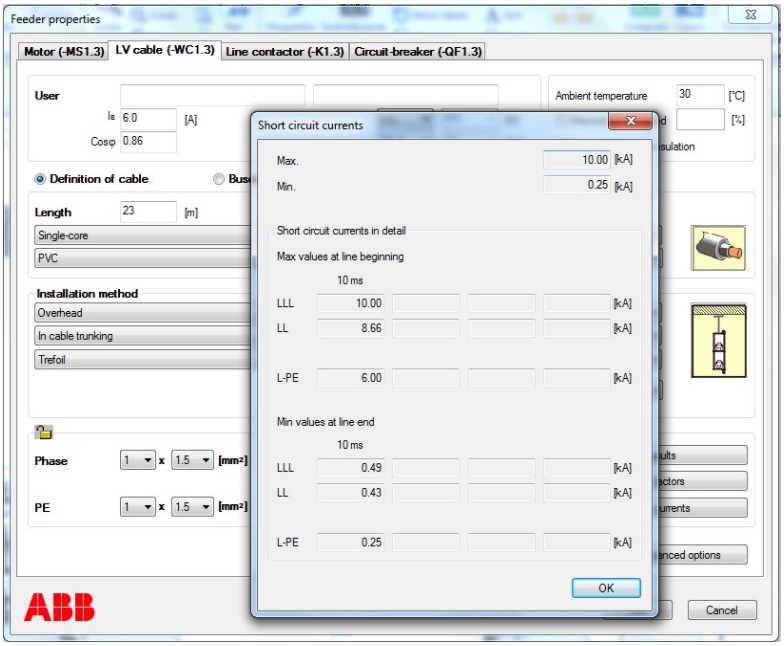
To make this document easier to consult, the images of the single-line diagram have – where possible – been created on a white background, thus with the same color configuration as that predefined in the program.

When using the program, you are advised to use the predefined colors (white background and black, green, yellow or red symbols, depending on their state).

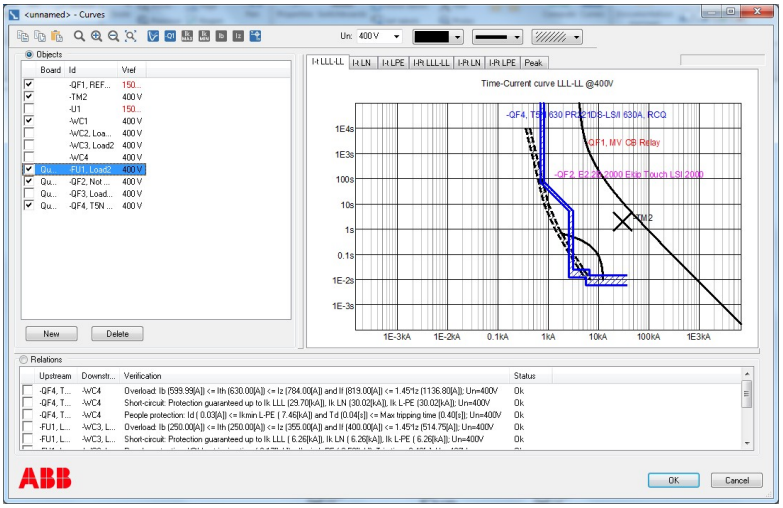
Further explanations about color management are given in chap 2.7



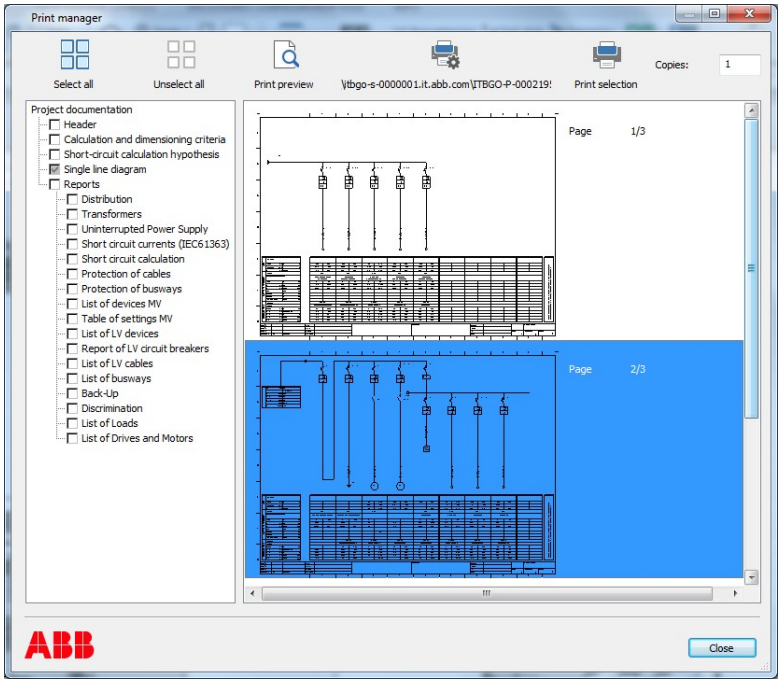
- *DOC: Drawing of the Single-line Diagram*



- *DOC: Cable Section Calculation; Short-circuit Calculations*



DOC: Cable Protection and Discrimination Verification



DOC: Print-out of Project Documentation

2. Starting to work with DOC

This chapter describes

- operations prior to drawing the single-line diagram;
- description of the work environment;
- customization of the work environment.

After reading this chapter, the user will be able to:

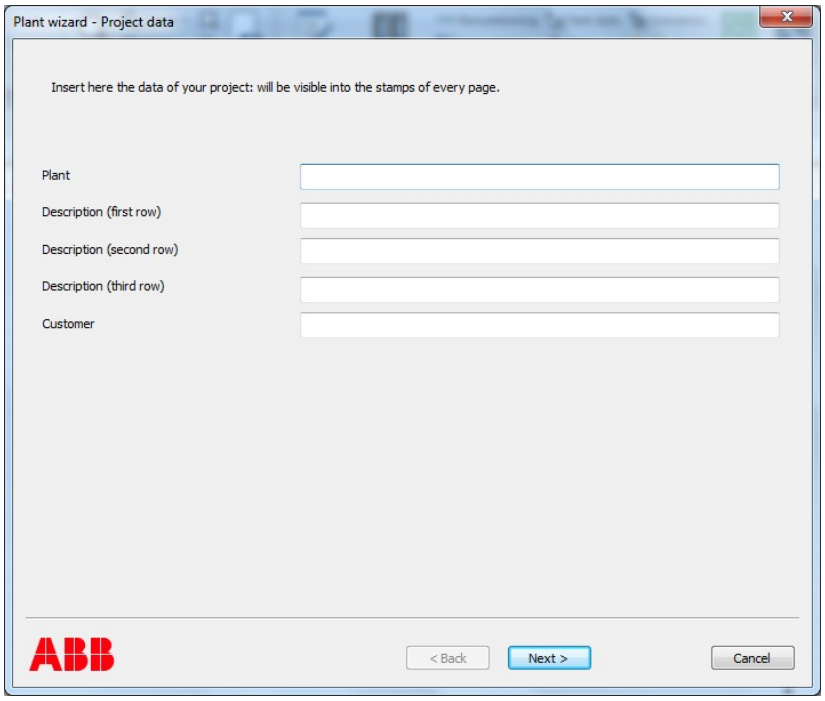
- customize the appearance of the program;
- select the utility;
- define the general properties of the plant;
- select the layout.

2.1. Definition of the general plant properties

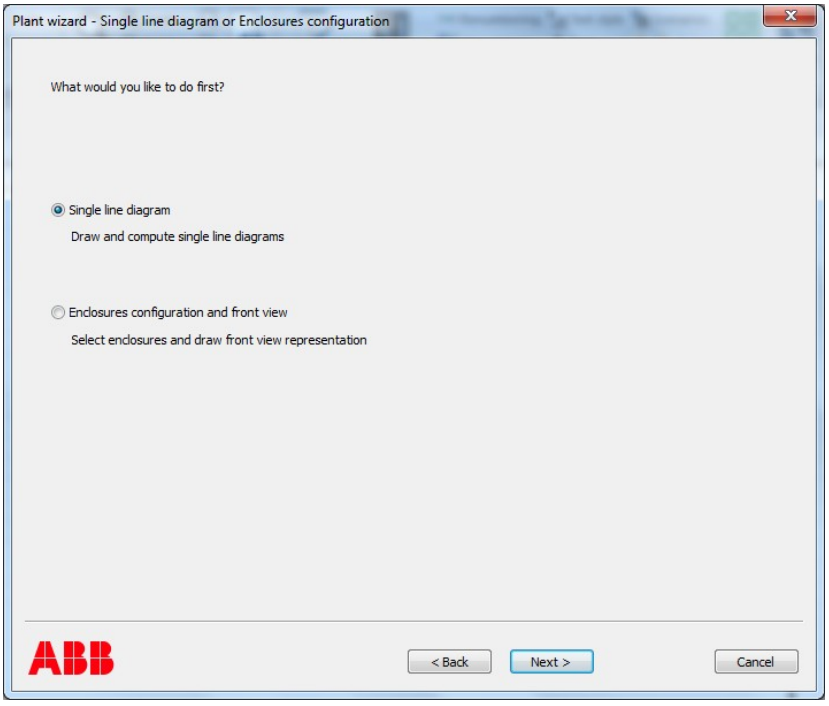
When a new project is opened, the program proposes a series of consecutive masks for the purpose of defining all the main characteristics.

Their sequence is proposed automatically by the program, depending on the selections made by the user.

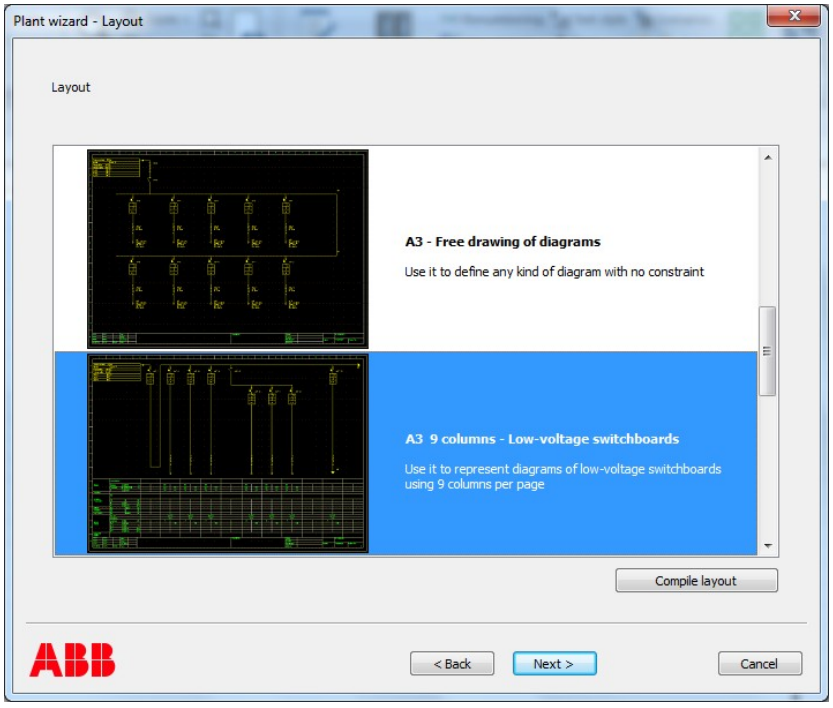
If required by the operation, the sequence is also run automatically by the program in an already opened file (e.g. when a transformer or some other electrial devices is inserted in a layout that is still without a utility).



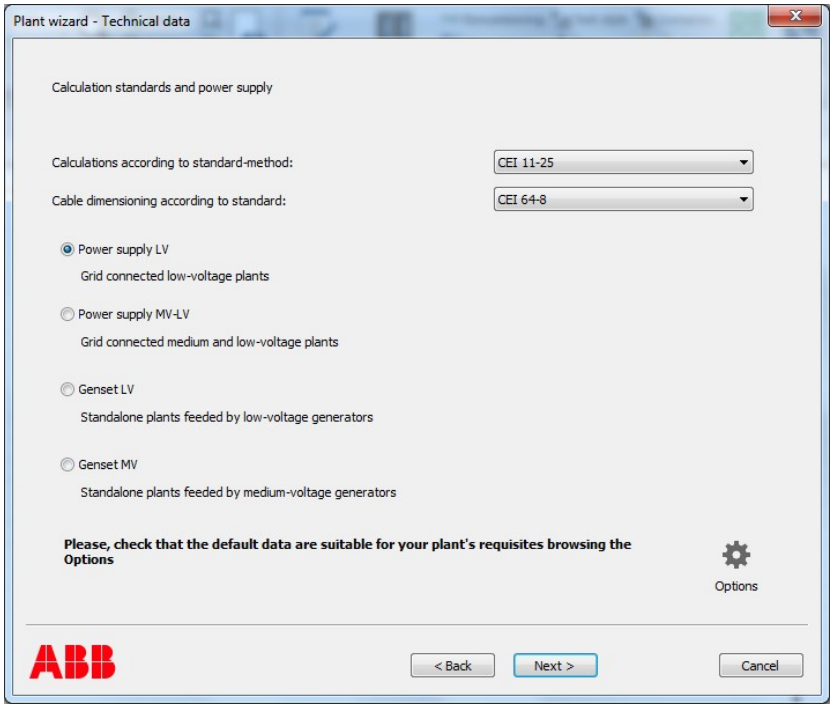
Plant Wizard - window for defining the project data



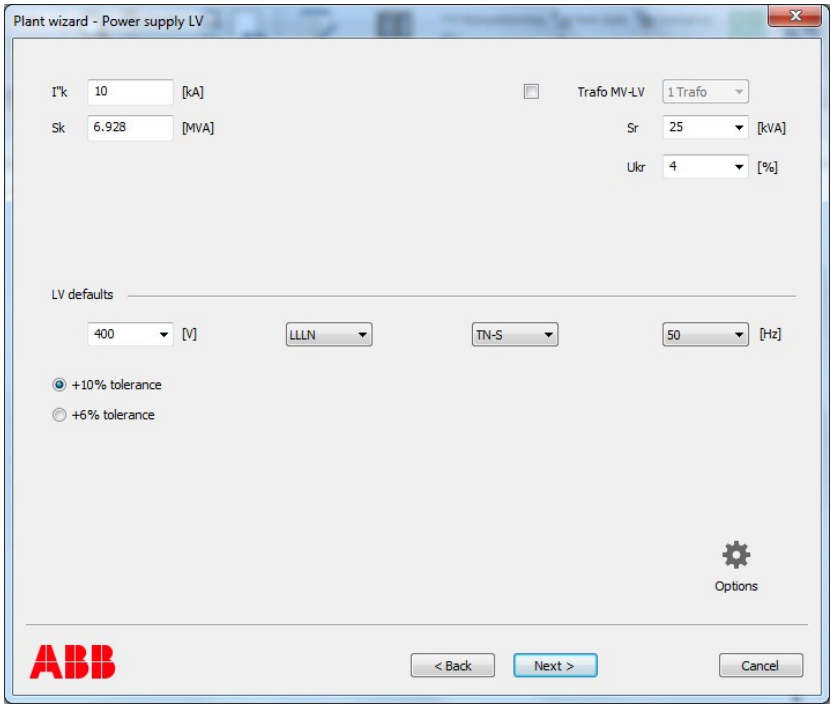
Plant Wizard - window for choosing between single-line diagram and enclosure configurator (only for Italy)



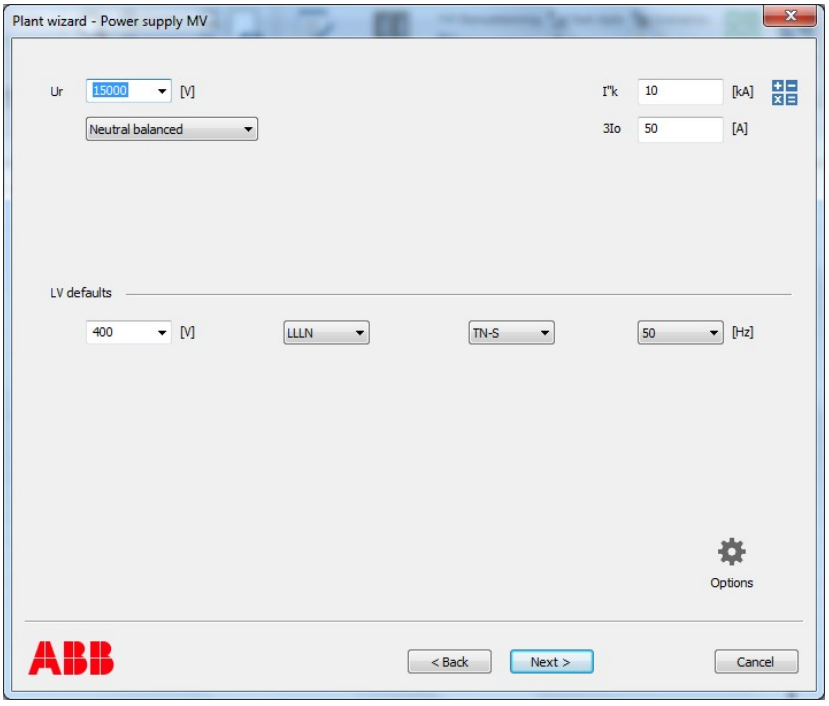
Plant Wizard - window for choosing the layout



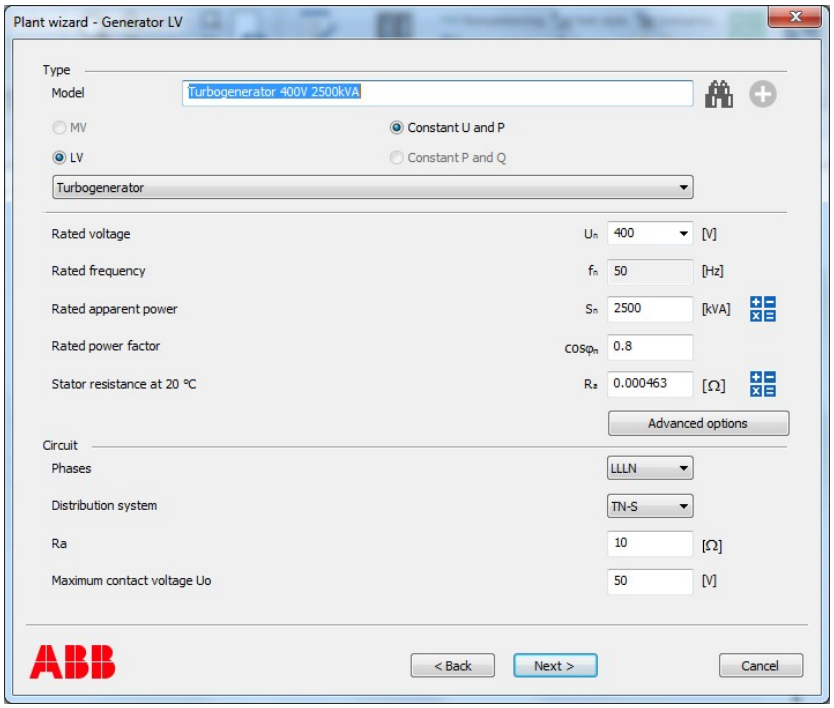
Plant Wizard - window for choosing the reference standards and utility



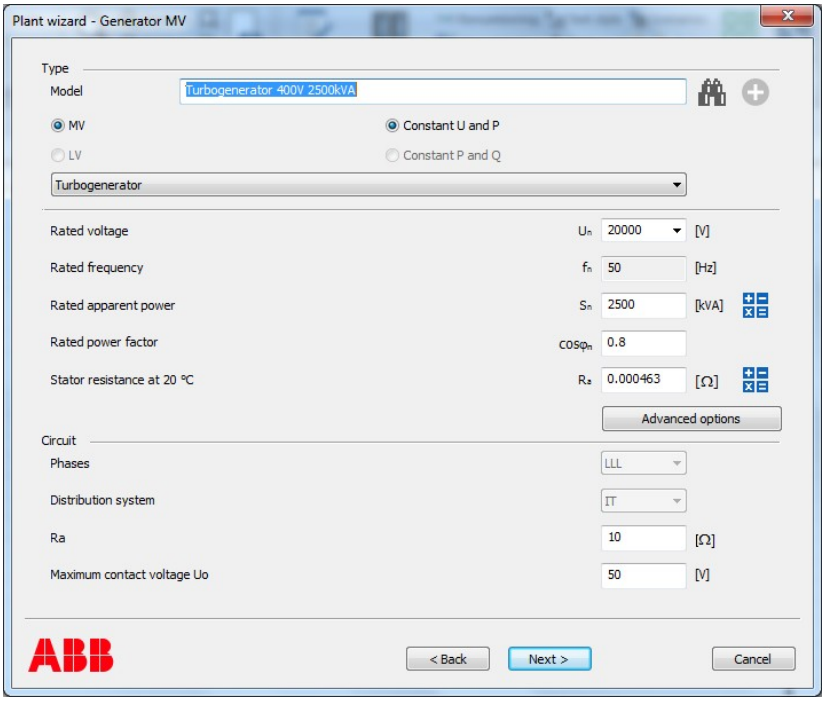
Plant Wizard - window displaying low voltage supply



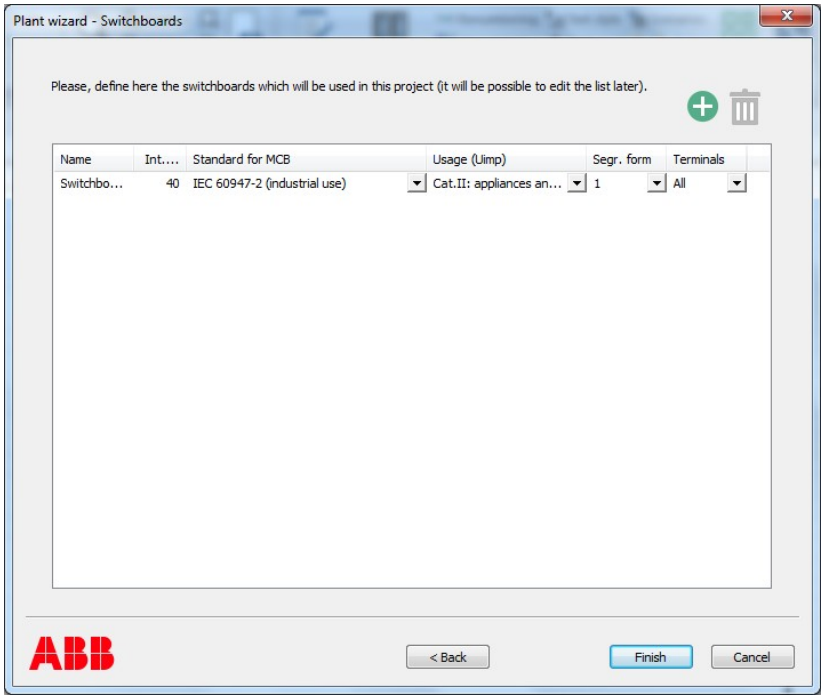
Plant Wizard - window displaying medium voltage and low voltage supply



Plant Wizard - window displaying network supplied by low voltage generator



Plant Wizard - window displaying network supplied by medium voltage generator



Plant Wizard – window for defining the switchboards

2.2. Plant Wizard for LV and MV-LV supply

Use of LV (low voltage) supply

This supply is suitable for:

- -installations for the residential and services-providing sectors or small industrial applications connected to the low voltage distribution network. Small and medium-sized installations connected to the distribution network by means of transformer substations belonging to the public utility company.
- -medium and high-power installations when only the low voltage section need be studied, where there is no need to coordinate the protections between the medium voltage side and low voltage side of the transformer/s.

In order to define the supply, DOC requires one of the following parameters:

- the three-phase short-circuit current
- the apparent short-circuit power

Enter one of the two parameters mentioned above and DOC will automatically calculate the other .

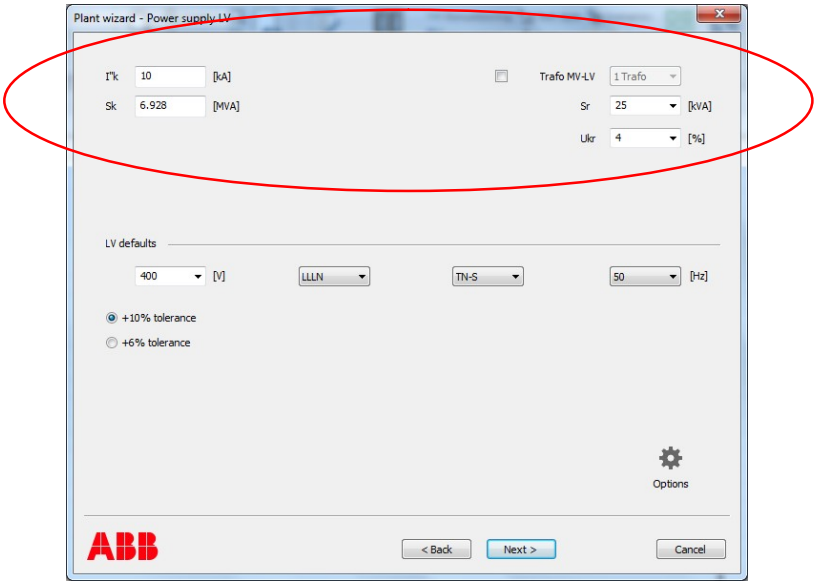
If the parameters of the medium voltage/low voltage transformer/s (transformer substation belonging to the public utility company) are known, they can be entered in place of the short-circuit current on the low voltage side or the apparent short-circuit power side.

To enter the values of the transformer/s, enable the fields by selecting the relative box at the top right of the supply window.

Select the number of transformers in parallel in the substation in the pull-down menu. Up to a maximum 3 transformers in parallel can be considered.

Now select the power of the transformer in the pull-down menu or type in the required value in the field. Similarly, select the percentage short-circuit voltage (Ukr) from the pull-down menu or type in the value.

Using these values, DOC calculates the voltage drop from the transformer secondary to the last load (without considering the internal voltage drop of the transformer, which would be counted by DOC if the Single Object "*Transformer with 2 windings*" with MV-LV supply were to be used).



Calculators for LV short-circuit definition – top part of LV supply window

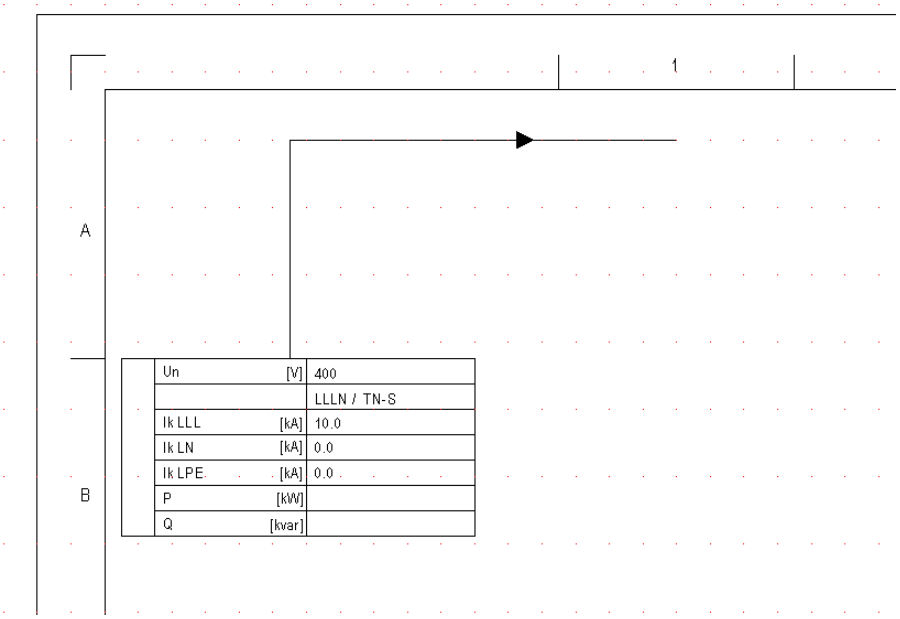
<u>If the exact value of the short-circuit current at the supply is not known, you can use the short-time withstand current of the main switchboard (Icw), or the breaking capacity value of the main circuit-breaker.</u>

Regarding the characteristics of the low voltage circuits, the supply window allows you to define preset values for the main parameters that characterize the low voltage section of the installation.

<u>Accurate entry of the parameters will speed up the drawing and data entry steps.</u>

Portions of the installation that must have different values from the preset parameters (e.g. if a three-phase system with neutral is chosen (Phases = LLLN) but single-phase loads must also be shown) can be customized afterwards when the drawing is made (Cf. point 3 of Chapter 3.2)

- **Rated voltage**: there is a list of normalized voltages. However, you can type in any value you require between 0V and 1000V
- **Distributed phases**: all the possible combinations in a three-phase system are available (LLLN, LLL, LLN, LL, L1N, L2N, L3N)
- **Distribution system**: distribution systems TN-C, TN-S, TT and IT are available. <u>It is advisable to enter the distribution system of the supply</u>. Instructions about how to proceed if sections of the installation have different distribution systems are given further on (e.g. sections controlled by the TN-S system in installations with TN-C supply)
- **Rated frequency**: 50 or 60Hz
- **Power supply voltage tolerance** (+10% or 6% depending on the short-circuit calculation)



"LV supply": representation on in the single-line diagram

Use of the MV-LV supply

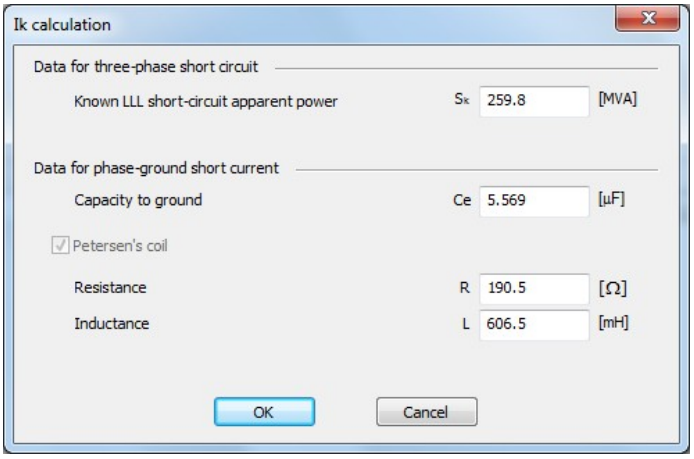
This supply is also suitable for representing the medium voltage section in large installations, by selecting the MV side switching and protection devices and coordinating them with the LV side of the installation.

The parameters required to define the supply (normally notified by the public utility company) are:

- the rated voltage.
- the short-circuit current.
- the earth fault current at the point of delivery.
- the state (insulated / compensated) of the neutral.

The calculator-shaped button allows the short-circuit current value to be entered in an alternative way, when the apparent short-circuit power is known.

Finally, the earth fault current value can be entered in an alternative way when the capacity to earth or the Petersen coil parameters are known (only in the case of compensated neutral).



"MV supply": Calculator for MV short-circuit definition

Earth fault calculation according to the state of the neutral

The formulae used by DOC for calculating the earth fault are given below with special attention to the parameters available for defining the MV short-circuit.

System with isolated neutral

$$3\mathrm{Io} = 3 \cdot 1{,}1 \cdot \mathrm{V} \cdot (2 \cdot \pi \cdot f) \cdot \mathrm{Ce}$$

System with compensated neutral

$$3\mathrm{Io} = \sqrt{\mathrm{Igr}^2 + \mathrm{Igi}^2} = \sqrt{\left(1{,}1 \cdot V / Rp\right)^2 + \left(3 \cdot 1{,}1 \cdot V \cdot \left(\left((2 \cdot \pi \cdot f) \cdot Ce\right) - \left(1/3 \cdot (2 \cdot \pi \cdot f) \cdot Lp\right)\right)\right)^2}$$

where:

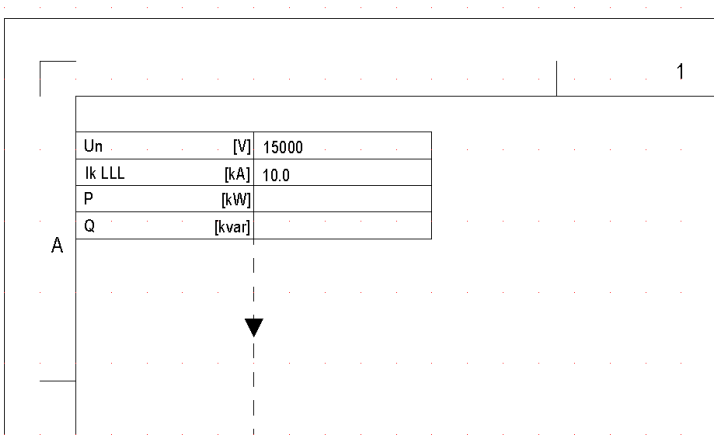
- 3Io [A]: earth fault current detected by the homopolar transformer
- 1.1V [V]: phase voltage corrected according to the c factor of Standard IEC 60909-0
- f [Hz]: frequency
- Ce [µF]: capacity to earth of the network on the supply side of the supply
- Igr [A]: real component of the earth fault current due to the resistance of the Petersen coil (Rp)
- Rp [Ω]: resistance of the Petersen coil
- Igi [A]: imaginary component of the earth fault current equal to the vector sum of the capacitive contribution of the network (Ce) and the inductive contribution of the Petersen coil (Lp)
- Lp [mH]: inductance of the Petersen coil

The window allows you to define the preset value for the main parameters that characterize the LV section of the plant.

Precise setting of the parameters speeds up the drawing and data input stages.

Parts of the plant which must have different parameter values (for example, you select three-phase distribution (Phases = LLLN) but you also have to represent single-phase loads) can be customized afterwards when drawing (Cf. point 3 of Chapter 3.2)

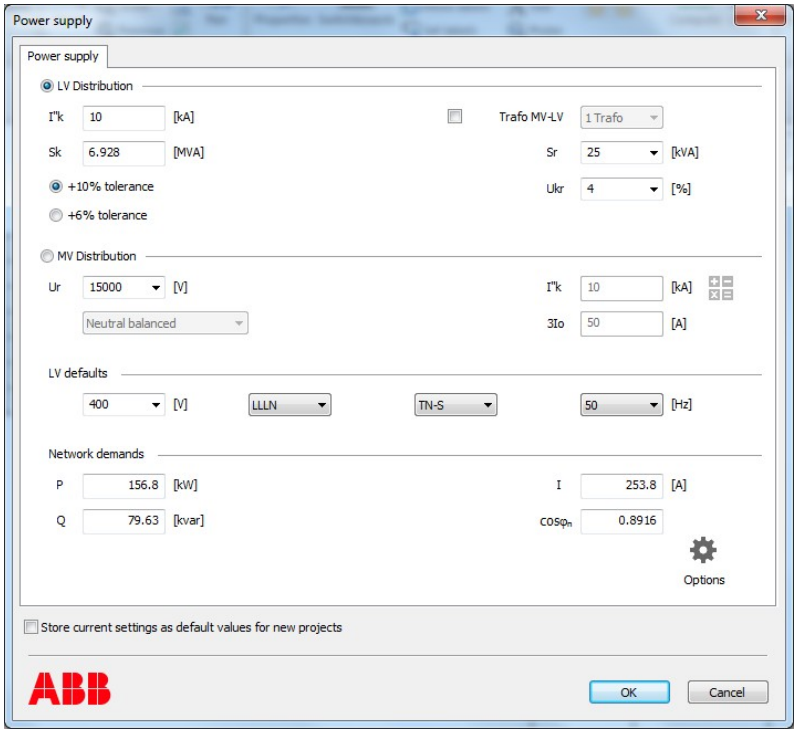
- **Rated voltage**: a list of standardized voltages is available. However, you can still type in a value between 0V and 1000V as you require
- **Distributed phases**: all possible combinations in a three-phase system are available (LLLN, LLL, LLN, LL, L1N, L2N, L3N)
- **Distribution system**: TN-C, TN-S, TT and IT distribution systems are available. It is advisable to enter the distribution system of the supply. Indications are given below about how to proceed if there are plant sections with a different distribution systems (for example, sections managed with the TN-S system in plants with TN-C supply)
- **Rated frequency**: 50 or 60Hz



"MV supply": representation in the single-line diagram

Further details about the LV and LV-MV supply

A simple double click on the symbol of the supply in the single-line diagram will call up a window where all the technical data can be entered.



"LV and MV-LV supply": supply data entry window

After the drawn single-line diagram has been calculated, the following plant load data are given in the "plant requirements" area of this window

- **Active power**
- **Reactive power**
- **Current**
- **Power factor**

Use the "Options command to access further advanced level settings which have already been pre-defined with values that generally need not be edited.

The advanced settings provided are:

- **Choice of Standards for short-circuit calculations**, i.e.:
  - IEC 60909 (International Standard for 50-60Hz applications)
  - IEC 61363 (Naval Applications)
  - NFC 15-100 (French Standard)
  - Symmetrical components method.
- **Choice of Standard for dimensioning cables**, i.e.:
  - CEI 64-8 (Italian Standard)
  - IEC 60092 (Naval Applications)
  - IEC 60364 (International Standard)

- UNE 20460 (Spanish Standard)
- VDE 294 (German Standard)
- NFC 15-100 (French Standard)

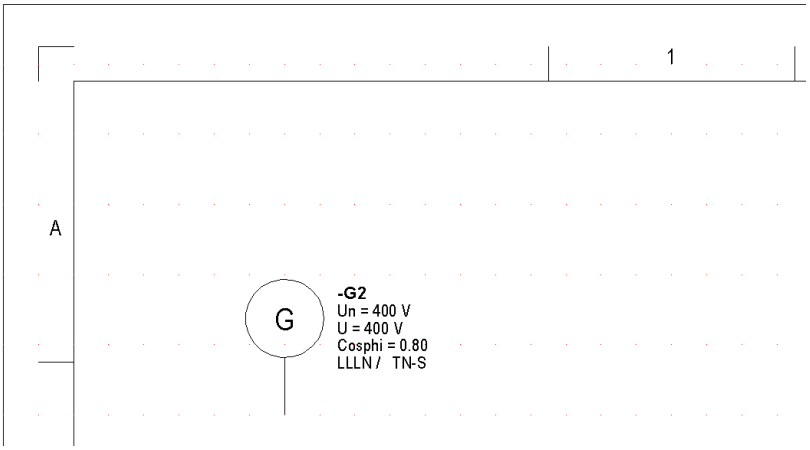
- **Temperature**: value of the ambient temperature (used for calculating temperature rises in the switchboard) and the temperature inside switchboards (presumed or calculated by DOC; used to consider a possible temperature derating of the performance of the protection device)
- **Protection of people**: contains the parameters used by DOC to verify protection against indirect contacts: Contact voltage; Tripping time; Resistance of the earth electrode (cf. Chapter 5.1.1 for a description of their use).
- **Automatic selection of the type of circuit-breaker**: data for guiding DOC in the selection of Miniature, Moulded-case or Air circuit-breakers according to the current.

Generator

This supply is suitable for representing plants totally supplied in an island, such as ships or off-shore platforms.

Selection of the "Generator" supply

The "*Generator*" **supply must not be used** in the case of cogeneration or service generators (Cf. Chapter 3.5)
In these cases it is advisable to use another of the supplies available and subsequently represent the generator by means of the "*Generator*" Single Object.

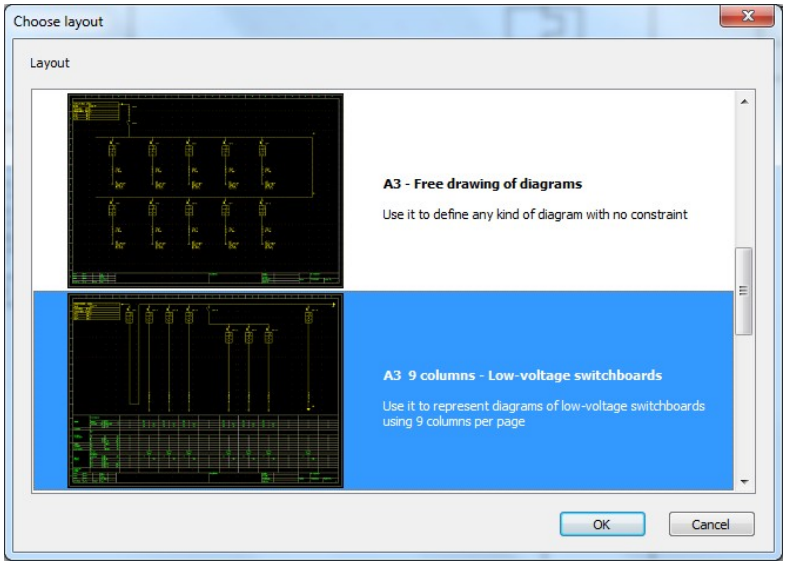


"Generator": representation in the single-line diagram

2.3. Selection of the layout

DOC allows you to define the layout to use among those available, when the general plant properties are defined (see section 3.1). You can choose from among various different ISO formats, suitable for drawing both low and medium voltage single-line diagrams and for drawing low voltage switchboard fronts.

There is a preview of all the available layouts to facilitate your choice



Preview of the available layouts

How to change the layout when the diagram is drawn

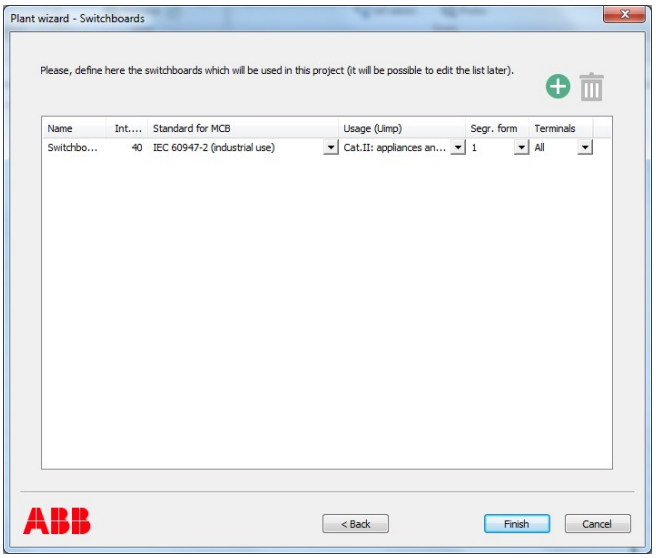
When you are drawing a diagram, it may be necessary to change the layout in relation to the one selected previously .

You can do this by using the "*Change layout* " command in the "*Home*" tab and selecting the icon on the left.

2.4. Definition and editing of the switchboard list

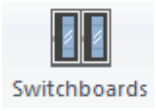
When the general plant properties are defined (see section 2.1), DOC also allows you to define the list of switchboards to use for the project you want to develop.

You can assign all the devices in the diagram to one of the switchboards in this list.



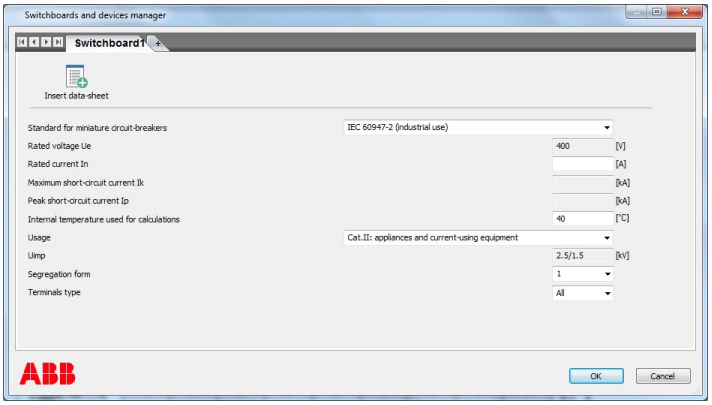
Window for defining the switchboards in Plant Wizard.

How to display and edit the list of switchboards outside the Plant Wizard definition procedure



When a diagram is being drawn, it may be necessary to change the list of switchboards or change their properties with respect to those defined during the Wizard procedure.

This can be done with the "*Switchboards*" command ("*Tools*" menu in the "*Home*" tab) by selecting the icon displayed on the left.



Window for defining/editing the switchboards available in any project development stage

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2.5. Main window

(1) **Quick access menu**

The Quick Access Toolbar, which can be displayed by using button “D”, provides you with commands for managing the project file, the print options and DOC options.

(2) **Ribbon toolbar**

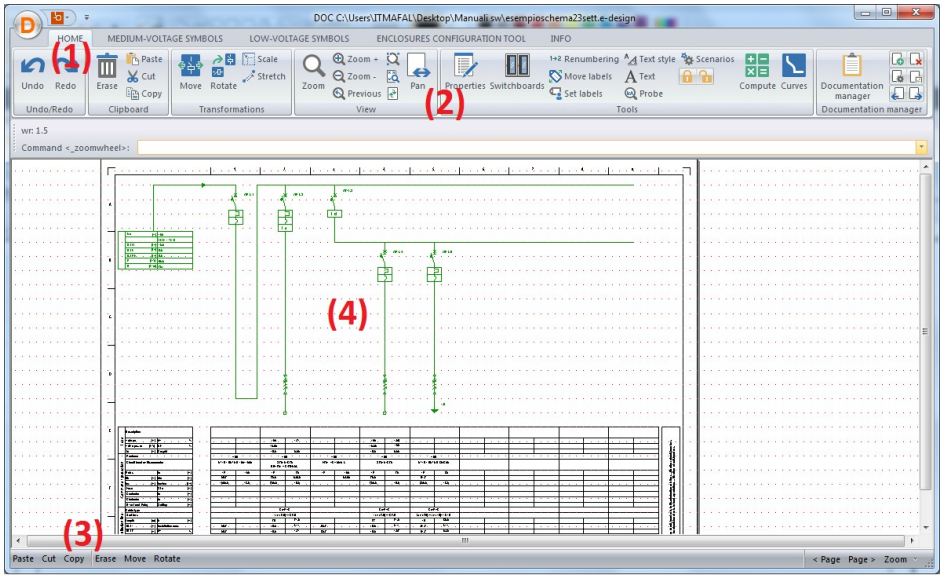
The Ribbon area contains all the commands for creating and editing the project. It is divided into tabs (“HOME”, “LV SYMBOLS”, “MV SYMBOLS”, “SWITCHBOARD CONFIGURATOR” and “INFO”) and offers all the functionalities for drawing and managing the project.

(3) **Status bar**

Area that contains certain, frequently used commands such as next page, previous page, zoom, etc.

(4) **Drawing sheet**

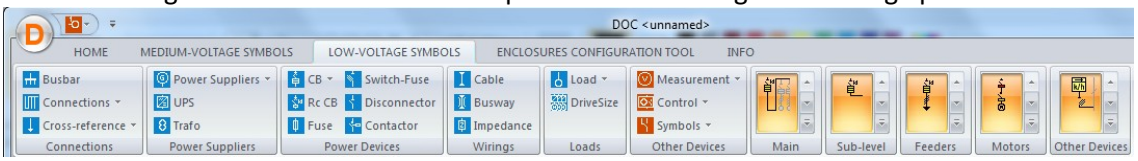
This is the area in which the project to be created with DOC takes shape. It represents the page, complete with layout, as it can be printed for the purpose of documenting the project itself.



DOC work area

LV SYMBOLS tab

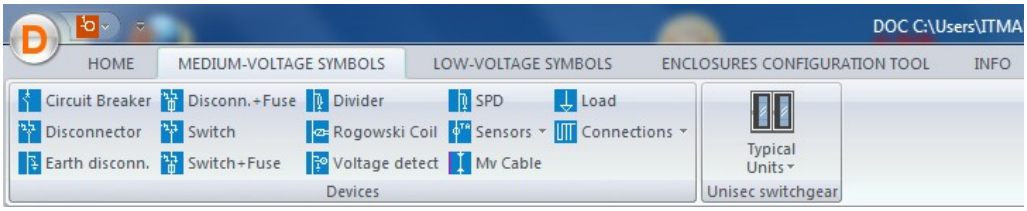
Tab containing all the commands and components for drawing a low voltage plant.



Low Voltage symbols

MV SYMBOLS tab

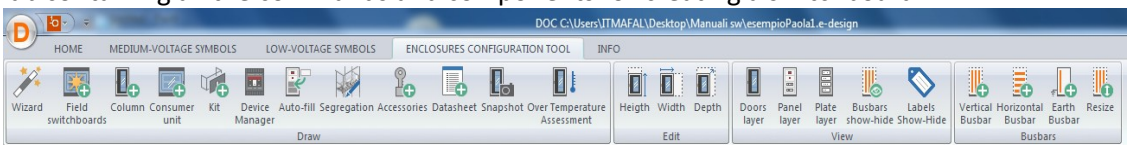
Tab containing all the commands and components for drawing a medium voltage plant.



Medium Voltage symbols

SWITCHBOARD CONFIGURATOR tab (only Italian market)

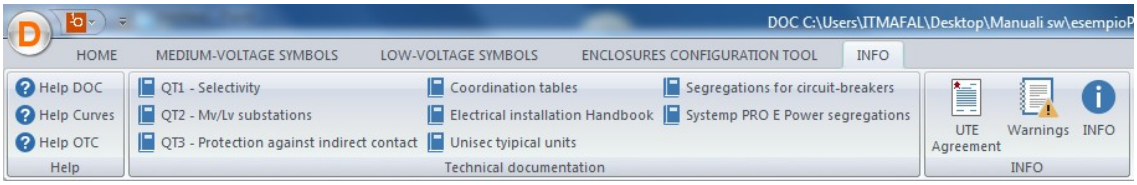
Tab containing all the commands and components for creating a switchboard.



Switchboard design elements

INFO tab

Tab with links to the manuals and other useful information.



Manuals and documents

2.6. Workflow

Comply with the following work flow to work with DOC in the best way:

Draw the Medium Voltage network using the tools in the "*MV SYMBOLS"* tab dedicated to this type of functionality (Cf. Chapter 3.4).

Draw the Low Voltage outgoing feeders using the tools in the "*LV SYMBOLS*" tab, which contains all the DOC functionalities for drawing LV layouts (Cf. Chapters 3.2 and 3.3).

Calculation and dimoensioning of the plant using the specific button in the "*HOME*" tab (Cf. Chapter 4).

Verification and drawing of the curves using the specific button also in the "*HOME*" tab (Cf. Chapter 5).

Functional drawing of the auxiliary circuit diagrams using the specific menu "*Other apparatus*" in the "*LV SYMBOLS*" tab (Cf. Chapter 6).

Creation and printing of the documentation using the "*Document manager*" function in the menu of the same name in the "*HOME*" tab (Cf. Chapter 7).

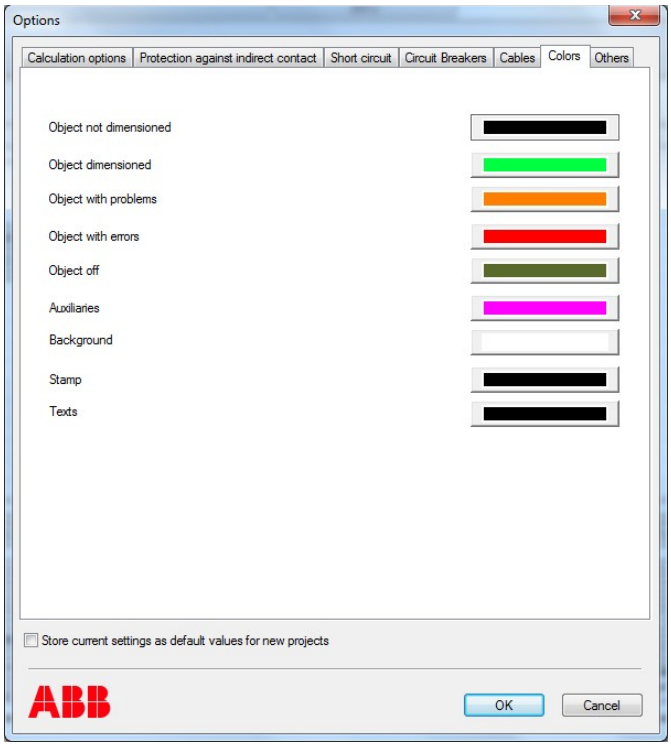
2.7. Customizing of layout and “Quick Access” menu colors

The appearance of DOC’s main window can be customized by changing the colors of the layout. In addition, a bar for quick access to the most frequently used commands can be created by selecting the command in the pull-down menu of button D (“*Quick Access*”).
Similarly, you can also edit the commands in the quick access menu as desired.
This allows you to continue working in your habitual way.

Colors

Use the “*Options*” command in the *“Quick Access”* menu to change the colors.
The settings are on the “*Colors*” page.

The colors which define the state of the Single Objects can be changed, as can the work sheet background color.



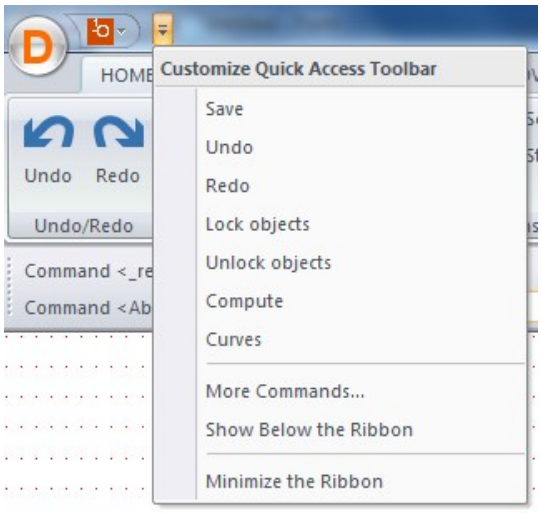
Window for customizing the colors

The meanings of the main preset colors used by the program are described below:

Color	Meaning
Black	Single Object to be dimensioned and verified
Green	Single Object dimensioned correctly
Orange	Single Object with missing elements
Red	Single Object with errors
Olive Green	Single Object off, not supplied in the current network configuration

Quick access menu

The commands in the Quick Access menu can be easily customized. There is a specific menu for this purpose, as shown in the figure below.



Menu for customizing the Quick Access menu

3. Drawing the single-line diagram

This chapter describes:

- drawing the single-line diagram of Low Voltage networks;
- drawing the single-line diagram of Medium Voltage networks;
- network data input;
- management of several power supplies in the same project.

After reading this chapter, the user will be able to:

- use the Single Objects and Macro Objects for drawing the single-line diagram of Medium and Low Voltage networks;
- draw all types of diagrams, even those consisting of several switchboards and shown in several pages;
- define the characteristics of loads and lines;
- configure networks supplied by a power supply and by back-up generators.

3.1. General indications about drawing

Once the general properties of the plant and the layout have been defined, the utility symbol will already be present on the drawing sheet.

You can therefore proceed to draw the single-line diagram as described in this chapter.

.

DOC allows you to use two different types of objects, present in both the “MV SYMBOLS” tab and “LV SYMBOLS” tab of the program:

- Single Objects
- Macro Objects

Single Objects are blocks which represent a single element of the electrical plant and which allow a single-line diagram to be made (for example: “*LV Circuit-breaker*”, “*LV Cable*”, “*Generic load*”, “*Busbar*”, “*Motor*”, …). By connecting the Single Objects with each other, you can obtain infinite combinations able to represent any type of plant.

The icons of the Single Objects are in the Toolbars area.

On the other hand, Macro Objects are a combination of several Single Objects already ready to be drawn with a single click.

Macro Objects thus allow you to draw much more quickly, at the expense of the variety of plants which can be shown.

Furthermore, Macro Objects only allow you to draw purely radial networks, whereas the Single Objects allow meshed type networks to be created, which DOC is able to manage during the calculations.

The best result is obtained by using both Single Objects and Macro Objects, thus combining the needs of each particular plant with speedy creation of the diagram.

To draw a Single Object or a Macro Object, just click on the icon that represents it. The Single Object or Macro Object will be hooked up to the mouse pointer, ready to be drawn with a click of the left button in the desired position of the diagram.

3.2. Drawing with Macro Objects

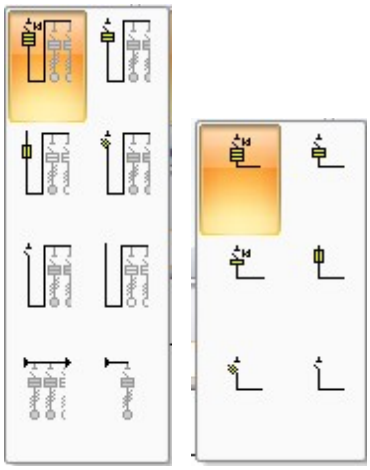
This chapter describes how to make a single-line diagram using only Macro Objects.

Macro Objects are useful for making a single-line diagram rapidly, starting from the main device and proceeding on to the load side feeders until the loads are reached.

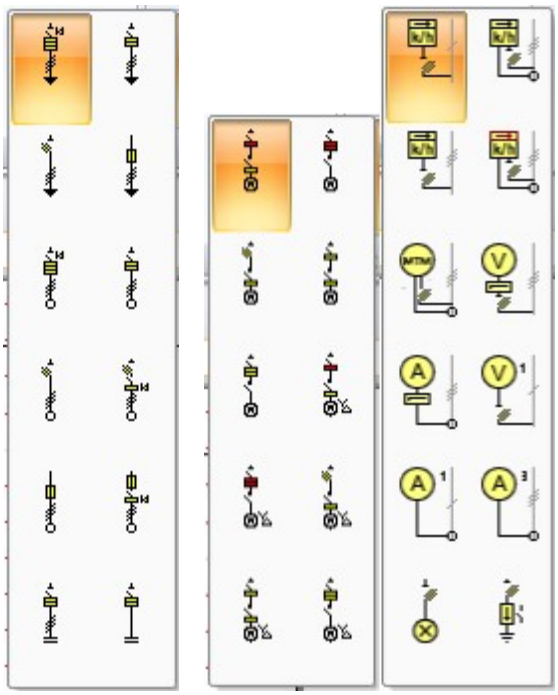
The program automatically checks to make sure that the single-line diagram is congruent.

Low Voltage Macro Objects

These can be easily found in the “LV SYMBOLS” tab of the Ribbon area

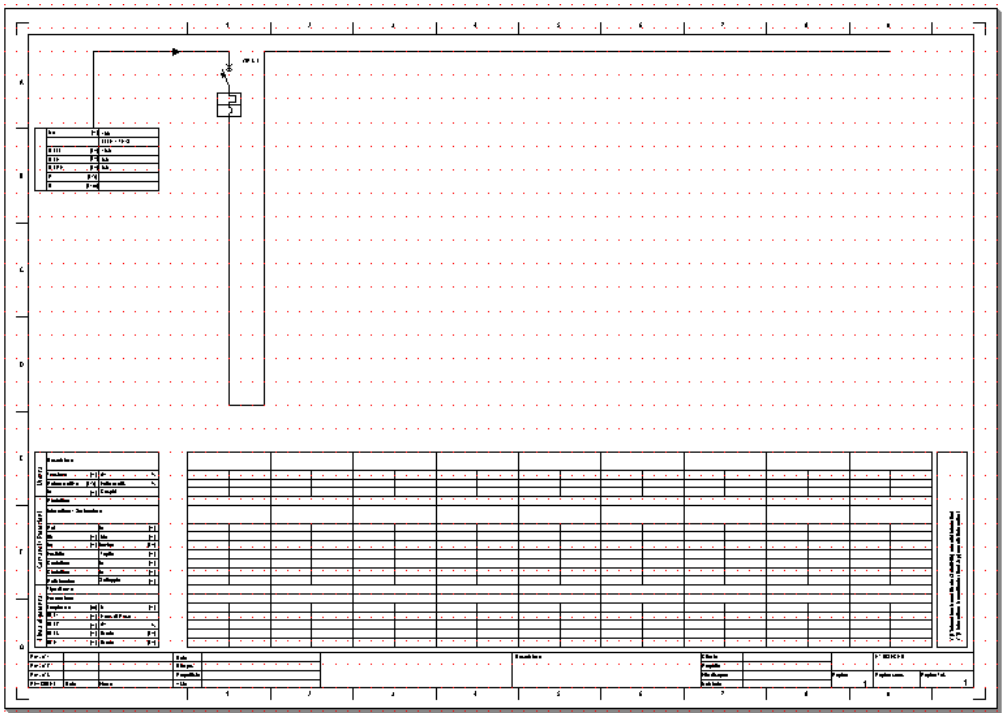


“General” and “Second level General” Macro Objects



“Generic feeder”, “Motor feeder” and “Other Devices” Macro Objects

1) Start positioning the main circuit-breaker by selecting the "*Main Thermal-magnetic CB*" icon from the *"Main"* menu of the "*LV SYMBOLS*" tab.
The program will see to stretching the connections so as to take up all the vertical space available on the work sheet.

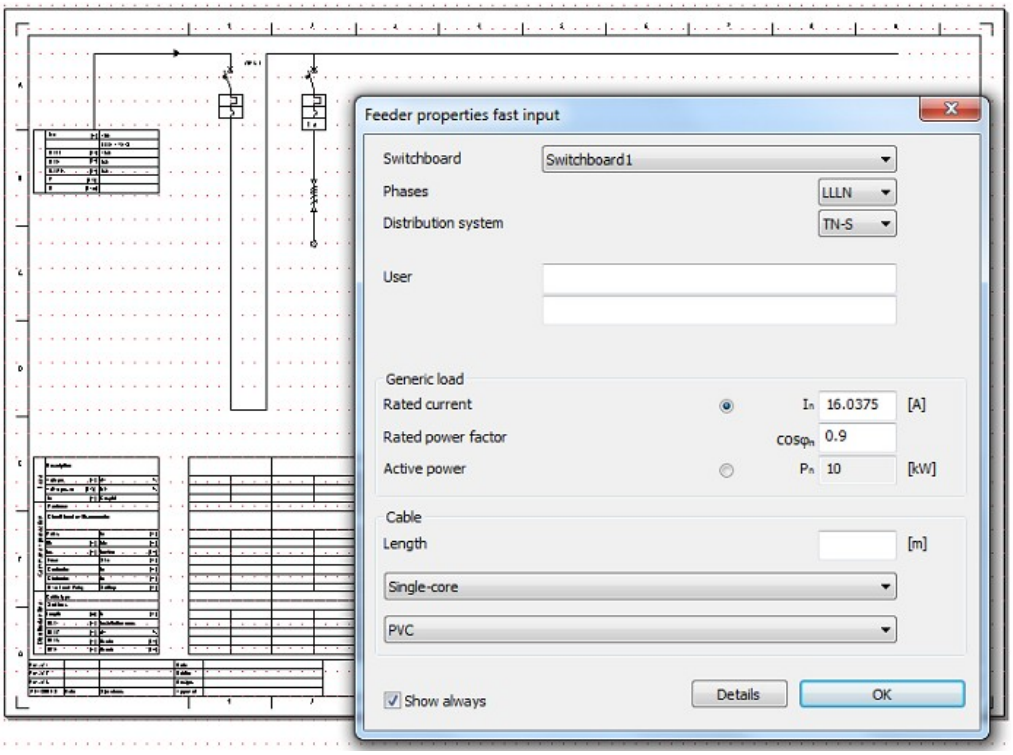


1) Main Thermal-Magnetic CB

2) Select the type of feeder to be shown from the *"Feeders"* menu, e.g. a "*Residual current thermal-magnetic circuit-breaker with generic load*" feeder. Hook the Macro Object to the line on the output from the main circuit-breaker.

3) The feeder line is now connected to the line and the program displays the dialog window for fast definition of the feeder data.
This allows you to define the main data of the feeder while drawing:

- Phases (single-phase, three-phase with and without neutral)
- Distribution system
- Description of the feeder (for improved flexibility, this is available on two lines)
- Consumption of the generic load (rated current or rated active power and power factor)
- Length and type of cable



3) Feeder properties fast input window

Remove the check mark from the "Always show" option to disable the feeder fast definition window.
Disabling these functions is useful if you want to edit the data of a feeder in detail.
The window can be re-enabled from the "Quick Access" – "Options" menu in the "Other" page.

Phases and distribution system

The phases and distribution system properties must be consistent in the plant.
This does not mean they must necessarily be the same throughout plant, but that there are rules which DOC helps you to follow (for example, you can manage sections of plant with a TN-S or TT distribution system starting from a TN-C supply, or single-phase lines derived from a three-phase system with neutral. But it is not possible, for example, to derive a single-phase load from a three-phase distribution without neutral or to derive an IT system from a TN system without using an insulating transformer which separates the two parts of the plant).

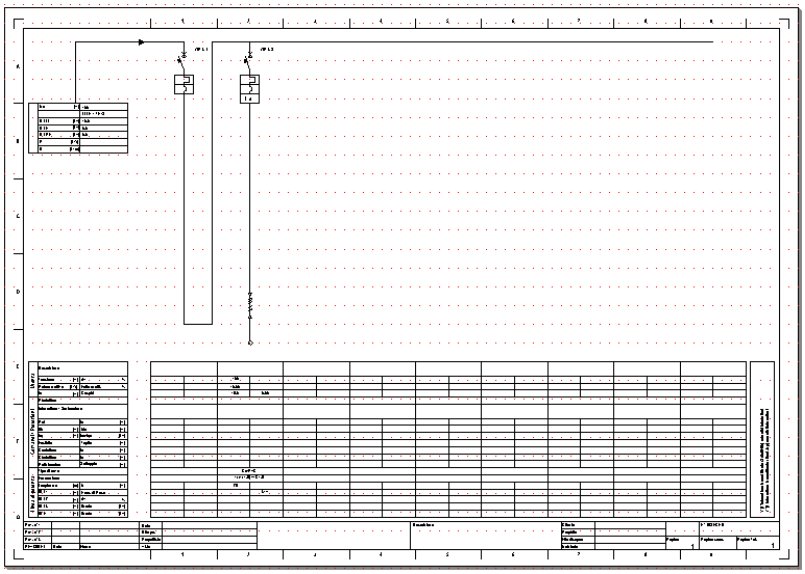
DOC helps the user by showing only properties compatible with the type of distribution selected.
In the case of incongruence, DOC warns of the incorrect situation during the calculations and signals the Single Objects by changing their color (Cf. Chapter 2.7).

Editing of phases and distribution system

The phases and distribution system can be edited in two ways:

- By selecting just one Single Object to be edited, applying the "*Properties*" command (the same as a double click on the Single Object symbol) and changing its Phase and/or Distribution system properties (DOC will only show the values compatible with the position the Single Object occupies in the plant).
- By selecting several Single Objects to be modified and using the "Properties" command, in the "*Edit*" menu. You can change the common properties with the "Common properties manager" window.

4) Once the main data have been defined, DOC adapts the feeder line in height depending on the layout, by occupying all the available space.



4) final appearance of a feeder line

5) Repeat the procedure for every other feeder line.

Advice on drawing in columns

There are two important rules to follow to improve the result of a drawing in columns:

- The Macro Objects must be entered in the center of the column. DOC helps you to do this correctly thanks to the predefined (and unalterable) grid step, with horizontal and vertical lines that intersect in the cursor position, following it in its movements, and with the actual structure of the column layout.
- Do not enter two Single Objects of the same type in the same column (for example, two "*Circuit-breaker*" Single Objects): the layout would not be able to host the data of both!

Codification of Single Objects

DOC automatically codifies Single Objects according to the type of layout:

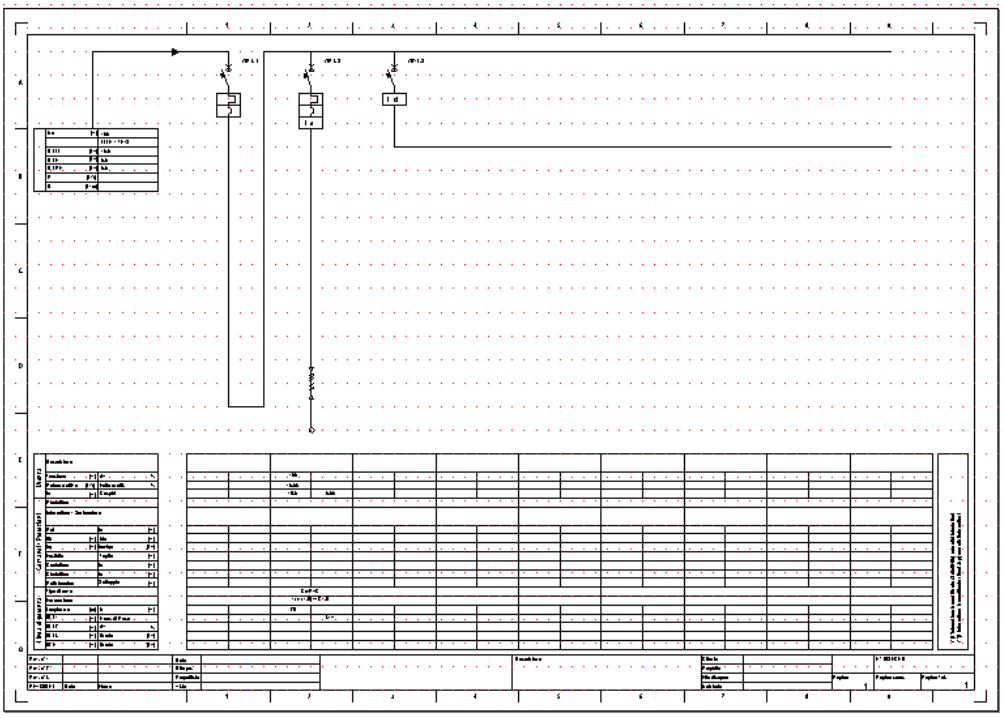
- Codification follows the *Page.Column* rule in column layouts.
  Different Single Objects drawn in the same column will have the same numbering (Circuit-breaker –QF1.1; Cable –WC1.1; Load –L1.1).
- In a free layout, Single Objects of the same type will have incremental codification. The fifth circuit-breaker entered from the start of the drawing will have code "–QF5" and could be matched to the third cable "-WC3".

3.3. Examples

3.3.1. Switchboard with sub-levels

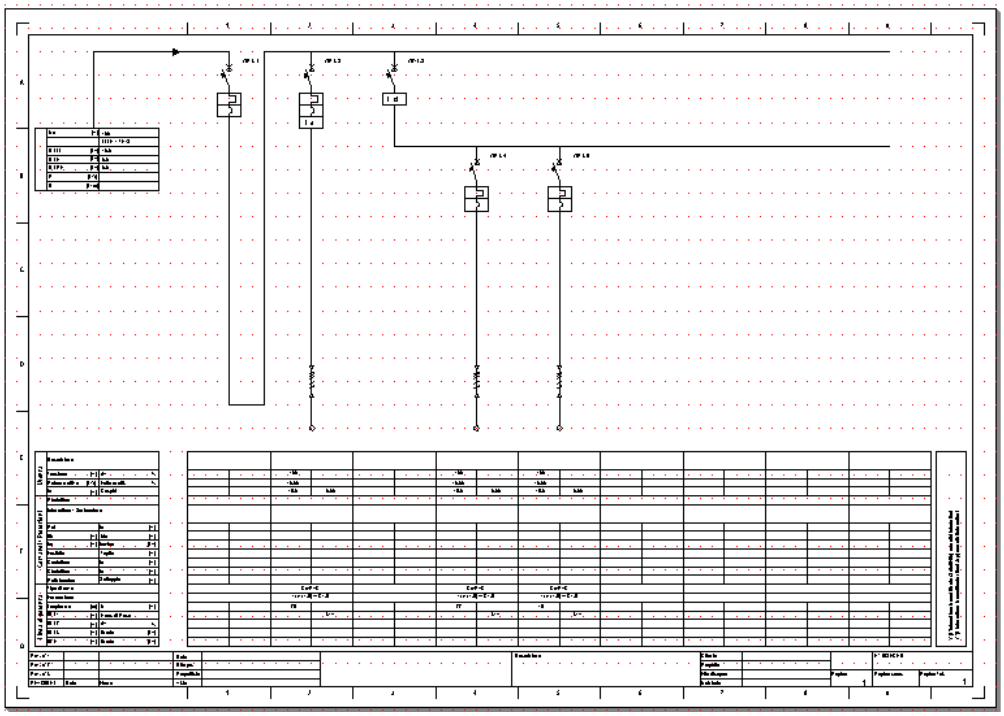
Using Macro Objects, you can also draw several levels in the same switchboard (for example, several thermal-magnetic devices subordinate to a single residual current device).

1) Starting from the switchboard already defined in Chapter 3.2, add a "*Sublevel pure residual current CB*" Macro Object from the *"Sublevels"* menu of the "LV SYMBOLS" tab in the first vacant column. The special line will be added directly on the load side of the sublevel main device.



1)Sublevel main residual current circuit-breaker

2) Select the type of feeder to be shown from the *"Feeders"* menu in the "LV SYMBOLS" TAB, e.g. a "*TMd feeder with generic load*". Hook the Macro Object to the line on the load side of the residual current device.

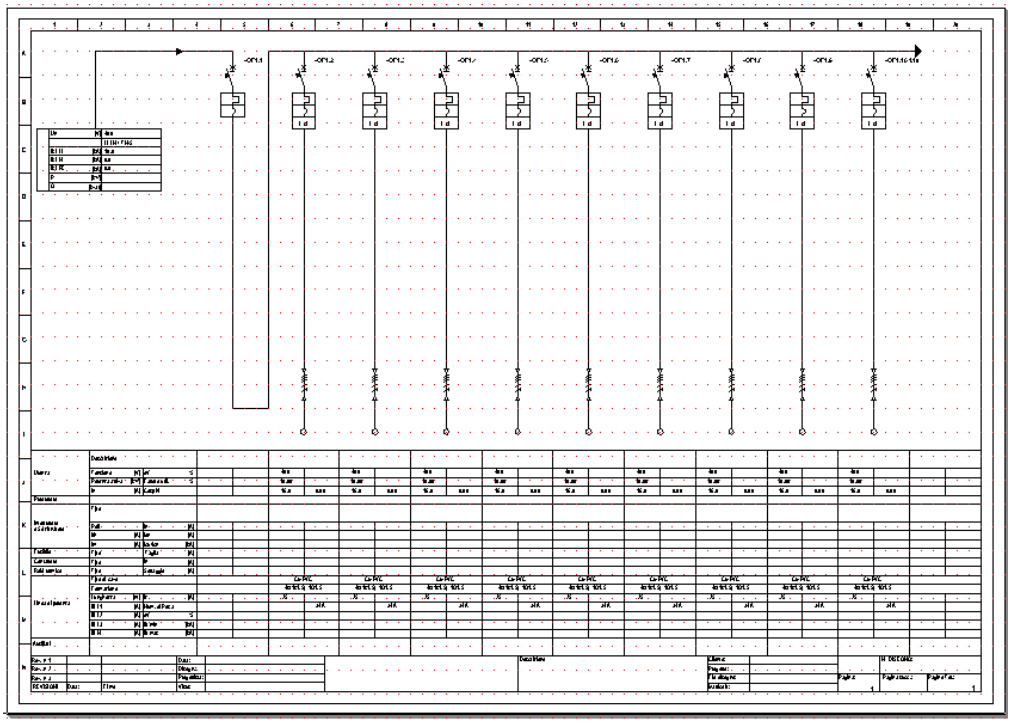


2) Feeders protected by a thermal-magnetic device

3.3.2. Switchboard over several pages

When a switchboard requires more space than the 11 columns available in the layout, the procedure described in this chapter can be repeated on several pages.

1) After having drawn the part of the switchboard which can be shown on the current page, add the *"Link to feeder"* Macro Object from the *"Main" Macros* to the line.

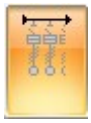


1) Board with link to page

2) Add a new page to the project with the *"Add a new page"* command in the "*Home*" tab, by clicking on the icon on the left

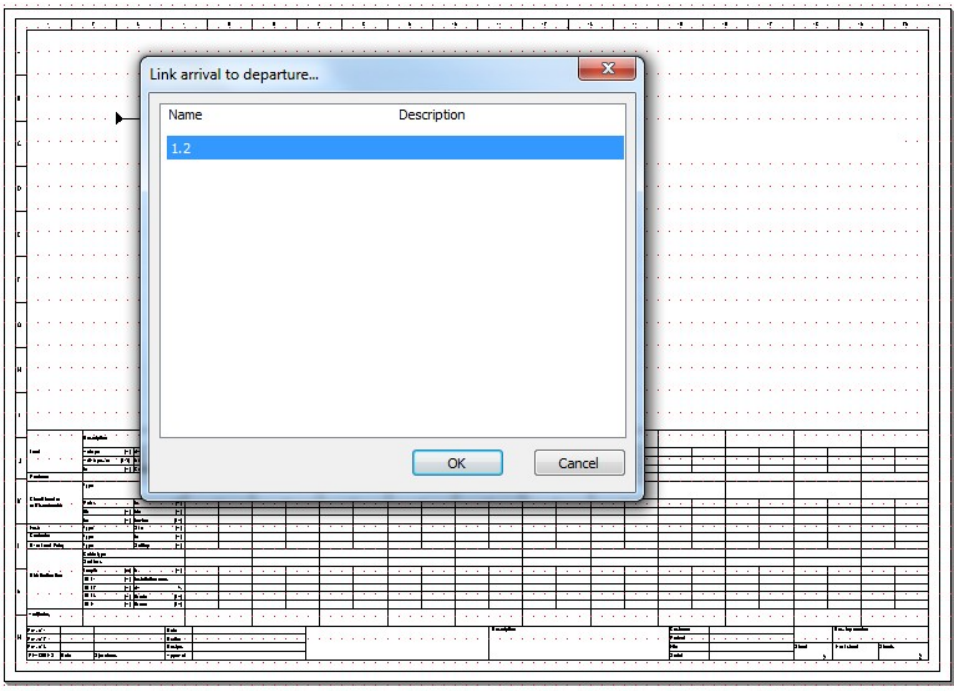
The settings on the current page, are also kept for the new page.

Chapter 7.4 describes the settings available and how to change them should the new page so require.



3) Add the *"Line"* Macro Object from the *"Main"* menu of the *"LV SYMBOLS"* tab to the new page. The pointer of the mouse must be positioned so as to fall half-way down the first column.

4) Once the line has been added, DOC will ask which "*Link to page"* to connect it to among those available.
The "*Link to page*" sign reflects the *Page.Column* format.
In the case of the image below, link arrival to departure will be connected to link 1.11.
A description can be added to make the links easier to identify.



Dialog window for connecting the "Links to page" "

5) The line on the new page has been added. You can now continue with the switchboard drawing on the new page!

Browsing through the project pages

When the project consists of several pages, they can be browsed using the *"Next page"* and *"Previous page"* commands in the "*Home"* tab of the *"Document manager"* menu. The commands can also be performed using function keys F12 and F11.

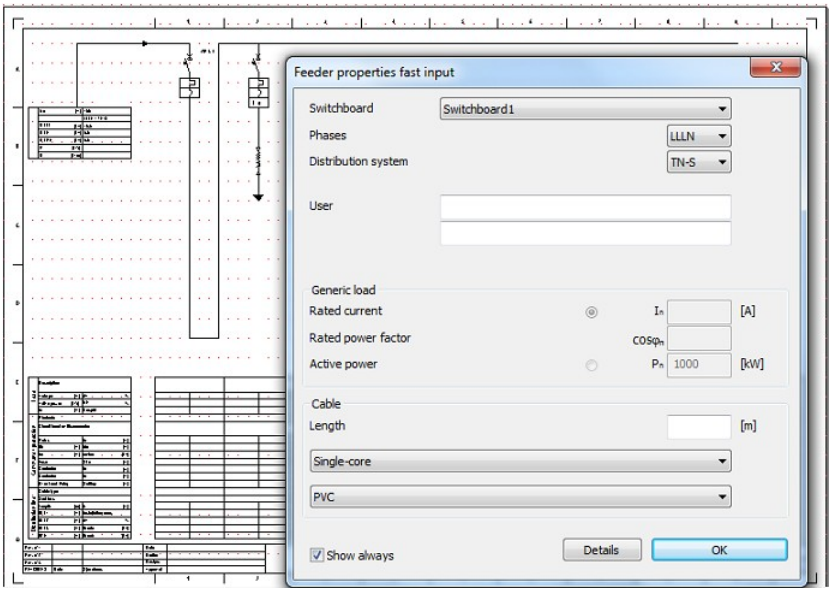
3.3.3. Diagram with more than one switchboard

If the plant includes several switchboards, they can be drawn in a single diagram with DOC.

1-Assignment of the switchboard of each apparatus must be performed in the manual mode since DOC stores the switchboard name entered during the diagram editing stage for each device. This means that the calculation procedures and the type of diagram used will not change the switchboard name entered by the user in the manual mode for each device.

2-A network consisting of dozens of switchboards and hundreds of circuit-breakers and cables, can take up a lot of the processor resources and require long processing times.
Should the calculation times become long, it is advisable to divide the project into several files. This is done by simulating a switchboard with a single generic load of equal power, net of the demand factor, and by saving the removed switchboard in a new file.
Simulate the network on the supply side in the new file by entering the supply data and copying the results of the calculation, voltage and short-circuit current of the original project.

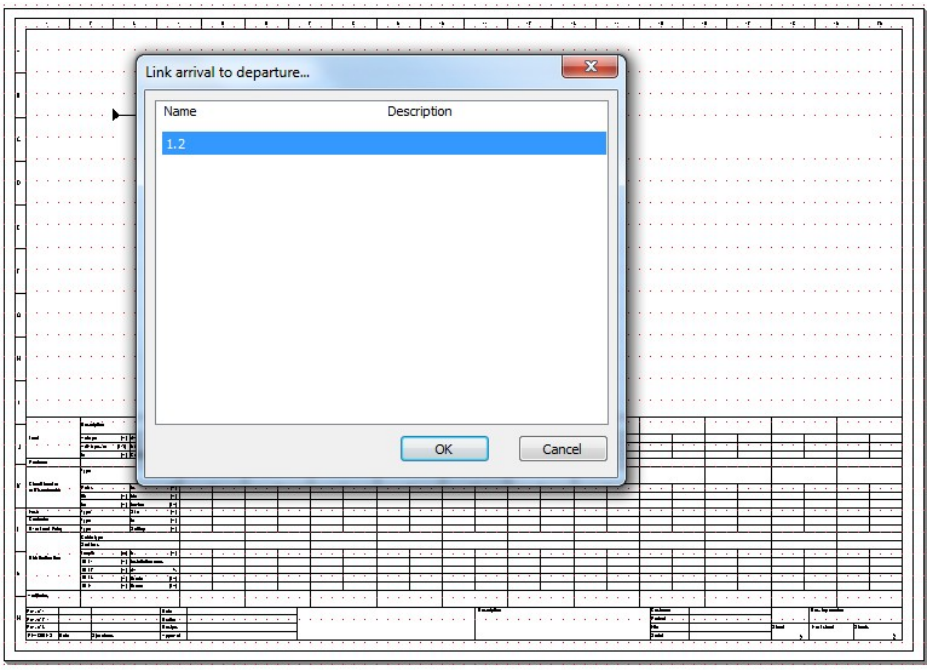
1) A section switchboard that supplies some of the feeders can be derived from the main distribution board.
The feeder from the main distribution board to the section switchboard is drawn by means of the *"Sub-switchboard feeder,Circuit breaker with Overload and Short circuit protection + RCB"* Macro Object in the *"Feeders"* menu.
The user can select the type of protection device to be used
.



Feeder for section switchboard

2) Add a new page as shown in the previous example

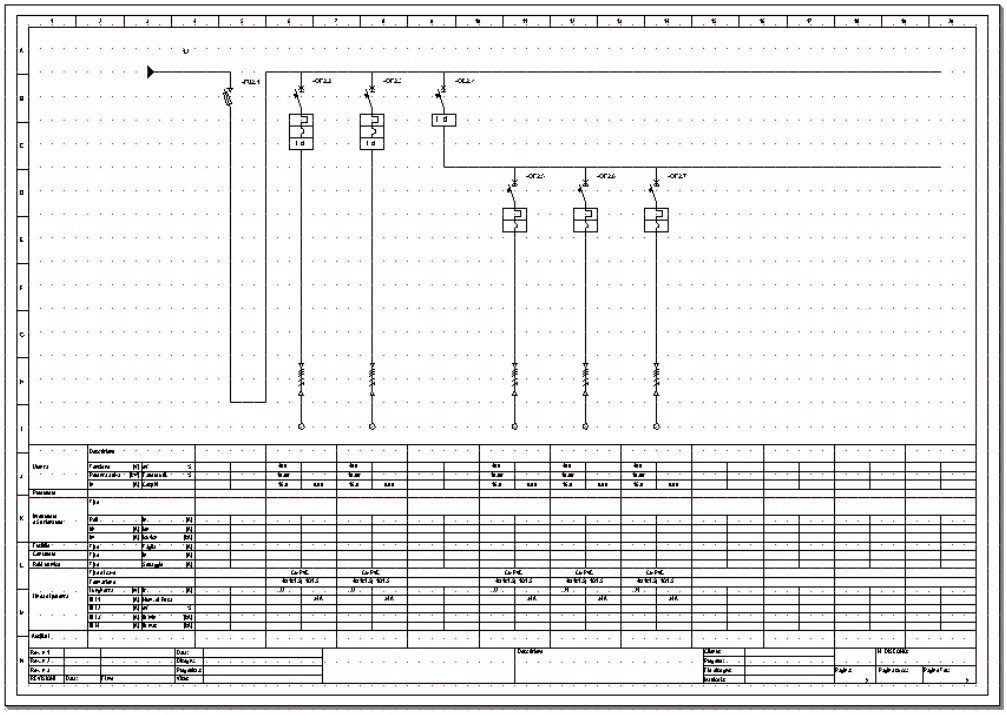
3) Draw the *"Arrival"* Macro Object from the *"Main"* menu of the "*LV SYMBOLS*" tab on the new page. The mouse pointer must be centered half-way down the first column of the layout. The program will ask to connect the Macro Object to the relative "*Link to page*" ".



Arrival page

4) Draw the general device of the section switchboard by selecting it from the Macro Objects available in the *"Main" Macros* toolbar.

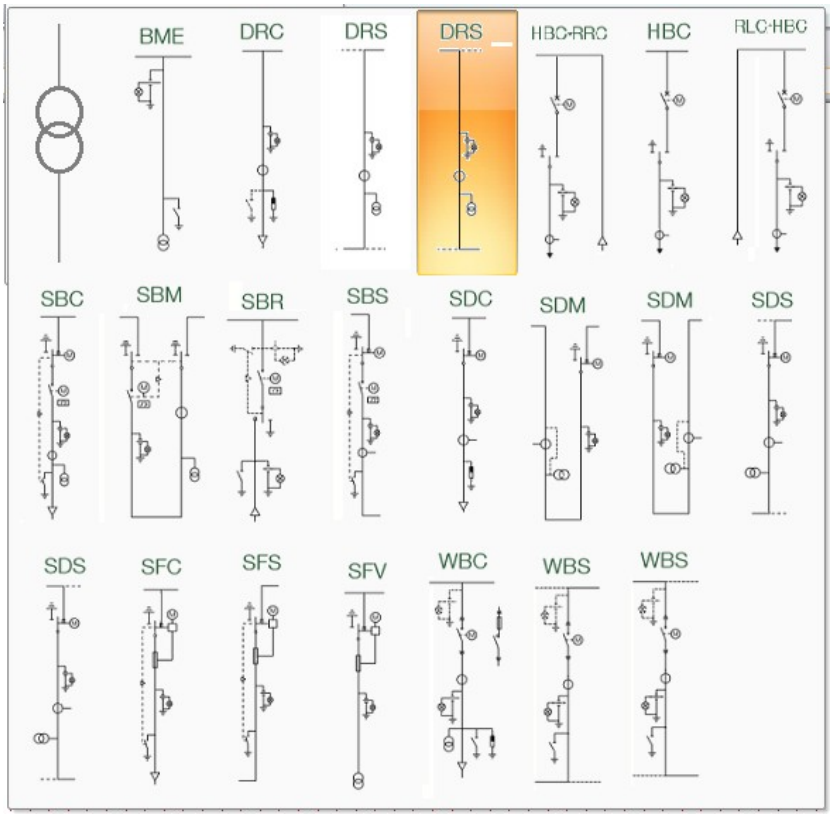
5) Complete the section switchboard with its feeder lines



Section-switchboard with main switch-disconnector

3.4. Drawing of an MV-LV single-line diagram with Macro Objects

Once the MV utility has been chosen in "*Plant Wizard*", you will be able to identify all the Medium Voltage Macro Objects in the "*MV SYMBOLS*" tab of the Ribbon area.
They will be found in the "Typical Unisec units" menu.

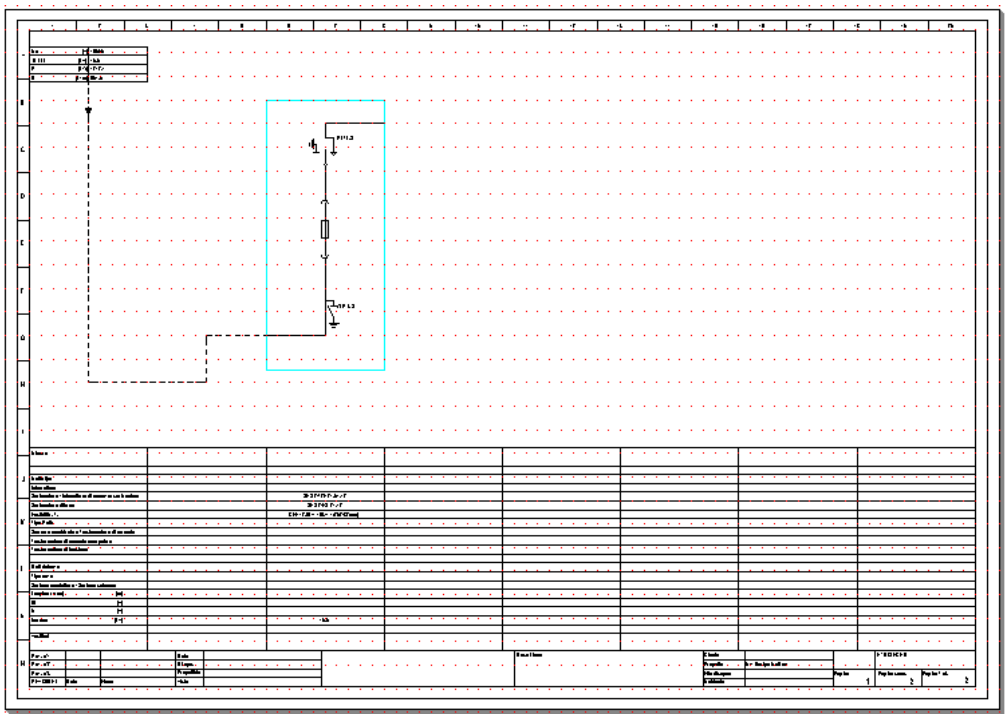


"Typical Unisec Units" Macro Objects

Medium Voltage Macro Objects

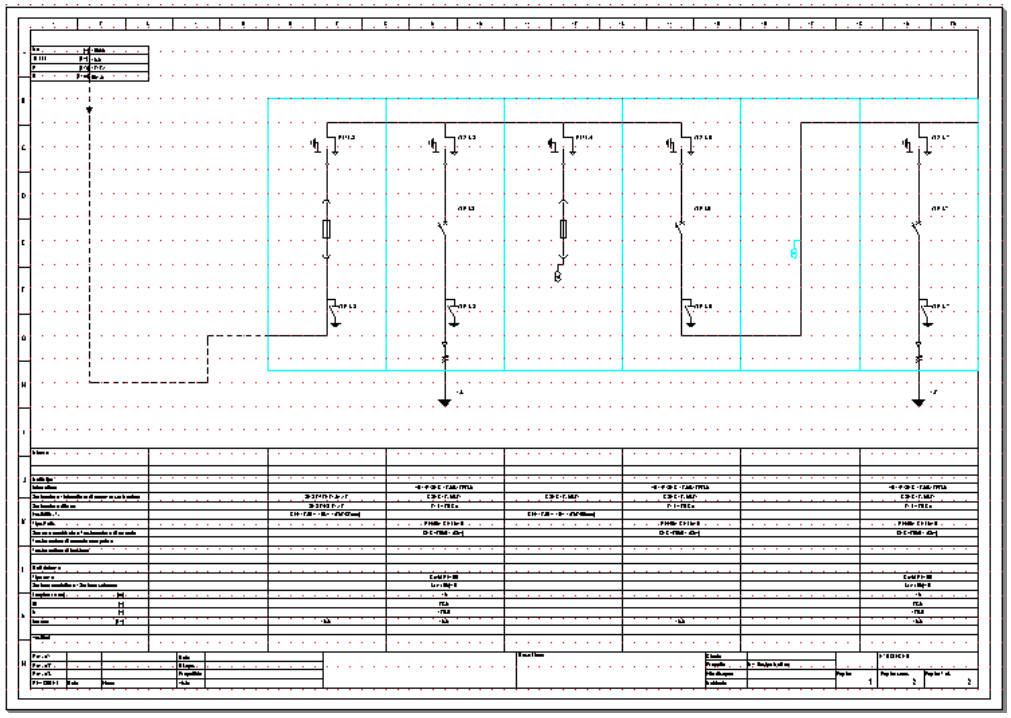
Each Medium Voltage Macro Object represents a typical compartment of the Unisec secondary distribution board

1) Select the compartment you want to use as arrival line from the utility company.



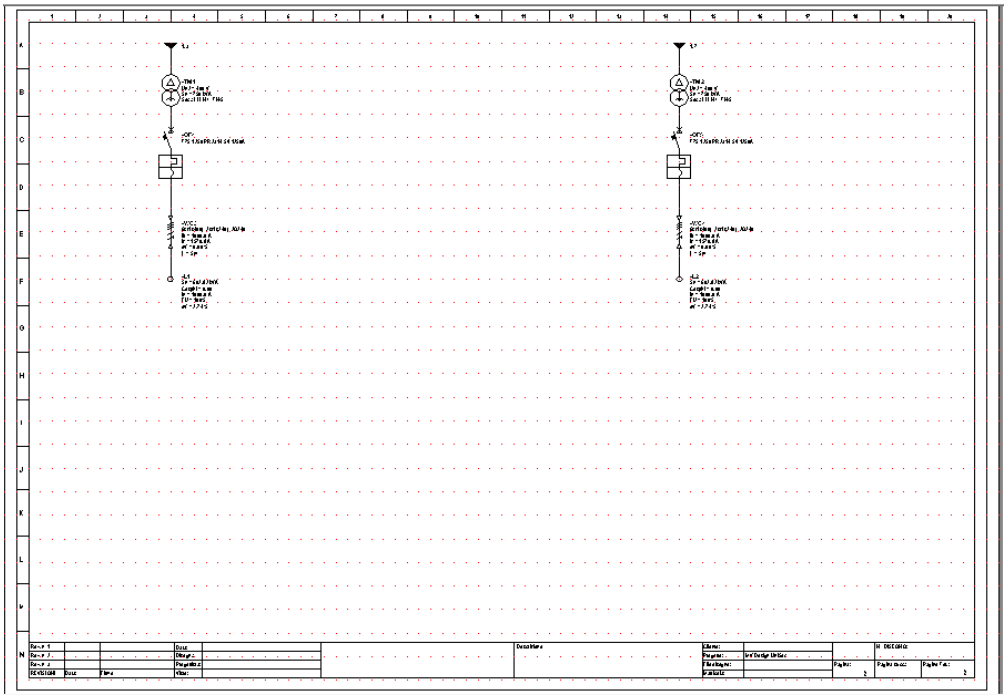
Arrival with typical Unisec compartment

2) Draw the Medium Voltage diagram with the Macro Objects available, already preset to make up a Unisec board, by placing a typical compartment alongside another.



3) Add the *"Transformers with 2 windings"* so as to prepare for drawing the LV section of the plant. To do this, use a pair of links so as to transfer the MV to the next page.

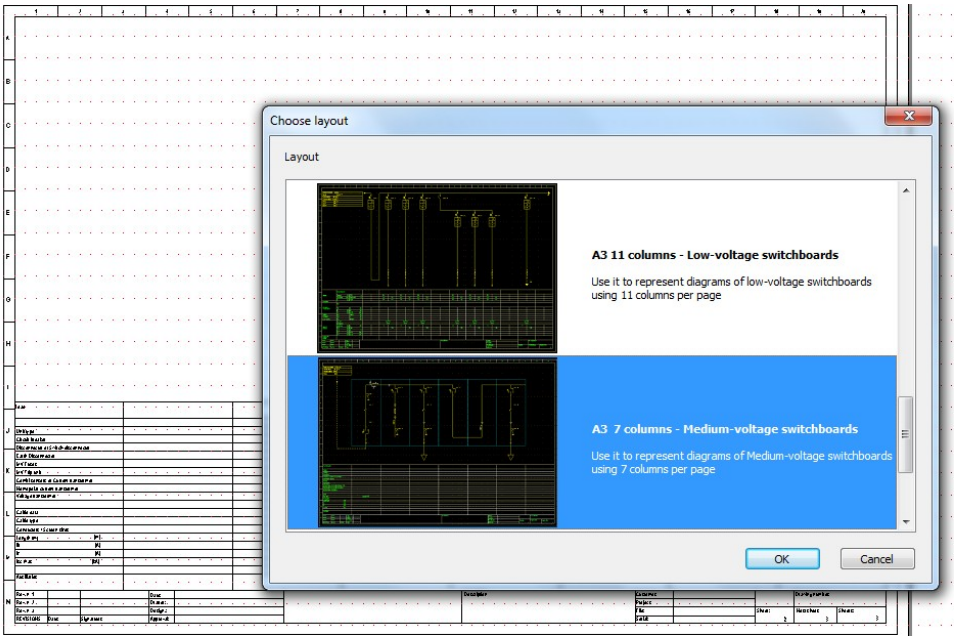
4) Complete the 2 LV lines with the main circuit-breaker, cable and load to outline the situation of all the LV loads.



5) MV switchboard with two transformers and two line feeders

5) Add a new page with the *"Add a new page"* command, available in the *"Home"* tab of the *"Document manager"* menu with the icon shown on the left.

6) Change the layout of the new page with the *"Change layout - page dimension "* command, available in the *"Home"* tab of the *"Document manager"* menu with the icon shown on the left).
Select the layout with low voltage columns.

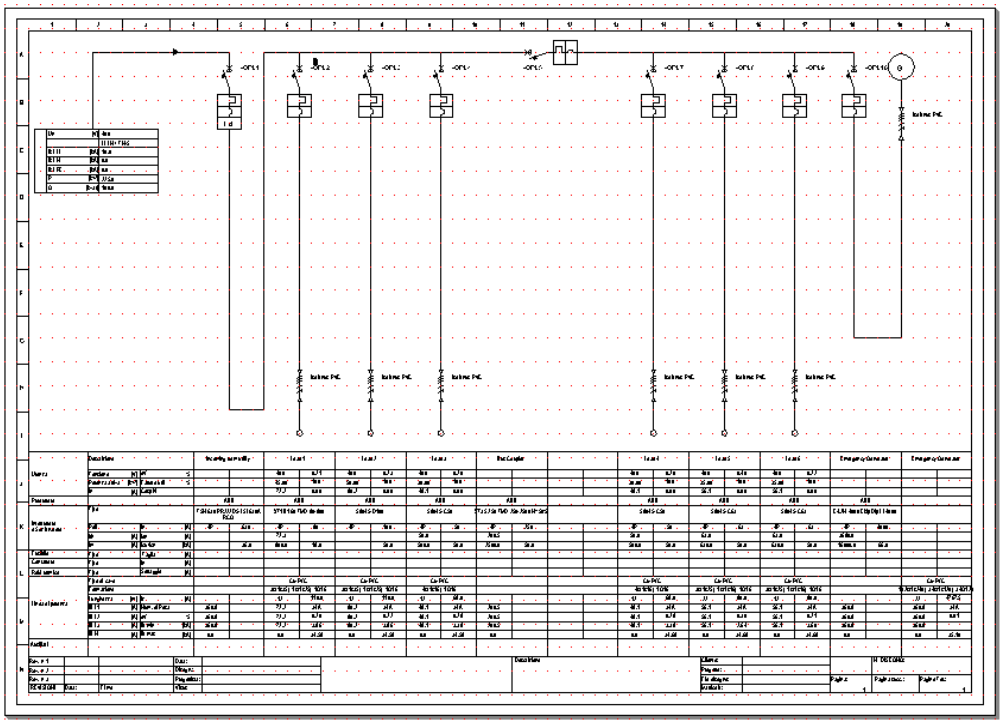


Changing the layout

3.5. Drawing and defining a Network – UPS changeover

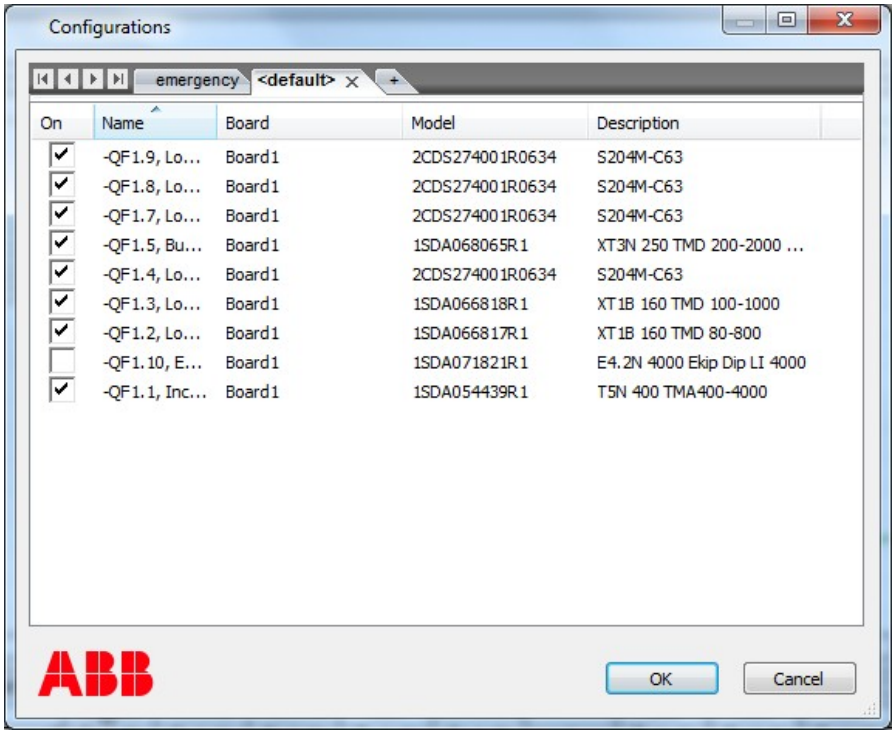
DOC allows you to define several power supplies in mutual exclusion for the same plant.

1) Draw a network with "*LV*" supply where a "*Generator*" Single Object is also present.



Example of a diagram with two power supplies

2) Use the "*Scenarios*" command in the "*Tools*" menu.



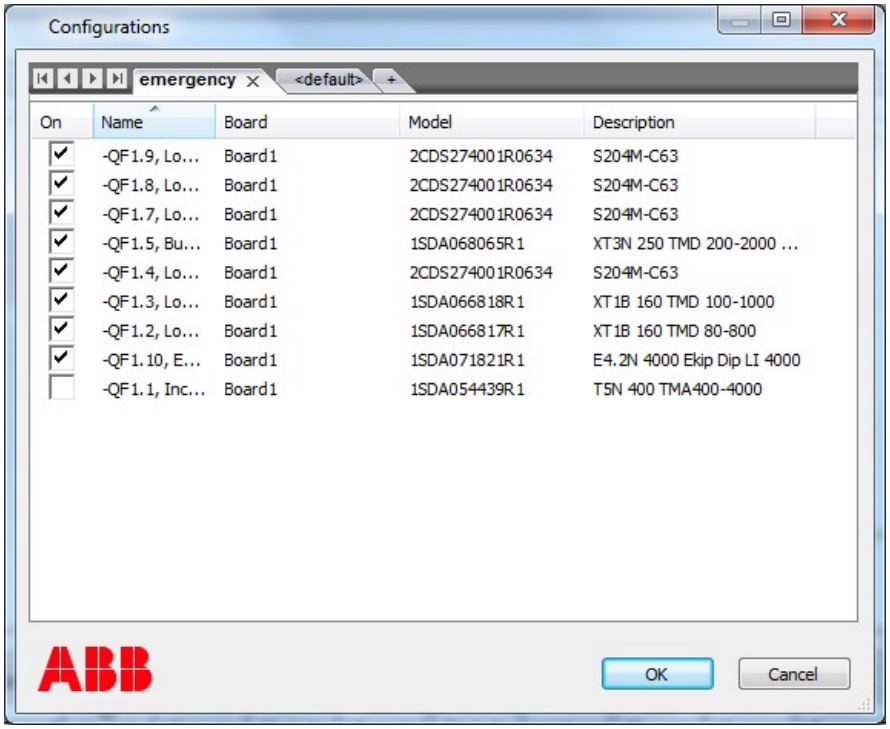
"Scenarios" command window

3) Define the "NETWORK" configuration:

- Double click over the "<default>" text to rename the existing configuration in "NETWORK";
- Deselect the protection device which connects the "*Generator*" Single Object to the rest of the network. In this way, the generator will be disconnected from the plant in the NETWORK configuration.

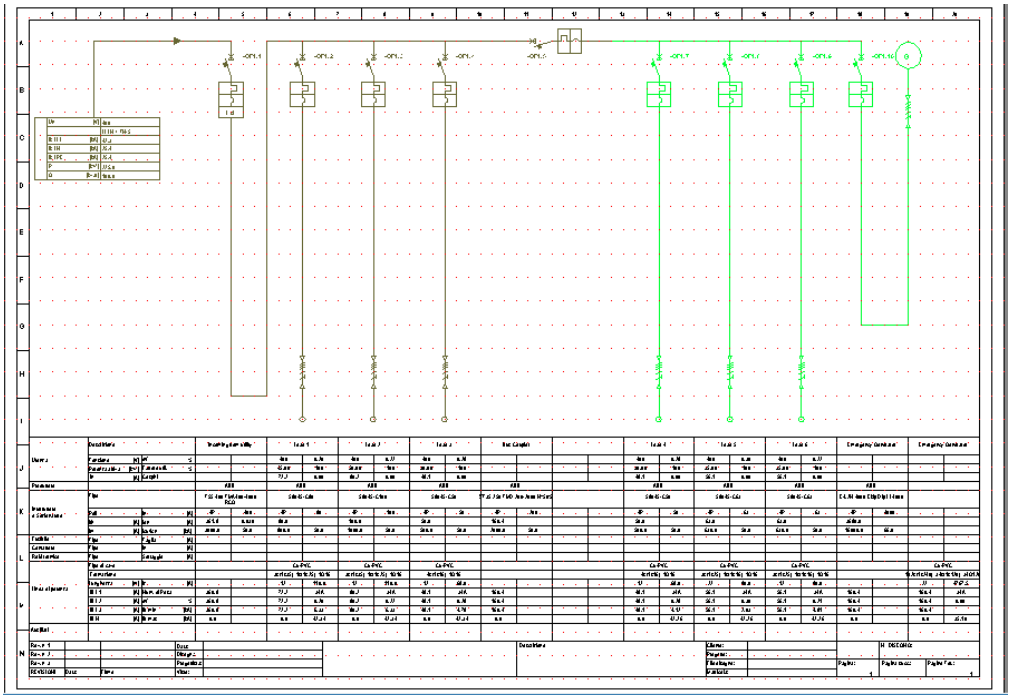
4) Define a new "Emergency" configuration:

- Click on the available tab to enter a new scenario;
- Assign the "emergency" name to the new configuration;
- Deselect the protection device which connects the supply to the rest of the network. In this way, the supply will be disconnected from the plant in the "emergency" configuration

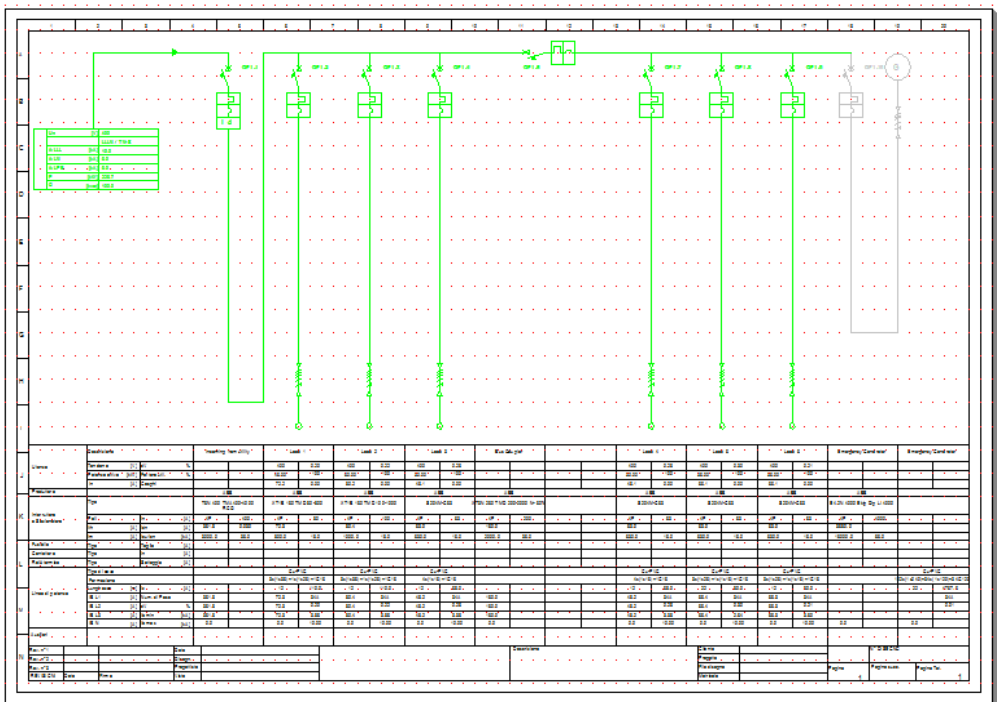


Network configurations: "emergency" scenario

5) Once the window for defining the configurations has been closed, part of the network will be in a different color, depending on the configuration selected.
The color indicates that part of network is "off", or not supplied (to change the colors or to know their meaning, Cf. Chapter **Error! Reference source not found.**)
The unsupplied part of the network will not be considered in the calculation of this configuration**.**

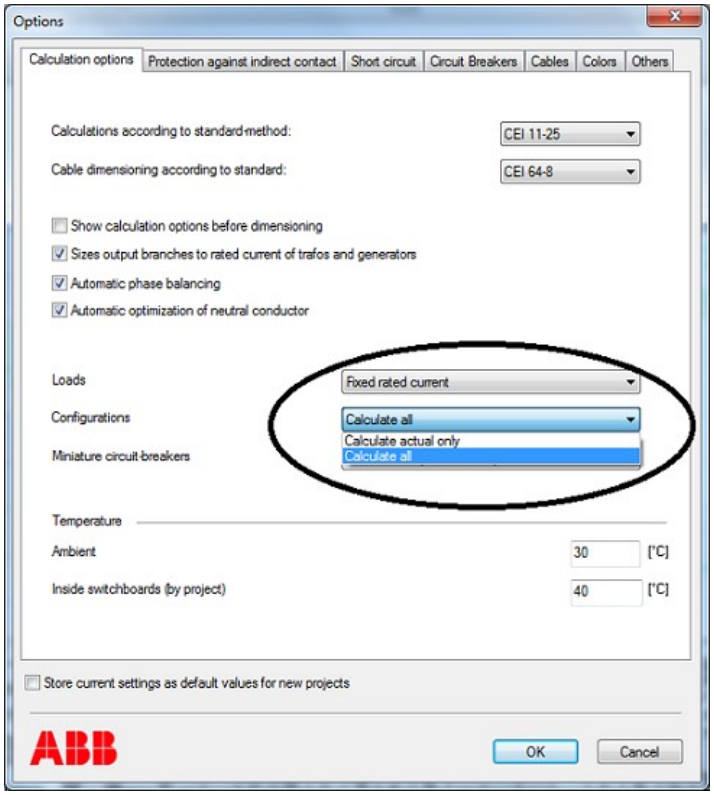


Single-line diagram: "GROUP" scenario



Single-line diagram: "NETWORK" scenario

Use of the "Calculate scenario" option under the "Calculation options" item of the "Options" command is of particular importance in this context



Window where the scenario calculation mode is entered

If you opt for the "Actual" value, all the dimensioning will be performed in relation to the scenario activated at that particular moment.

On the other hand, if the "All" value is entered, dimensioning will take account of the performance required from every device in all the network scenarios envisaged in the project: this means that a higher performance level that does not take account of a single scenario may be required from each device.

The flag on the "Show calculation options before dimensioning" accesses the "calculation options" window prior to each dimensioning.

3.6. How to edit the drawing

This chapter describes the most useful commands for editing the single-line diagram drawing.

Zoom In, Zoom Out and Pan with the mouse

The *"Zoom In"*, *"Zoom Out"* and *"Pan"* commands can be given using the mouse wheel: this way the relative part of the diagram can be displayed rapidly with the right level of detail.

The "*Zoom In*" and "*Zoom Out*" commands are, respectively, turning and clicking the mouse wheel upwards and downwards.

The "*Pan*" command is obtained by keeping the mouse wheel pressed and dragging the page.

These commands are also present in the "View" menu of the "HOME"tab.

Multiple selection by means of selection box

To select several Single Objects it is advisable to:

- Disable any active command by pressing the "Esc" key.
- Click over an empty point of the drawing.
- Create a selection box which touches or completely includes the Single Objects to be selected.

The selection will consist of all the Single Objects touched or completely included in the selection box, depending on the first click and the direction in which the Single Objects are selected.

- **If the first click is on the right of the Single Objects to be selected,** DOC will add all the Single Objects touched by the selection box to the Multiple selection.
- **If the first click is on the left of the Single Objects to be selected,** DOC will add all the Single Objects completely included in the selection box to the Multiple selection.

Multiple selection by clicking over the Single Objects to be selected

A multiple selection can be created by clicking over each Single Object you want to add to the selection list. First select all the Single Objects required, then select the Command you want to apply (for example, the "*Properties*" command)

Copy –Paste

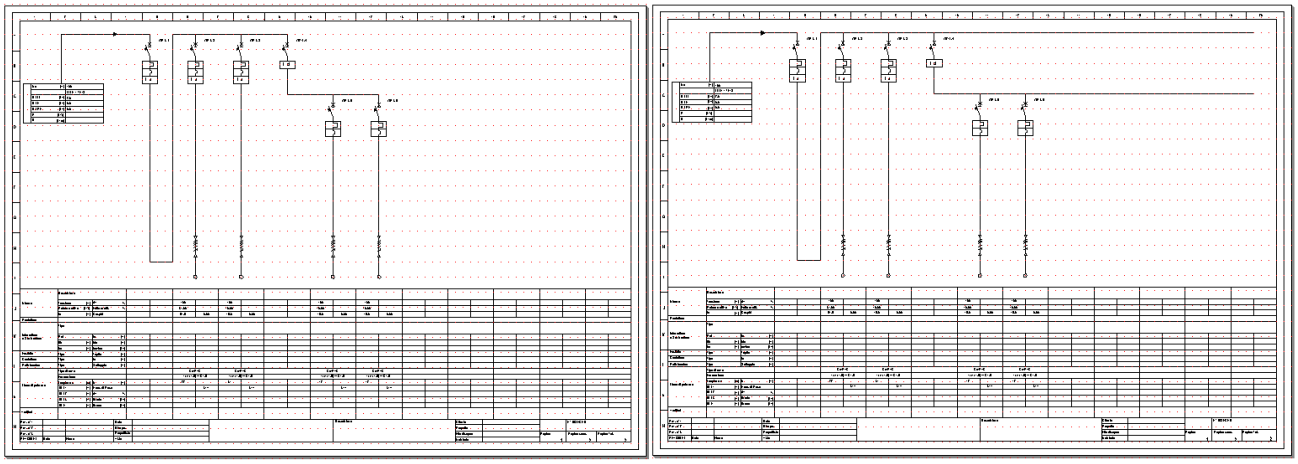
The *"Copy"* and *"Paste"* commands allow a Single Object or a Multiple Selection of Single Objects to be copied onto different pages of the drawing.

The predefined values of the original Single Objects will be indicated in the pasted Single Objects.

These commands are present on the “Clipboard” menu of the “HOME” tab.

Stretch

The *“Stretch”* command allows the length of “*Busbars*” and “*Connections*” to be modified. This command is present in the “Trasformations” menu of the “HOME” tab.



Connections stretched using the “Stretch” command ”

Add a text

To add text notes to the single-line diagram, use the *“Text”* command in the “Tools” menu of the “HOME” tab.

3.7. Labels

Labels are texts associated with each Single Object which allow the characteristics and calculation results to be displayed, such as the Iz of a Cable, the Description of a Circuit-breaker or the short-circuit current at a Busbar.

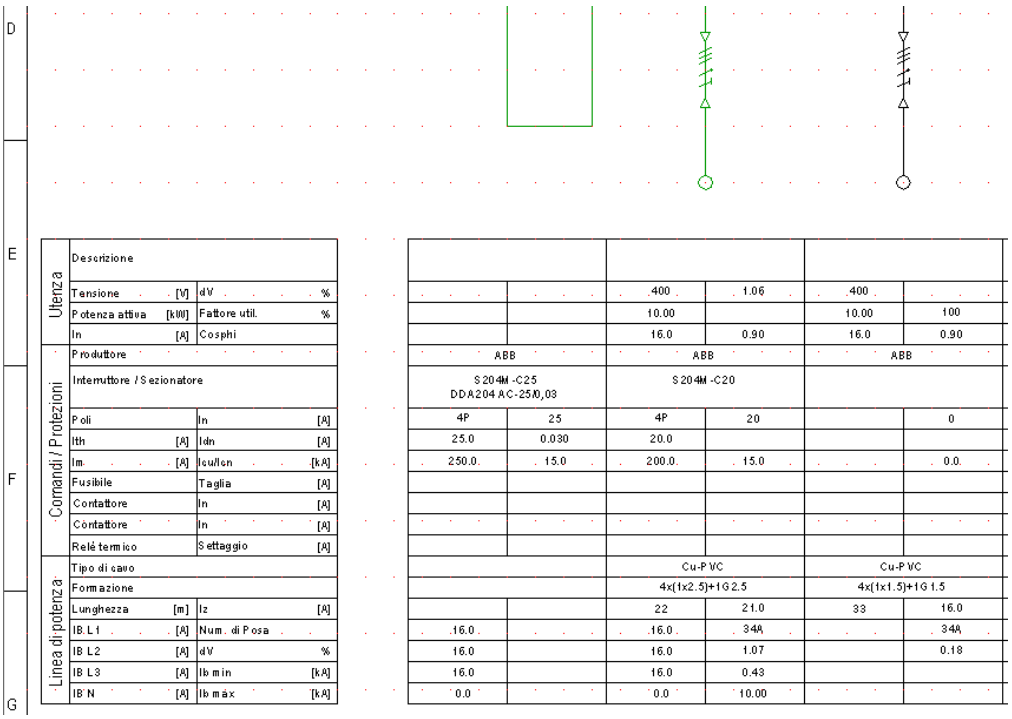
The position of the Labels depends on the layout.

Layout in columns

The layout in columns shows all the data relative to a Single Object in the layout below it.

The contents of each compartment of the layout is explained in the caption at the bottom left.

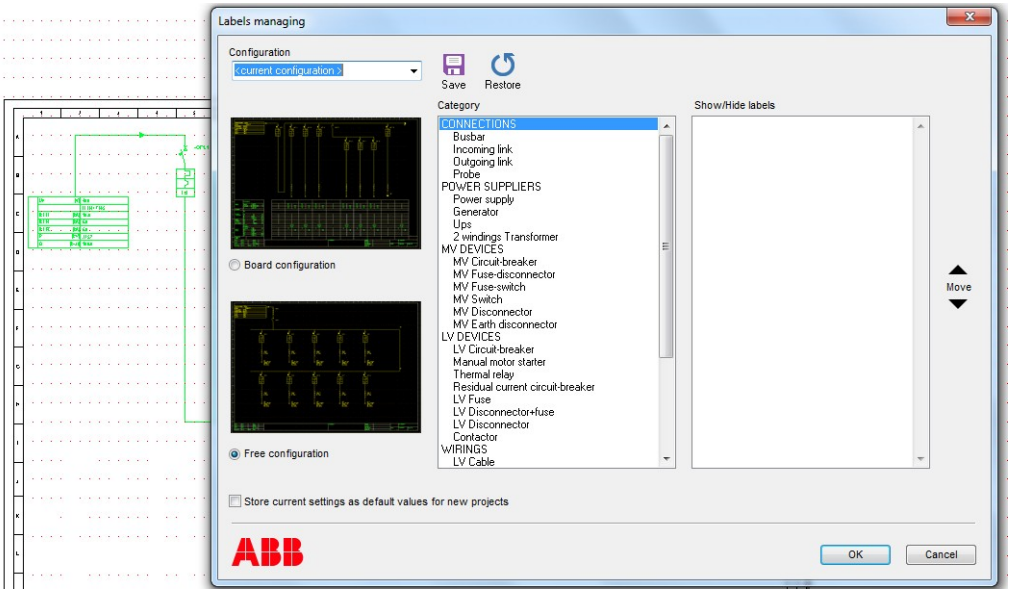
You cannot change the layout and results displayed.



Layout: Caption (first column on the left); data of a dimensioned feeder (green color) and data of an undimensioned feeder (black color)

Free Layout

The free layout shows some of the calculation results in the labels alongside each Single Object



Labels in a free layout; Label Manager window

Label manager

The Labels show the user the main data of each Single Object.

The Labels can be customized:

- The list of data contained in the Label can be changed by the user with the *"Set Labels"* command in the *"Tools"* menu. There are two predefined Label configurations: one for the free layout, the other for the layouts in columns. Special Label configurations can be saved for subsequent use in other projects.

Move labels

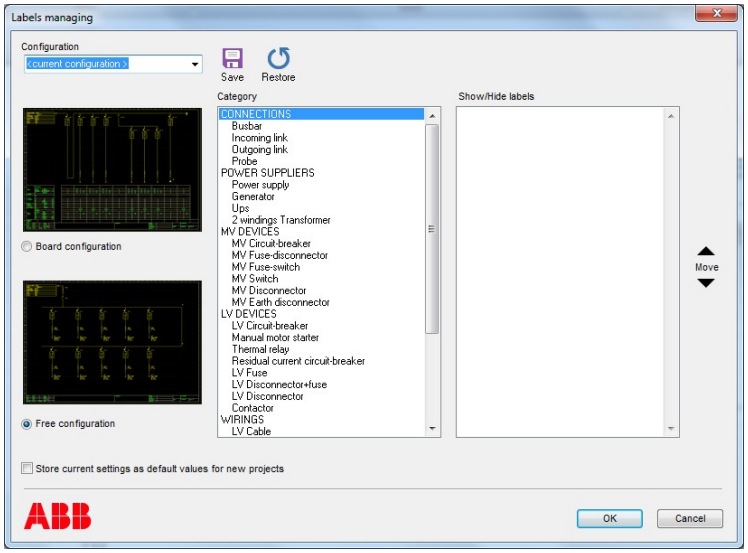
Using layouts A3, A2, A1 or A0, which allow free drawing of the single-line diagram, the labels are shown alongside the Single Objects.

When two or more labels are overlaid, they can be moved with the *"Move labels"* command.

This command is present in the "Tools" menu of the "HOME" tab.

Change the data shown on a Label

Use the *"Set Labels"* command in the *"Tools"* menu to change the list of data shown on a Label.



Label managr window

The label manager window allows you to define which properties to display in the diagram.

To change the state of a property, first select the Single Object to be modified in the "*Object*" menu, then enable or disable a property in the "*Properties*" list. The selection affects all the Single Objects in the single-line diagram.

You can also save a label configuration by means of the "Save configuration…" button, and use it again in another project.

The "*Board configuration*" and "*Free configuration*" options refer to the two types of layout:

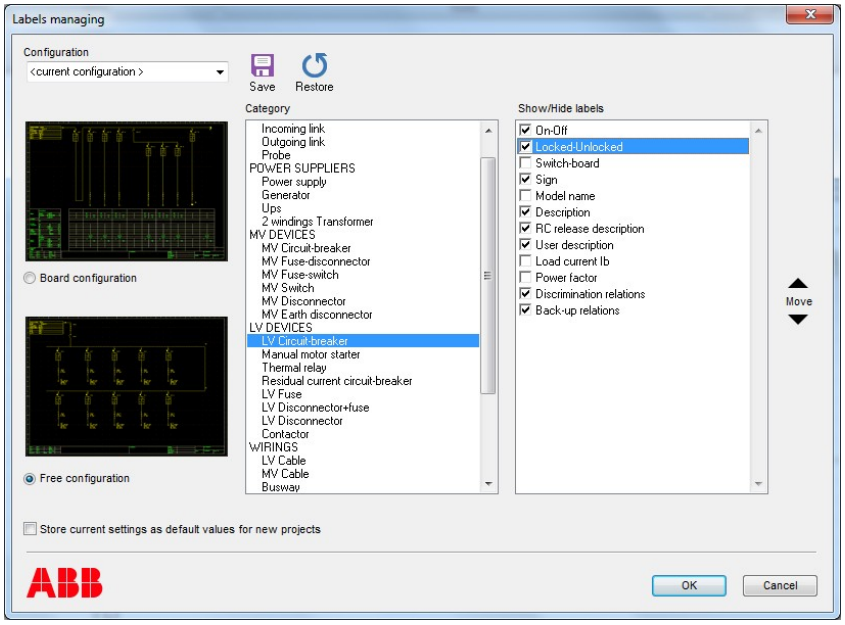
- "*Board configuration*" is the layout in columns, available in two variants: one for LV plants and one for MV switchboards.
- "*Free configuration*" is the layout without columns, where the labels are displayed beside each Single Object.

Example of label manager use: Display\Hide the padlock

The padlock icon (Cf. Chapter **4.5**) in Labels is used to make the Single Objects, which have been locked by the user and that DOC cannot change following a calculation, recognizable.
The symbol is very useful during design, but cannot be used in the printing stage.
This means that it may be useful to know how to manage the Labels so as to show or hide the padlock icon, depending on the task you are performing.
This situation can be managed with two label configurations:

- With padlock
- Without padlock

1) Run the "*Set labels*" command in the "Tools" menu of the"HOME" tab.
2) Select the "*Board configuration*" or "*Free configuration*" option, depending on the layout used
3) Activate the padlock for all the Single Objects. The padlock is managed by the "*STATE*" property.



Label manager: STATE label of the LV circuit-breaker

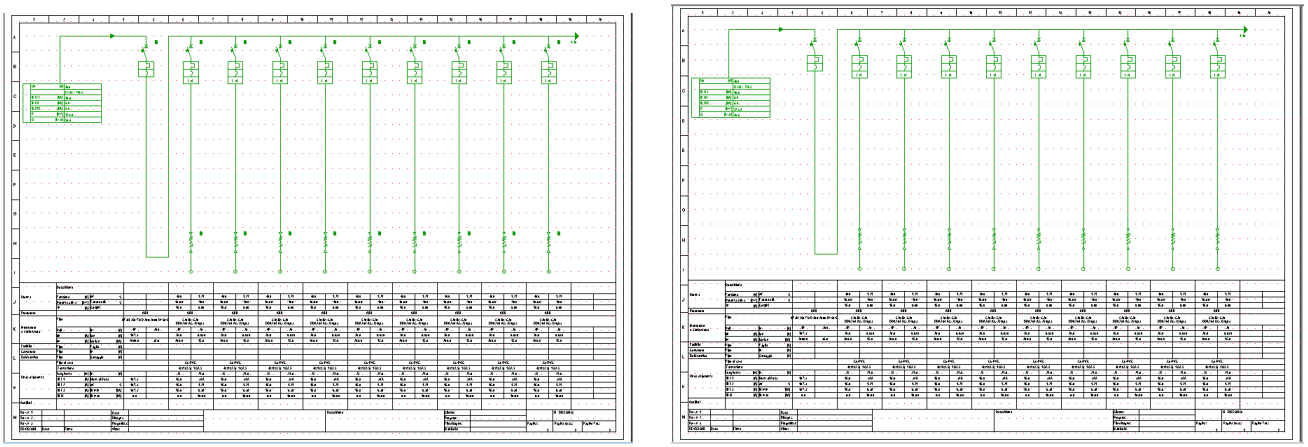
4) Save the configuration with the "*Save configuration…*" button and assign it the name you prefer.

5) Disable the padlock for all the Single Objects.

6) Save the new configuration as described in point 4).

7) To display of the padlock, run the "*Label manager*" command in the "Tools" menu of the "HOME" tab, select the type of diagram used, board or free and select the configuration where the padlock is to be displayed from the pull-down menu.

8) Once the two configurations described in points 4) and 7) have been created, you can rapidly pass from one to the other by executing the "*Set Labels*" command and selecting the desired configuration from the list at the top left.



Single-line diagram with the padlock visible and not visible

4. Calculation and Dimensioning

This chapter describes:

- the DOC calculation potential;
- results of the calculation;
- verification of existing plants.

After reading this chapter, the user will be able to:

- understand what is calculated by the program;
- understand how the calculations are made;
- resolve any incorrect situations highlighted by the program;
- read the calculation results;
- customize the program choices

4.1. Calculation and Dimensioning

When the single-line diagram drawing is completed and the data of the Single Objects have been defined, you can then calculate the single-line diagram.

DOC has a powerful calculation engine able to rapidly and automatically perform long and complex operations which would take a long time to carry out in the manual mode or using some other, less powerful software.

In particular the DOC calculation engine is able to:

- Verify correctness of the single-line diagram design
- Calculate the load currents at all points of the diagram
- Calculate the voltage drops
- Balance single-phase - two-phase loads over the three phases
- Calculate the power consumed by the supply and the power factor
- Dimension the cables according to the calculated load currents and/or the voltage drops
- Repeat steps 2 and 3 until all the cables have been correctly dimensioned
- Calculate the maximum and minimum short-circuit currents at all points of the single-line diagram
- Choose the protection devices according to the load currents, short-circuit currents, protection of cables and people and, if required, coordinate the protection devices (discrimination and/or back-up).

The calculations are made using the *"Calculate"* button of the "Tools" menu in the "HOME" tab. All the calculation parameters are preset so as to meet the needs of the more common plants. Calculation thus begins immediately and does not require any further decisions from the user.

Advanced calculation settings

Some parameters used in the calculation procedure can be changed by the user.

This operation is generally not indispensable because the parameters are preset so as to satisfy the most common needs. To view and edit these parameters, you must use the "*Options…*" command (in the main windows of the program, e.g. in the Supply window) and select the "*Show calculation settings before dimensioning*" box on the "*Calculation options*" page.

Modification of the advanced calculation options is only recommended for expert users with special requirements as they concern:

- Definition of the instants at which the short-circuit currents must be calculated;
- Power supply voltage tolerance;
- Reference temperature of the cables for calculating the maximum short-circuit currents;
- Type of over-excitation of the generators in the diagram;
- Manual exclusion of motor contributions in short-circuit current calculations.

Minimum and maximum fault currents

DOC calculates the Minimum and Maximum short-circuit currents it all points of the network.

Their difference is explained in Standard IEC 60909-0 chapters 2.4 and 2.5 (the differences are also given in DOC during printing in Printout of the **Error! Reference source not found.** section; **Error! Reference source not found.**).

It is important to underscore that, with regard to the end-of-line fault currents, DOC calculates:

- **The Minimum fault current** in the cable, used for protection against indirect contacts (Cf. Chapter 5.1).
- **The Maximum fault current** in the switchboard on the load side of this line, used for selecting the Breaking Capacity of the protection devices installed in the switchboard.

Two different short-circuit values are therefore available at the end of the line, defined as follows:

Maximum short-circuit currents

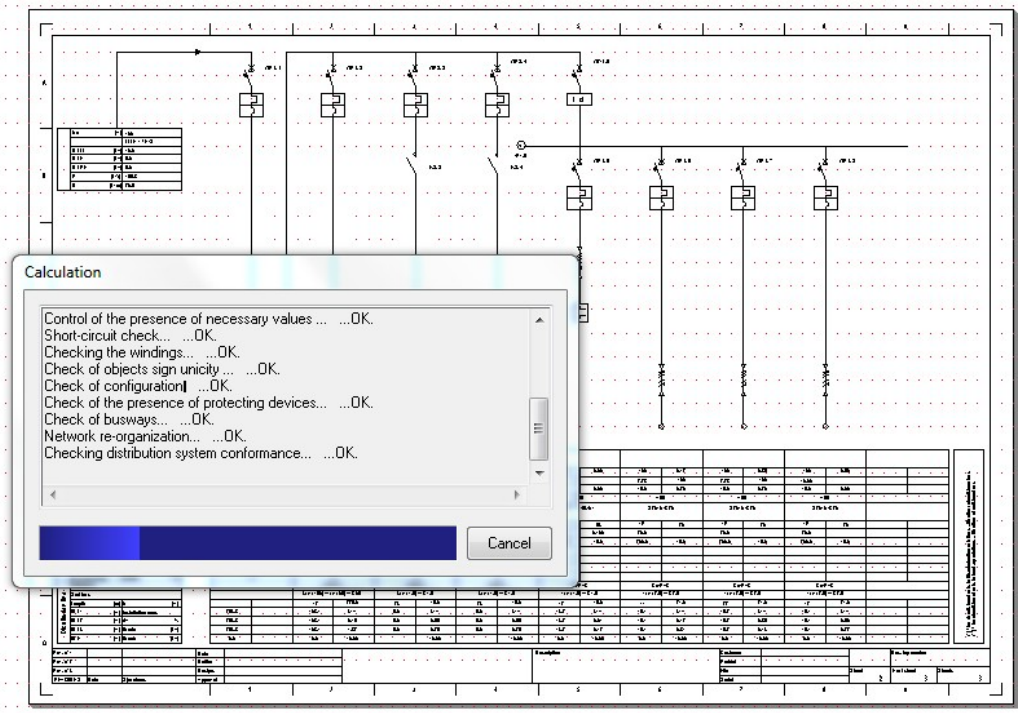
- Voltage factor c_{max} (equal to 1.1) is applied to calculate the maximum short-circuit currents;
- The motors are included if their contribution is more than 5% of the maximum short-circuit current calculated without this contribution;
- The resistances of the lines (overhead and in cables) are taken at a temperature of 20°C.

Minimum short-circuit currents

- Voltage factor c_{min}, equal to 0.95, is applied to calculate the minimum short-circuit currents;
- The contribution of motors is excluded;
- The resistances of the lines (overhead and in cables) are taken at a temperature of 80°C.

The cable resistance values at 20°C and at 80°C can be printed by enabling Printout in the **Error! Reference source not found.** section of the Project documentation (Cf. Chapter **Error! Reference source not found.**.).

A window showing the state of progress of the process is visible during the calculations.



Calculation window

Messages may appear during the calculations, when significant or abnormal situations occur.

The meaning of the main messages is explained in chapter 4.2.

Depending on what DOC finds, the Single Objects may change color at the end of the calculations, in accordance with the color profile (Cf. chapter 2.7).

In certain situations DOC may not be able to select some of the switching and protection devices.

The main cases are explained in chapter 4.3.

The results available at the end of the calculations and the methods for displaying them are described in chapter 3.7.

The main actions that can be taken at the end of the calculations to check the results and, where necessary, to change the program selections, are described in chapter 4.5.

4.2. Error Messages

This chapter explains the most important and frequent error messages that can appear during the calculations.

These error messages are of two types:

- **Blocking messages:** warn of a critical and incorrect situation that must be corrected before being able to proceed with the calculation.
- **Warning messages:** draw the user's attention to a faulty or potentially incorrect situation but do not block the calculation process.

Blocking messages

- **Phases – Distribution system not consistent in highlighted Objects**
  DOC checks the congruence of the single-line diagram (for example: a single-phase cable cannot supply a three-phase load).
  Solutions: check the phase and distribution system properties in the Single Objects indicated. If there are discrepancies, cancel and draw new the Single Objects or change the Phase and Distribution system properties after having performed a Multiple selection (Cf. Chapter 3.6) of the Single Objects involved.
- **Single-line diagram incorrect: a busway must be added between supply and loads. Check Highlighted Objects**
  DOC needs at least one Single Object with impedance not nil (for example, a cable or a busway) to be present between supply and loads.
  Solution: make sure that there is at least a cable or busway between the supply and loads.
- **Single-line diagram incorrect: a busway must be added between two supplies. Check Highlighted Objects**
  DOC needs at least one Single Object with non-nil impedance (for example, a cable or a busway) to be present between two supplies that operate in parallel.
  Solution: make sure that there is at least a cable or busway between the two power supplies.
- **Single-line diagram incorrect: some objects are short-circuited! Check Highlighted Objects.**
  DOC checks that there are no branches with nil impedance in parallel with Single Objects or branches of the plant: current would not, in fact, pass through these latter and this would indicate an error in the single-line diagram drawing.
  Solution: check the connections between the two short-circuited Single Objects.
- **Single-line diagram incorrect: connections missing. Check Highlighted Objects**
  Part of the single-line diagram is not connected to the supply.
  Solution: connect the Highlighted Single Objects to the supply.
- **Single-line diagram incorrect: links not connected. Check Highlighted Objects**
  A link has not been connected to the relative arrival.
  Solution: check the link indicated and connect it to another link; should the link be superfluous, cancel it.

Warning messages

- **Voltage drop higher than limit set for the highlighted Objects**

  DOC checks that the voltage drop percentage on each load is no higher than 4% (or than the value entered by the user) and signals the loads for which the threshold has been exceeded.

  Solution: check the sizes of cables on the supply side of the load involved.

- **Highlighted transformer is not dimensioned correctly: increase the size!**

  DOC checks that the transformers are able to supply the power required by the plant. The message generally appears when the transformers have been locked with a padlock, otherwise DOC would be able to automatically select another power transformer suitable for the load required.

  Solution: Increase the size of the transformer, check that the power of the loads and the demand coefficients have been entered correctly.

- **These objects are not protected against overload \ short-circuit \ indirect contacts**

  DOC checks that all the cables and switching devices are protected against faults (the warning can be disabled in the window that displays the warning).

  Solution: It is not always necessary to take measures (for example, the absence of protection against overload in emergency configurations): users can decide, under their own responsibility, to omit the protections when allowed by the Standards and/or plant characteristics.

  If necessary, add a protection device on the supply side of the unprotected object.

- **Warning: some supplies consume power instead of supplying it**

  DOC checks whether power flows from the supply to the loads. If there are several power supplies in parallel (generator and power supply) a generator may meet the power requirements of the plant and also supply energy to the power supply.

  Solutions: if you do not want the generator to supply energy to the power supply, check the size of the generator, the power of the loads and the demand coefficients.

  If it is normal for the generator to supply power to the network, the message confirms this behavior.

- **Warning: some supplies have lower rated power than that required by the plant**

  DOC checks that the generators and UPS are able to supply the power required by the plant, by comparing their rating plate data with the requirements of the loads (the supply is considered to be a generator with infinite power).

  Solution*: check the rating plate data of the generators and UPS, the demand coefficients and the power consumed by the loads, in that order.*

- **Highlighted cables do not conform to the following dimensioning criteria:**

  - The carrying capacity is insufficient

  - The voltage drop exceeds the set limit

  DOC checks that the locked cables (Cf. Chapter 4.5) comply with the required carrying capacity and voltage drop criteria.

  Solutions: check cable data (length, insulation, method of installation) and load data; or unlock the cable and let DOC re-calculate the section.

4.3. Failed selection of Single Objects

DOC is sometimes unable to find a valid product, or shows the products locked by the user with the padlock as invalid.
The most frequent cause of failed selection or verification of a product are listed below and can help the user to modify the selection criteria appropriately.

- If the Single Object is locked with the padlock, unlock it and rerun the calculation.
- Check for the presence of appropriate protections against indirect contacts with the power sources by means of residual current devices, when the distribution system is TT. It may be impossible to ensure protection against indirect contacts with other protection functions.
- If the fault current is high (over 15kA) and the section of cable to be protected against short-circuit is less than 4 mm^2, try to rerun the calculation after having selected a cable with a larger section and having locked it with the padlock.
- Make sure that you are not in one of the cases specified below, for which suitable products do not exist:
  - 1P, 1P+N and 2P products in circuits with over 125A current (the 1P, 1P+N and 2P devices are the modular type and have 125A maximum rated current. 3P, 3P+N or 4P devices must be selected).
  - Residual current protection with over 2000A rated current (the maximum size of an RCQ external toroid is 2000A).
  - Fuses with over 630A rated current (the maximum rated current of the fuses managed by DOC is 630A).
  - Fuses with over 100kA breaking capacity (the fuses have 100kA breaking capacity. If DOC has calculated higher short-circuit currents, check the supply data, or select a circuit-breaker instead of a fuse).
  - Circuit-breakers with over 200kA breaking capacity (The circuit-breakers have maximum 200kA breaking capacity. If DOC has calculated higher short-circuit currents, verify the supply data).
  - Moulded-case circuit-breakers with over 160A rated current for protecting residual current circuit-breakers (residual current circuit-breakers cannot be protected using moulded-case type circuit-breakers with over 160A rated current).

- Moulded-case circuit-breakers with 160A current or less for protecting residual current circuit-breakers with over 6kA short-circuit current (moulded-case circuit-breakers with up to 160A rated current can only protect residual current circuit-breakers up to 6kA).

- Miniature circuit-breakers in circuits with current over >125A or >25kA breaking capacity. In this case, remove the limit on the type of product and allow a moulded-case type of circuit-breaker to be selected.

- If a fuse, or a switch-fuse, protects a cable, make sure that the ratio between Iz and Ib is at least equal to 1.2 (Cf. Chapter 5.1.1: a cable with 30A Iz can only be protected by a fuse up to 0.9 x 30A = 27A.

- If a circuit-breaker protects a cable, make sure that there is sufficient space between Ib and Iz to be able to select a size of product. For example: if Ib is 26A and Iz is 30A, a miniature circuit-breaker cannot be selected as protection since the closest sizes are 25A, lower than Ib, and 32A, higher than Iz.

- Make sure that not too many objects are protected by the same protection device (the window for displaying \ editing the list of the protections is described in **Annex B**).

- For the circuit-breaker, check that there are not too many simultaneous discrimination, back-up and cable protection restrictions. In this case, slacken one or more of the restrictions.

Help for failed selection of Single Objects

If you are unable to select a product using the suggestions given above, you can the send the project file and a description of the problem to the assistance service, which is at your disposal.

The address is as follows: software.tools@it.abb.com

4.4. Calculation and dimensioning results

Calculation results

DOC calculates the following, both in low and in medium voltage:

- Maximum short-circuit currents at all points of the single-line diagram.
- Minimum short-circuit currents at the end of the line.
- Phase and neutral currents (in unbalanced networks) at all points of the single-line diagram.
- Power factor on each line and at each busbar.
- Active and reactive power required at the supply.

Dimensioning results

The program is able to select the following, both in low and in medium voltage:

- The minimum cable sections that comply with the following criteria:
  - thermal, depending on the Standard selected
  - voltage drop in the single line less than 4% (can be changed by the user)
- The most economical protection apparatus (circuit-breakers, fuses) in the list of technically correct ABB products.
- The most economical switching apparatus (disconnectors, contactors) in the list of technically correct ABB products.

Further results

Other results from a calculation:

- Balancing unbalanced networks. The program applies an algorithm to “move” the single-phase and two-phase loads from one phase to the other, so that current consumption on the supply side is as balanced as possible.
- Dimensioning for the rated current of a transformer or generator. The Single Objects placed on the load side of a transformer or generator will be dimensioned according to the rated current of the secondary winding of the transformer or the rated power of the generator, rather than according to the current required by the plant.

  This option is useful for those who possess machines dimensioned by considering future plant enlargements. Cables and switching and protection devices will not have to be changed, with obvious savings in times and costs.

4.5. How to change the dimensioning results

This chapter explains how to change the selections made automatically by the program.

Locking and unlocking Single Objects

When program selections are changed after dimensioning, the most important commands, are those which allow a Single Object to be Locked or Unlocked.

The *"Lock objects"* command changes the calculation settings, so that at the next dimensioning, the locked Single Object is only checked and not changed by DOC.

The locked Single Objects behave as follows:

Object	**Lock effect**
Cable	The section is not re-calculated.
Protection device	The product is not changed for a more economical one.
Switching device	The product is not changed for a more economical one.
Transformer	The size is not re-calculated according to the loads.
Load	The single-phase loads are not connected to a different phase so as to minimize the unbalance.

The *"Unlock objects"* command resets the calculation settings, so that at the next dimensioning, the unlocked Single Object is selected by DOC.

The unlocked Single Objects behave as follows:

Object	**Lock effect**
Cable	DOC re-calculates the section and optimizes it according to the voltage drop and the carrying capacity
Protection device	The most economical product among those technically suitable is proposed.
Switching device	The most economical product among those technically suitable is proposed.
Transformer	The size is re-calculated according to the loads.
Load	If it is single-phase, it can be connected to a different phase to minimize the unbalance.

Changing product

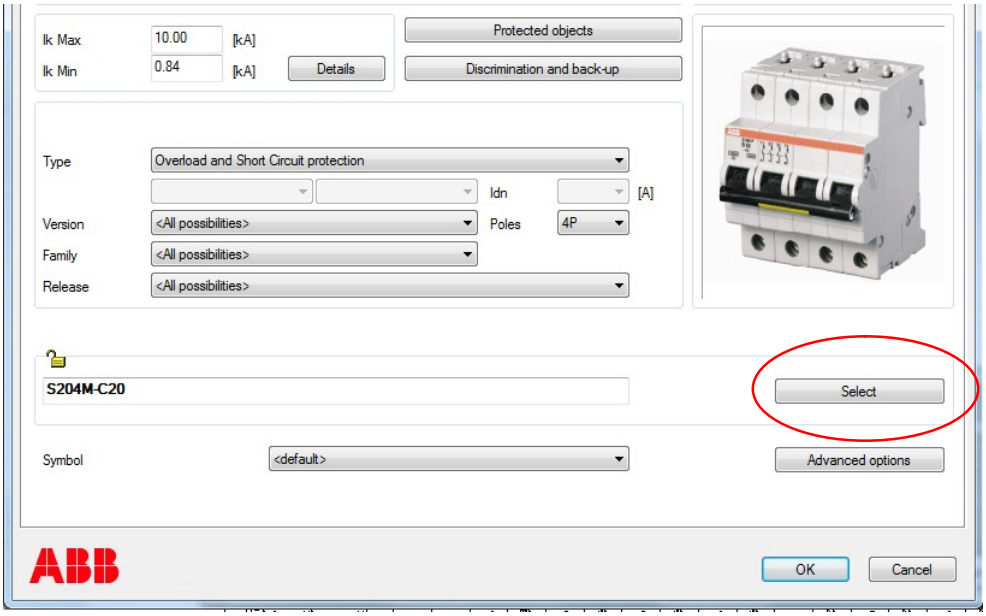
The automatic selections made by DOC cannot take the requirements of all program users into account!

To change a product proposed by DOC, simply:

- Access the Single Object Properties window.
- Click over the “Select >>>” button
- Navigate the tree to find the desired product.
- Lock the desired product with the padlock.

On access to the selection window, the list of products displayed considers the technical selection filters of the product itself (for example, circuit-breakers with breaking capacities lower than the short-circuit current will not be shown).

If the desired product is not in the list, remove the technical filters by selecting the “Free selection” option at the top left.



“Select >>” button in a circuit-breaker window

At the next calculation, DOC will check the locked product instead of selecting a new one.

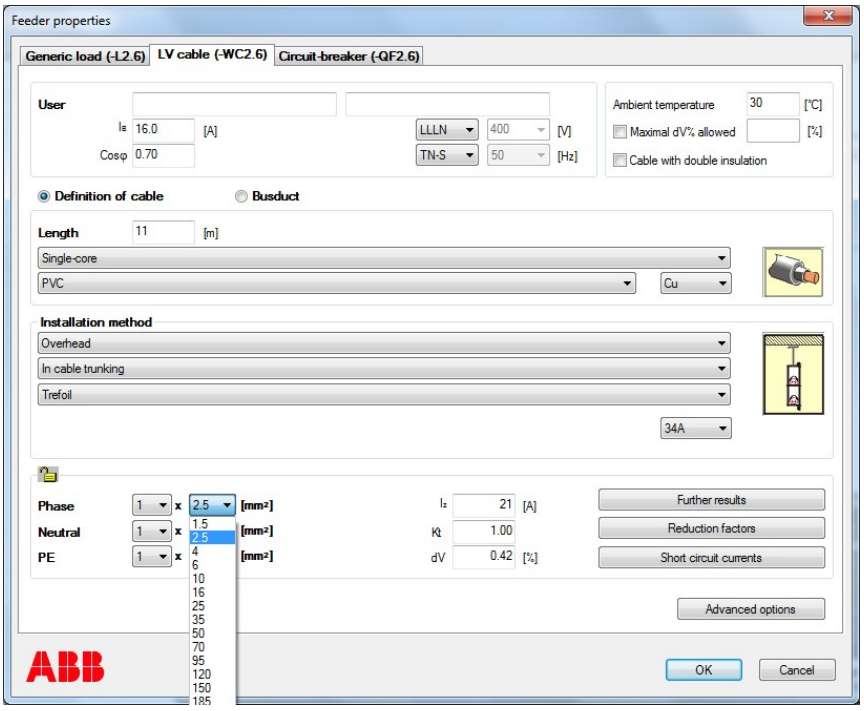
Changing cable sizes

DOC selects the cable sections according to the Standard, the carrying capacity of the cable and the voltage drop.

You can change the cable sections, for example, to check a cable already installed, by accessing the cable Properties window.

Select the most suitable sections for your situation in this window and lock the selection with

the padlock.



Cable dimensioning window – changing the cable sections

When the section of a cable is changed, the impedance of the cable and, therefore, the voltage and short-circuit values on its load side also change.

New values for the short-circuit currents could invalidate the selections made for the already selected protection devices: it will therefore be necessary to re-calculate the whole single-line diagram !

5. Verifications and protections

This chapter describes:

- verification of overload, short-circuit, indirect contacts and discrimination from a theoretical viewpoint;
- the verifications performed by the program.

After reading this chapter, the user will be able to:

- understand the overload, short-circuit, indirect contact and discrimination verifications;
- use the curves module to perform overload, short-circuit, indirect contact and discrimination verifications.

5.1. Verifications and protections

This chapter describes how to check the cable protection and the discrimination criteria by means of the module dedicated to drawing curves.

5.1.1. Description of the Protections

DOC checks, in real time, the protections against:

- Overload (hereinafter **OL**).
- Short-circuit (hereinafter **SC**).
- Indirect contacts in TT systems (hereinafter **NDT-TT**).
- Indirect contacts in TN systems (hereinafter **NDT-TN**).

The protection criteria are defined in standard IEC 60364-4-43:

- **Overload** (Standard IEC 60364-4-43 Chapter 433):
  - The set current of the protection device (In) must be between the service current (Ib) and the carrying capacity of the busway (Iz).

$$Ib \leq In \leq Iz$$

  - The threshold of guaranteed tripping of the protection device must be less than 1.45 times the carrying capacity of the busway.

$$If \leq 1.45 \cdot Iz$$

where:

I_b = Service current.
I_z = Carrying capacity in permanent regime of the busway.
I_n = Current set of the protection device (for non-adjustable protection devices, this coincides with the rated current).
I_f = Current which ensures effective operation of the protection device within the prearranged time under defined conditions.

Guaranteed tripping current for circuit-breakers and fuses

For construction characteristics, guaranteed tripping current I_f is:

- Always $1.45 \cdot In$ or less for circuit-breakers
- $1.6 \cdot In$ for fuses.

This means that:

- A circuit-breaker is able to protect a cable against overload over the whole of its carrying capacity, thus making verification superfluous $If \leq 1.45 \cdot Iz$

- In a fuse, the most stringent condition is verification on I_f. If I_f is substituted with value 1.6 *In*, you obtain:

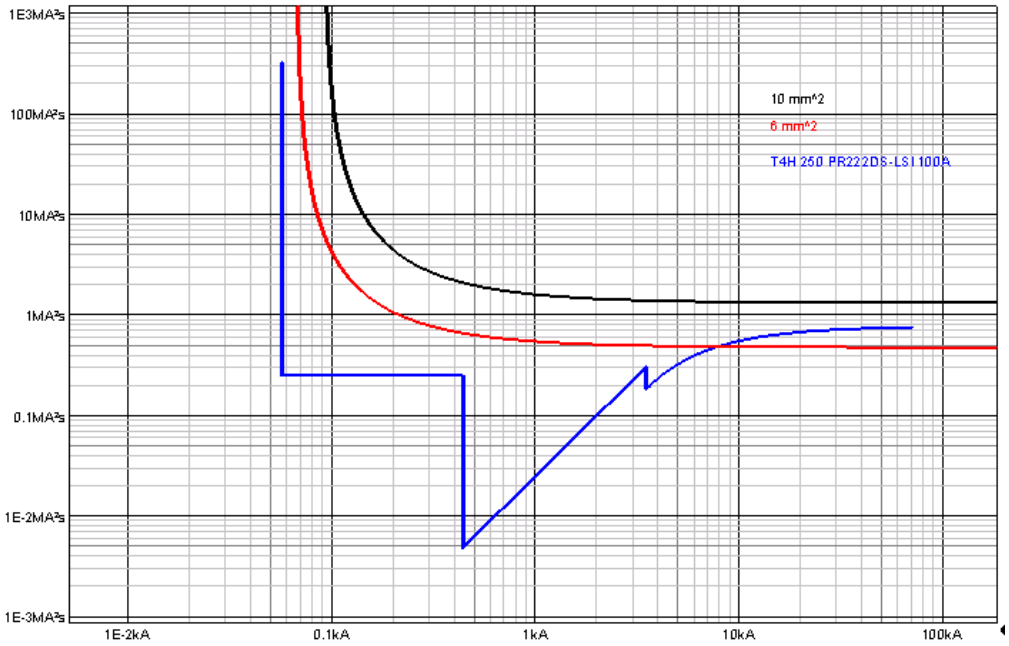
$$1.6 \cdot In \leq 1.45 \cdot Iz$$

Which means that:

$$In \leq 0.906 \cdot Iz$$

In other words, protection of a cable against overload by means of a fuse does not allow this cable to be used up to its carrying capacity, but only up to about 90% of its carrying capacity.

- **Short-circuit** (Standard IEC 60364-4-43 Chapter 434):
  - The specific energy let-through by the protection device is less than the specific energy supported by the cable for all the current values from Ib to the maximum short-circuit current.
    With DOC, verification is performed graphically by comparing the curve of the specific energy let through by the circuit-breaker (I^2t) and the curve of the maximum energy which can be supported by the cable (K^2S^2), and by checking that there are no intersections in the range of currents defined by the Standard.



Energy diagram: comparison of the curves of a circuit-breaker (blue) with a completely protected cable (black) and a partially protected cable (red)

- **Indirect contacts in TT systems** (Standard IEC 60364-4-43 Chapter 413):
  - The contact voltage is less than 50 [V], i.e.:

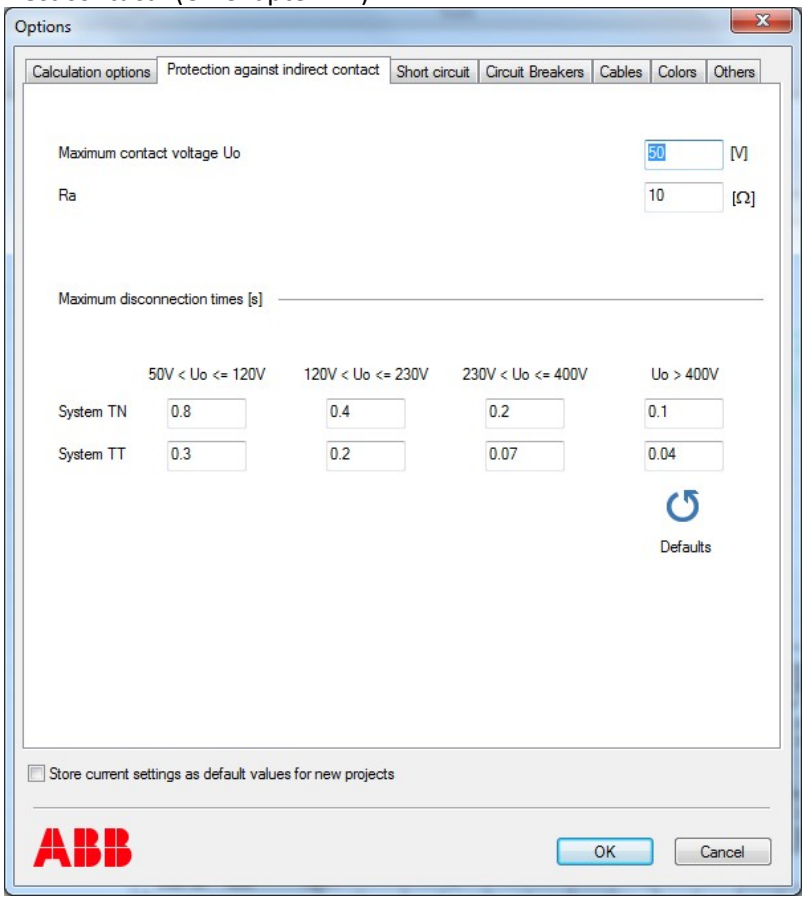
$$Ra \cdot Ia \leq 50$$

where:
R_A [Ω] = Sum of the resistances of the earth electrode and protection conductors of the exposed conductive parts.
I_A [A] = Current which causes automatic operation of the protection device (if the protection device is the residual current type, I_A is the Idn rated residual current Idn).

Modification of the R_A value

As described in the previous section, R_A is given by the sum of two resistances: the earth electrode and the protection conductors of the exposed conductive parts.

- **Earth electrode**: its value is defined using the command "*Options*" under the item "*Protection against indirect contact*" (Cf. Chapter 2.1).



Window for setting the RA value

If necessary, you can set a different earth electrode value for each single feeder in the "*Protected Objects*" window of the protection device ("*LV circuit-breaker*", "*LV Fuse*", "*Residual current circuit-breaker*") on the supply side of the feeder itself.

- **Protection conductors of exposed conductive parts**: the resistance value of the the conductors is calculated by the program depending on the type of cable and its section. The conductor resistance values can be
  - Consulted in the "*LV cable*" properties (Cf. Annex B);
  - Printed in the **Error! Reference source not found.** section **Error! Reference source not found.**).

- **Indirect contacts in TN systems** (Standard IEC 60364-4-43 Chapter 413):
  - The trip threshold of the protection device must be lower than the fault current at the end of the Phase – Earth line, i.e.:

$$Zs \cdot Ia \leq Uo$$

where:

Z_S [Ω] = Impedance of the fault ring which includes the source, the live conductor as far as the fault point and the protection conductor between the fault point and the source (in DOC, this type of fault is called "*L-PE*", i.e. between phase and protection conductor).

I_A [A] = Current which causes automatic operation of the protection device within the time defined in the following table (if the protection device is the residual current type, I_A is the rated residual current I_{dn}).

Uo [V]	Tripping time [s]
120	0.8
230	0.4
400	0.2
>400	0.1

U_0 [V] = Rms value of the rated voltage between phase and earth.

DOC calculates value Uo/Zs, indicated as "*Icc L-PE*" (short-circuit fault current between Phase and Protection conductor). The verification performed is therefore:

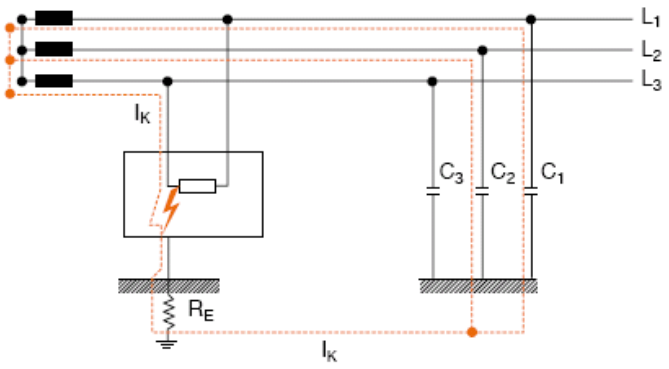
$$\mathrm{Im} \leq IccL - PE$$

where:

I_M [A] = is the current which causes the protection device to trip within the scheduled tripping time.

- **Indirect contacts in IT systems** (Standard IEC 60364-4-43 Chapter 413):
  - In IT systems the live part of the network is electrically insulated from the exposed conductive parts, therefore the circuit of any possible earth fault can only be re-closed in capacitive couplings between live conductors and exposed conductive parts or earths (as in the diagram below).

    The value of these capacitive couplings is not easy to calculate, so it is impossible to give a value to the impedance of the fault ring and therefore to the current which passes through it.



Circuit of an earth fault in an IT system

Since the value of the first earth fault is not known, DOC is unable to check the protection against indirect contacts.
Remember that, in any case, the above-mentioned Standard envisages the use of an insulation control device to indicate the appearance of an initial fault between a live part of the network and exposed conductive parts or earth.
The same Standard does not impose protection against indirect contacts in IT systems by means of automatic interruption of the power supply.

The parameters used for verifying protection against indirect contacts can be changed in the *"General plant properties"* window (Cf. Chapter 2.1).

Further information about protection against indirect contacts

For further details, we recommend consulting the "*QT3 - Distribution systems and protection against indirect contacts and earth faults*" guide.

5.1.2. Protection devices

The protection devices are able to supply the types of protection listed in the table below

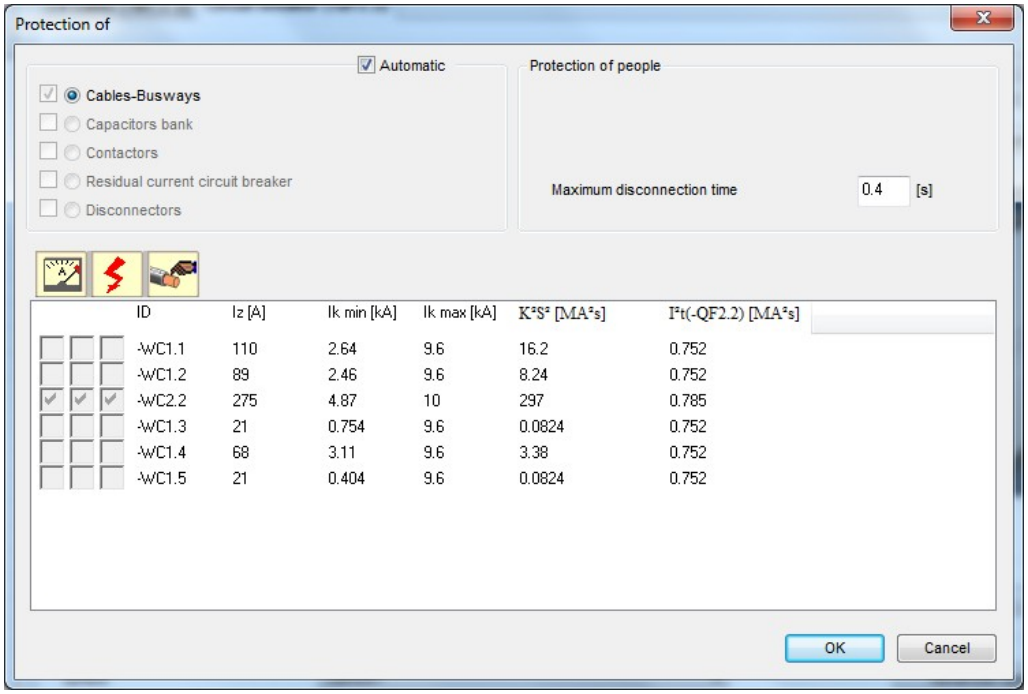
			
Protection device	**SC**	**CC**	**CI-TN**	**CI-TT**
Thermal-magnetic circuit-breaker	**X**	**X**	**X**	
Thermal-magnetic circuit-breaker with residual current	**X**	**X**	**X**	**X**
Magnetic only circuit-breaker		**X**	**X**	
Magnetic only circuit-breaker with residual current		**X**	**X**	**X**
Residual current circuit-breaker				**X**
Fuse	**X**	**X**	**X**	
Switch-fuse	**X**	**X**	**X**	
Thermal-magnetic motor protector	**X**	**X**	**X**	
Magnetic only motor protector		**X**	**X**	
Thermal relay	**X**			

DOC automatically assigns cable protection to the most suitable device on the supply side.

However, the program selections can be changed by pressing the "*Advanced Options >>>*" or "*Protected Objects*" buttons, which are always present in the windows dedicated to each protection device.

Removal of the protection restrictions of switching devices or busways could leave these objects unprotected in the case of a fault.

You are advised to use this option very carefully.



Window for assigning the protections.

5.1.3. Protection verification

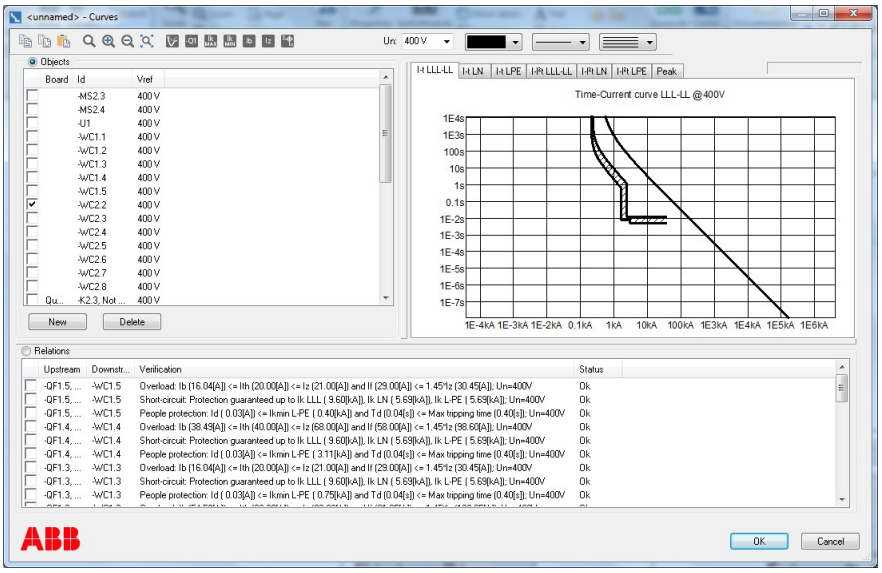
Curves module manual

This Chapter only contains basic indications about using the curves module.

For a detailed explanation about how to set the releases and on the functionalities of the application, please consult the *"Curves Manual"* under the "*Help Curves*" item of the *"INFO"* tab of DOC).

Protection verification is performed with the curves module, which is enabled by clicking over the "Curves" icon of the "Tools" menu in the "HOME" tab (shown on the left).

Once the command is given, DOC displays a new work environment where you can work on the curves of the devices in the diagram and on all the available settings



Main curves module window.

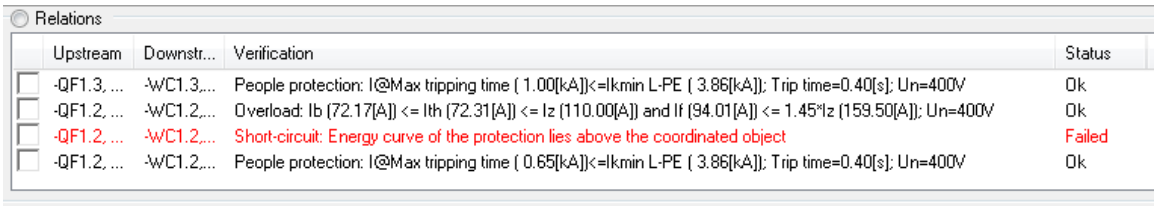
"Relations", i.e. the list of protections verified by DOC, are shown in the lower part of the screen.

The *"Relations"* window is divided into four columns:

- Object on the supply side (protection device, a circuit-breaker or a fuse).
- Object on the load side (object protected, typically a cable).
- Corroborating calculation performed by DOC (the calculation is made in real time as soon as a curve is changed and in conformity with the previously described criteria).
- Present state of the verification.

If a protection relation is satisfactory, the text which describes it is black and the state is "*OK*".
If a protection relation fails, the text which describes it is red and the state is "*Failed*".

You can print the results of all the verifications made by DOC in Print of the **Error! Reference source not found.** section (Cf. Chapter **Error! Reference source not found.**).

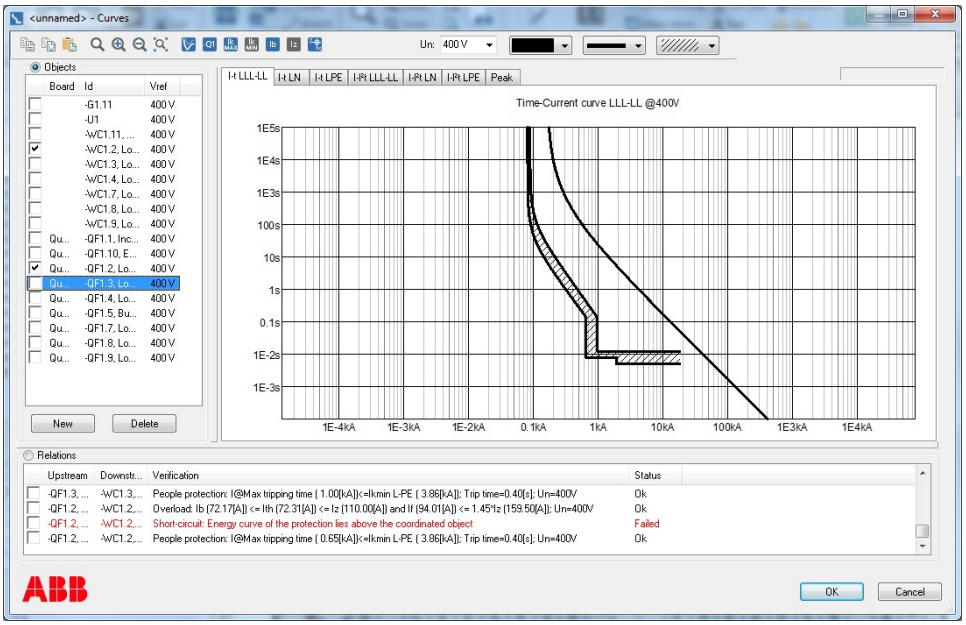


Examples of satisfactory and failed verifications

5.1.4. Management of the protection device settings

When a protection relation fails you can proceed according to the indications given below so as to understand the reasons for this and take the appropriate measures to make it satisfactory

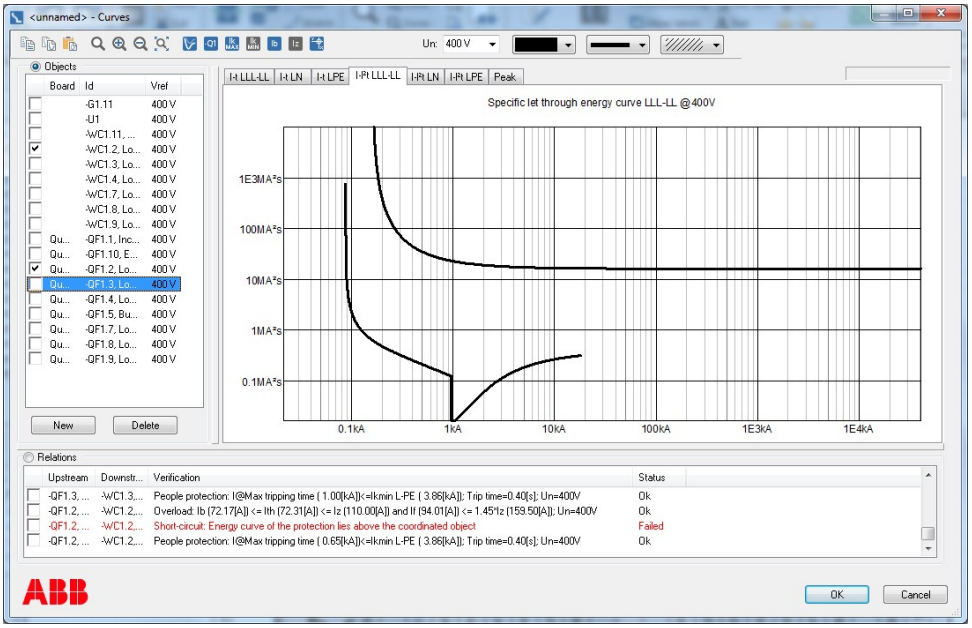
Verification of protection against overload



Overload verification

- Select the failed verification by ticking its box;
- The curves module will show the Time-Current diagram (I-t);
- The protection device and the cable to which the verification refers will be shown;
- Double click over the curve of the protection device;
- Change the setting of the thermal threshold ("*L*" threshold) until the current setting between "*Ib*" (load current) and "*Iz*" (cable carrying capacity) falls;
- The color of the message will change in real time from red to black, when the protection relation has been verified.

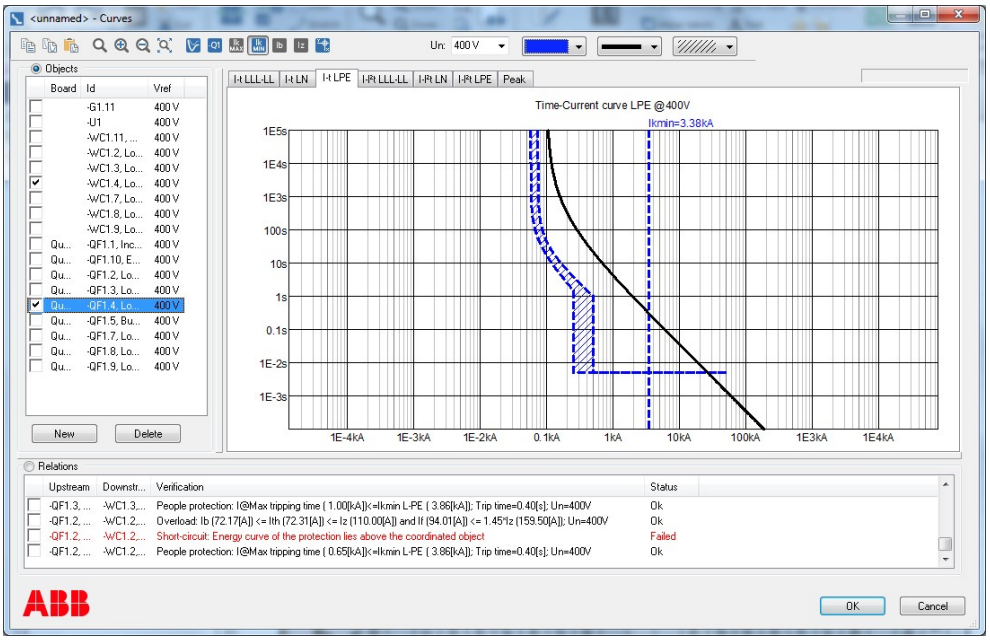
Verification of protection against short-circuit



Short-circuit verification

- Select the failed verification by ticking its box;
- The curves module will display the diagram of the specific let-through energy (I-I^2t);
- The protection device and the cable to which the verification refers will be shown;
- There may be large circuit-breakers fitted with electronic releases: in this case enable functions "*S*" and "*I*" of the electronic release and change the setting until the circuit-breaker curve is completely under the cable curve;
- The color of the message will change in real time from red to black, when the protection relation has been verified.

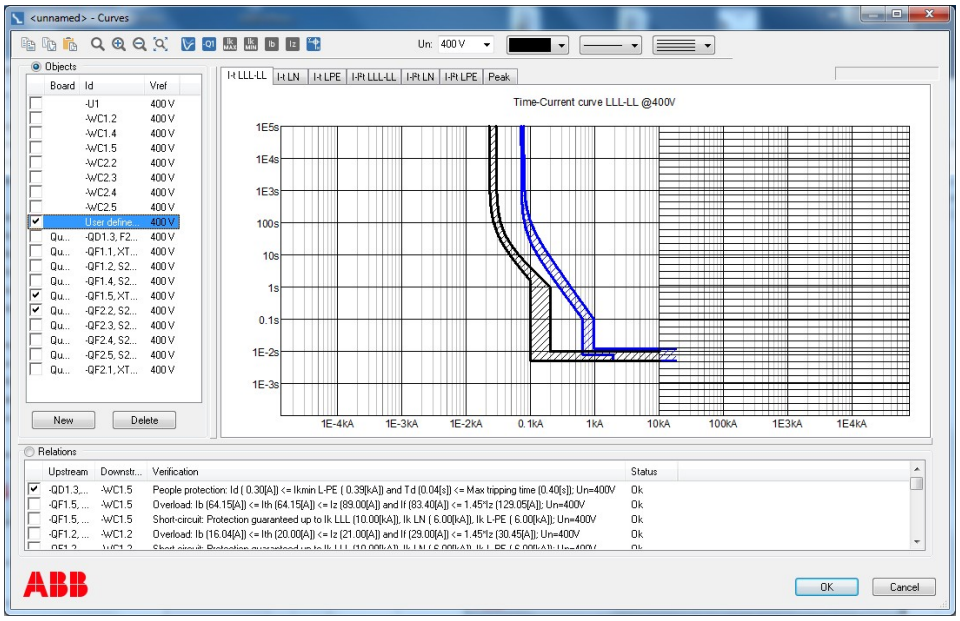
Verification of protection against indirect contacts



Indirect contact verification

- Select the failed verification by ticking its box;
- The curves module will display the Phase-earth fault current – Time (I-t LPE) diagram
- Select the circuit-breaker curve by clicking over it;
- Click over the “min Ik” icon: the command makes a vertical straight line appear on the diagram which represents the fault current at the end of the line. A positive verification is obtained when the magnetic threshold of the circuit-breaker is on the left of the fault current at the end of the line;
- Lower the magnetic threshold of the thermal-magnetic releases, or enable thresholds “*S*” or “*I*” of the electronic releases and use sufficiently low setting values;
- The color of the message will change in real time from red to black, when the protection relation has been verified.

Discrimination verification



Discrimination verification

Discrimination is achieved when both the following conditions are satisfied:

- The circuit-breakers have been selected by assigning them the discrimination restriction in the single-line diagram (Cf. Annex B, “LV circuit-breaker” chapter).
- The curve of the circuit-breaker on the supply side, in the Time-Current diagram, does not intersect that of the circuit-breaker on the load side

When the program warns that discrimination verification has failed, it is advisable to proceed as described below:

- Select the failed verification by ticking its box;
- The curves module will display the Time-Current diagram (I-t)
- Double click over the circuit-breaker on the supply side to access the window where its release is set.
- If the release is the thermal-magnetic type (“*Circuit-breaker with thermal magnetic relay*”), raise threshold “*I*” up to the maximum value allowed.
- If the release is the electronic type (“*Circuit-breaker with electronic relay*”), disable function “*I*”;
  - Once function “*I*” has been disabled, it is advisable to enable function “*S*” (protection against delayed short-circuit);
  - Raise threshold “*S*” both as to time and current until discrimination is obtained.
- The color of the message will change in real time from red to black, when the protection has been verified.

The hatched area appears in the diagram when a discrimination verification has been selected. This area represents the maximum discrimination value which can be achieved by the pair of circuit-breakers.

The maximum discrimination value is defined as:

- The magnetic setting of the circuit-breaker on the supply side minus the tolerance, if:
  - The circuit-breaker on the supply side has an electronic release and function "*I*" is enabled;
  - The circuit-breaker has a thermal-magnetic release and the magnetic threshold "*I*" setting is lower than the maximum value allowed.
- The discrimination value published in the ABB "*Coordination Tables*" if:
  - The circuit-breaker on the supply side has an electronic release and function "*I*" is disabled;
  - The circuit-breaker has a thermal-magnetic release and the magnetic threshold "*I*" setting equals the maximum value allowed.

Further Information about discrimination verification

The "*QT1 - Discrimination in low voltage with ABB circuit-breakers*" guide is available in the "*Help"* menu. You are advised to consult it for in-depth information on the subject.

Discrimination studies between MV Apparatus and LV Apparatus

The "*QT2 - MV/LV Substations: theory and short-circuit calculation examples*" guide is available in the "*Help"* menu. You are advised to consult it for in-depth information on the subject.

Inability to verify all the relations

It may not be possible to satisfy all the protection relations simultaneously, since a setting made to satisfy one of them may not allow others to be satisifed.

This can occur, for example, if both protection against indirect contacts and discrimination with circuit-breakers on the load side must be guaranteed using the same protection device: the former requires a low magnetic setting, whereas the latter requires high values or disablement of function "*I*".

It is advisable to:

- Replace the thermal-magnetic releases with microprocessor ones, which have more options during the setting stage.
- Use releases with the "*G*" function, which allows you to have high magnetic settings for discrimination verification and low magnetic settings for protection against indirect contacts.

Back-up verification

DOC is able to select circuit-breakers coordinated by means of back-up.
This relationship does not require any further verification: back-up is a function of the construction characteristics of the circuit-breakers and does not depend on the release settings.
The back-up value is declared by the Manufacturer in the ““*Coordination Tables*”.

Use with Ekip Connect of the circuit-breaker settings obtained with DOC

DOC files can be opened with the Ekip Connect application for the purpose of managing the electronic settings of ABB apparatus: the settings calculated by DOC will be visible to the application and can be transferred to the apparatuses after the required verifications have been performed by the user.

5.2. Data export options of the curves module

5.2.1. Exporting data from the diagram

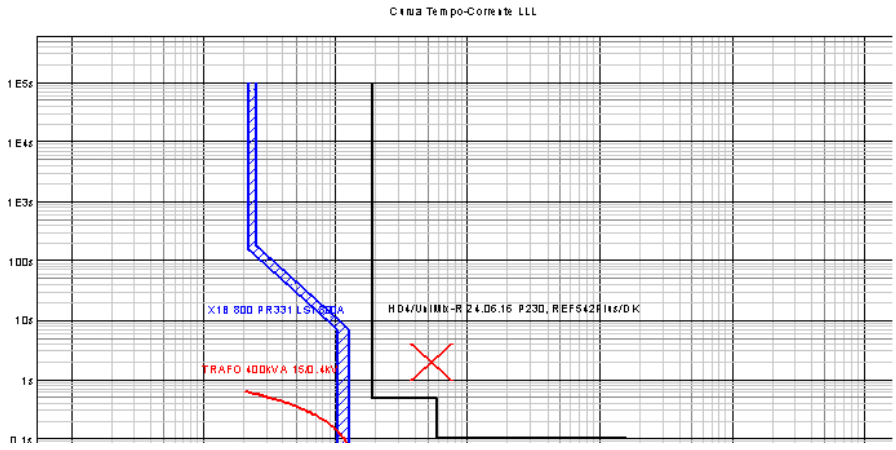
The curves module has two commands for exporting the diagram ("*Copy graph*") and the setting values ("*Copy values*").

Once copied, the graph or values are pasted into any application which supports MS Windows copy-paste.

Using these commands, you can create a customized document containing:

- The diagram shown on screen;
- The settings of the objects in the diagram;
- The verification currently selected (in this case, the objects visible will only be those involved in the relative verification).

InN: 50%
I1: 0.72
t1: 24s
S - off
I3: 4.00
-QF1.1, HD4/UniMix-R 24.06.16 P230, REF542Plus/DK
Tensione nominale: 11000 [V]
Circuito: LLL
Sistema di distribuzione: IT
I> - OFF
I>>
I>> 2.38
t>> 480.000
I>>>
I>>> 7.38
t>>> 101.000
Io>> - OFF



Document created by copy-paste of values and graph

5.2.2. Copying the diagram onto the single-line diagram

From the curves module, you can add the diagram currently displayed onto the single-line diagram, by means of the "*Draw*" icon.

Comply with the instructions below to draw a diagram in the single-line diagram:

- Select the page of the single-line diagram where you want to add the diagram, or create a new one.
- Launch the curves module.
- Select the objects to be displayed in the diagram.
- Select the "*Draw*" command.
- DOC will temporarily show the single-line diagram.
- Give an initial click to determine the vertex at the top left of the diagram.
- Give a second click to determine the second vertex of the diagram. After the second click, DOC will show the new curves module

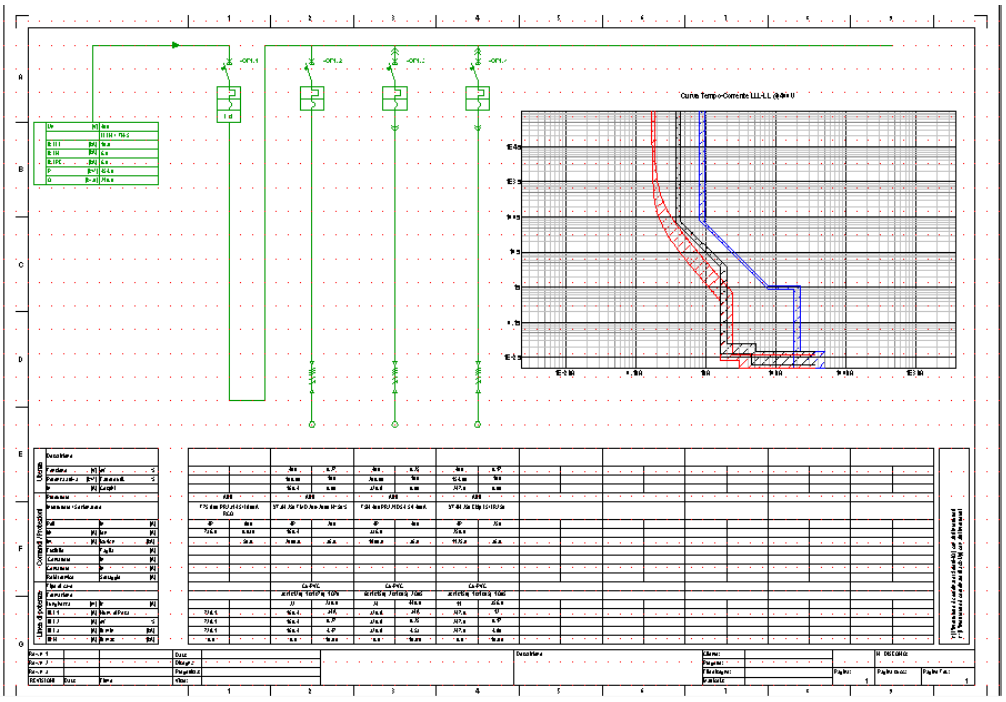


Diagram drawn in the single-line diagram

6. Drawing diagrams of auxiliaries

This chapter describes:

- the drawing functionalities not included in the power diagram.

After reading this chapter, the user will be able to:

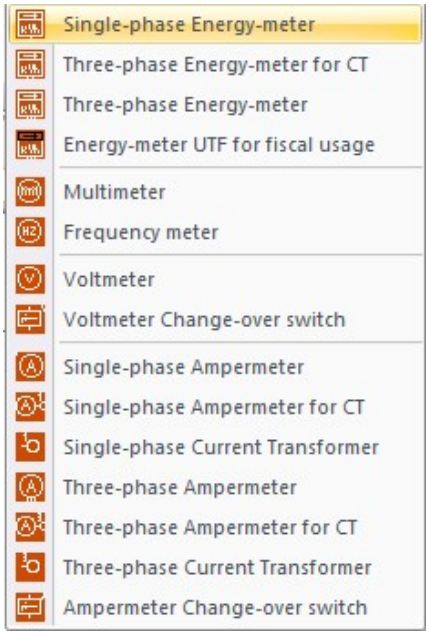
- add purely graphic symbols to the diagram;
- draw simple key diagrams.

6.1. Drawing the key diagram of the auxiliary circuits

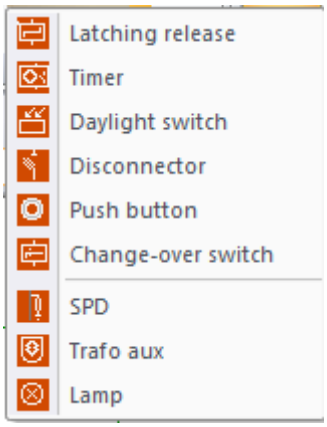
This chapter describes how DOC can be used for drawing key diagrams.

6.1.1. Symbol toolbar for key diagrams.

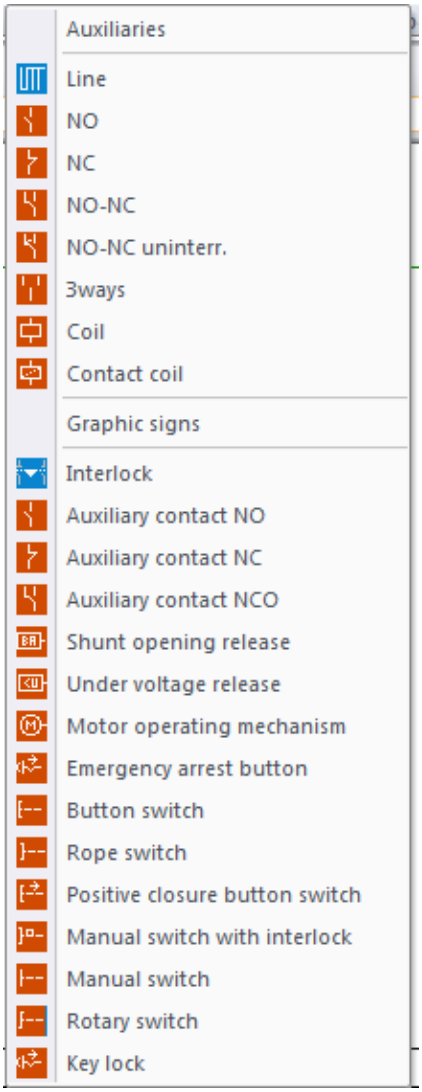
When drawing key diagrams, the first step is to access the "*Other apparatus*" menu of the "LV SYMBOLS" tab of the Ribbon area.
The "Measurement", "Control" and "Symbols" menus will now be available to the users.



"Measurement" menu



"Control" menu



"Symbols" menu

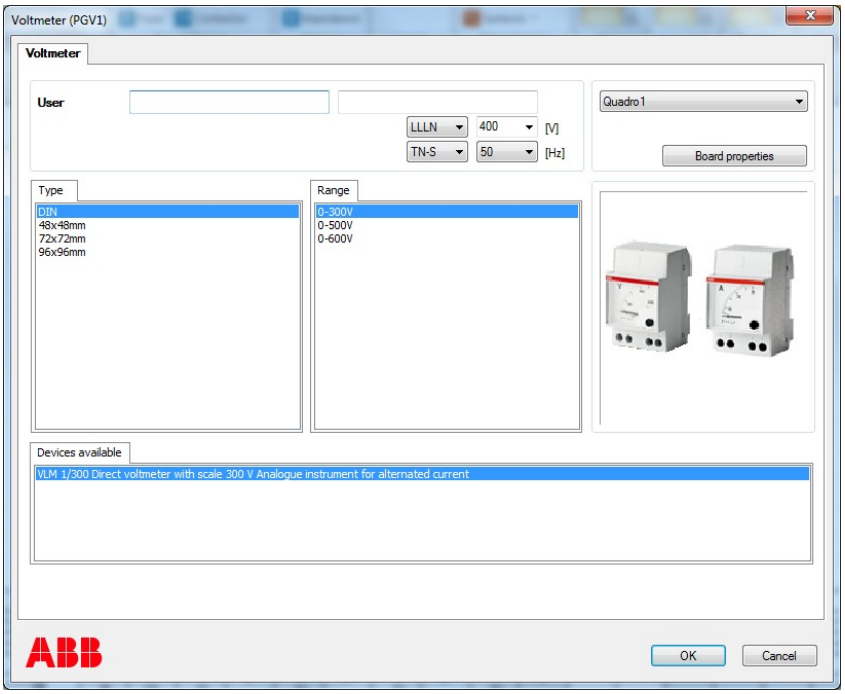
The devices in the "Control" and "Measure" menus must be completed with the product codes by means of the automatic window that DOC 3 automatically proposes.

Apparatus/devices with only one connection point need not be connected to the network obligatorily. On the other hand, devices with 2 connection points must be added to the network context so that they are shown to be correctly connected to it.

Key diagrams obtained with the “Symbols” menu allow you to draw purely Graphic Objects. Purely Graphic Objects are not considered in the drawing of the power single-line diagram, thus they do not affect the calculations in any way.

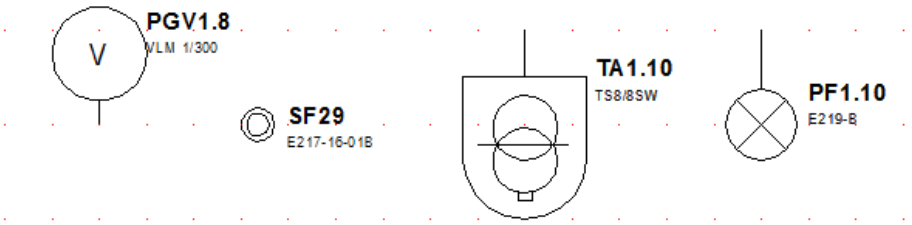
Use of the devices in the “Control” and “Measure” menus

Entry in the diagram of any of the devices in the “Control” and “Measure” menus results in automatic opening of a specific window for selecting products. In practice, the user is allowed to match the symbol to an ABB product.



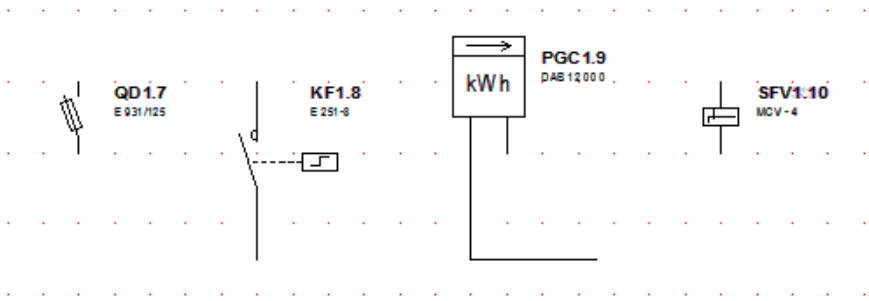
Product window that opens when a voltmeter is added to the diagram

Apparatus/devices with one single connection point need not be connected to the network obligatorily.



Volmeter, push-button, transformer and indicator light: examples of devices that are not obligatorily connected to the network

Apparatus/devices with 2 connection points must be connected to the network obligatorily



Disconnector, step-by-step relay, energy meter, voltage switch: examples of devices that must be obligatorily connected to the network

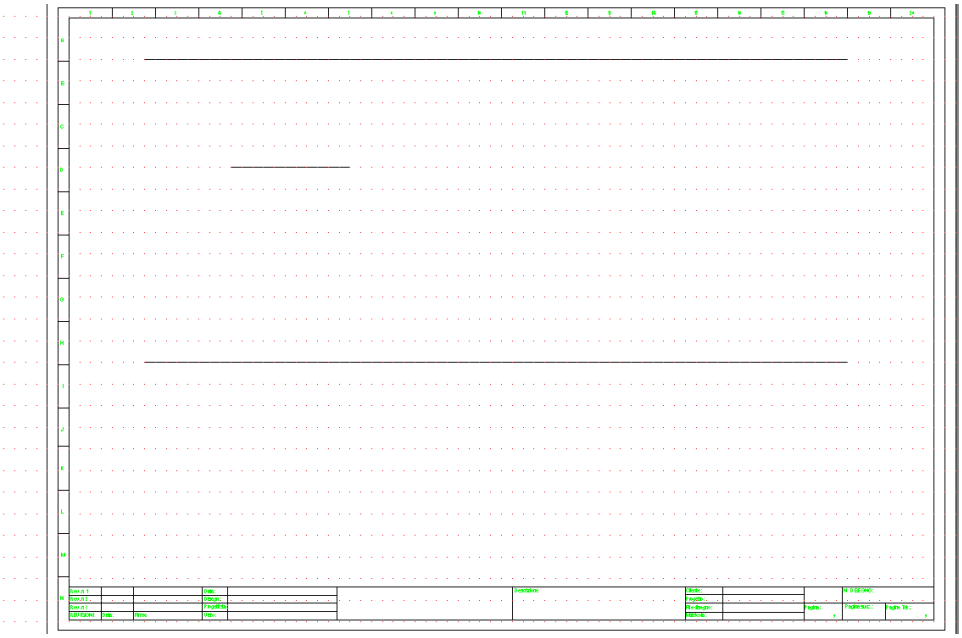
All apparatus defined by means of the “Control” and “Measure” menus are available to the user when the switchboard fronts are defined.

Connection of auxiliaries in the symbols menu

“*Connection of auxiliaries*” in the symbols menu is a particularly important graphic object since it represents the line that must be drawn in order to connect the objects in the auxiliaries diagram together.

6.1.2. Drawing of key diagrams

1) Select "*Connection of auxiliaries*" and draw the main lines of the diagram.



Main lines of a key diagram

2) Add the contacts and coils that must be drawn.

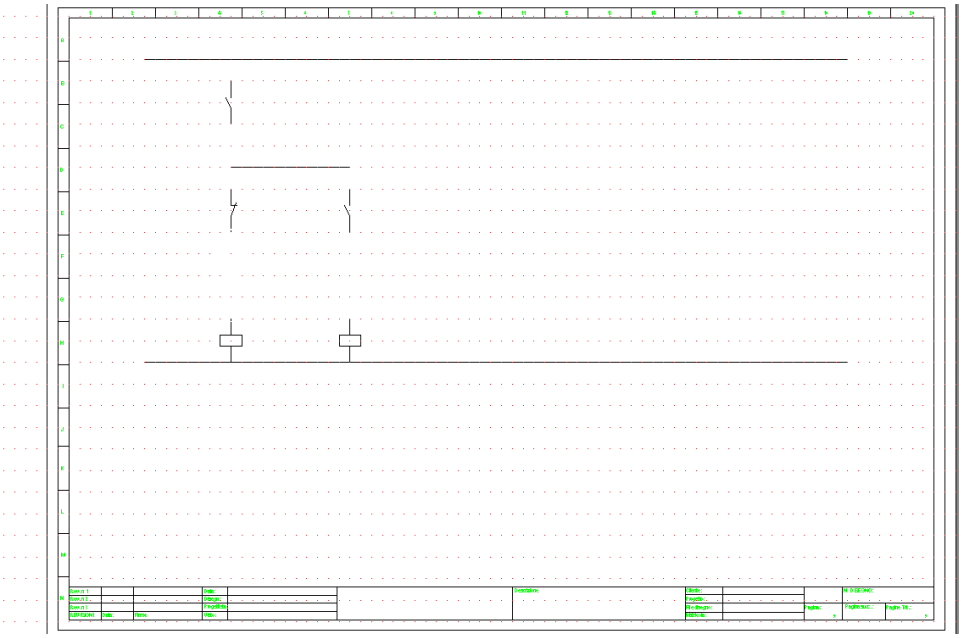
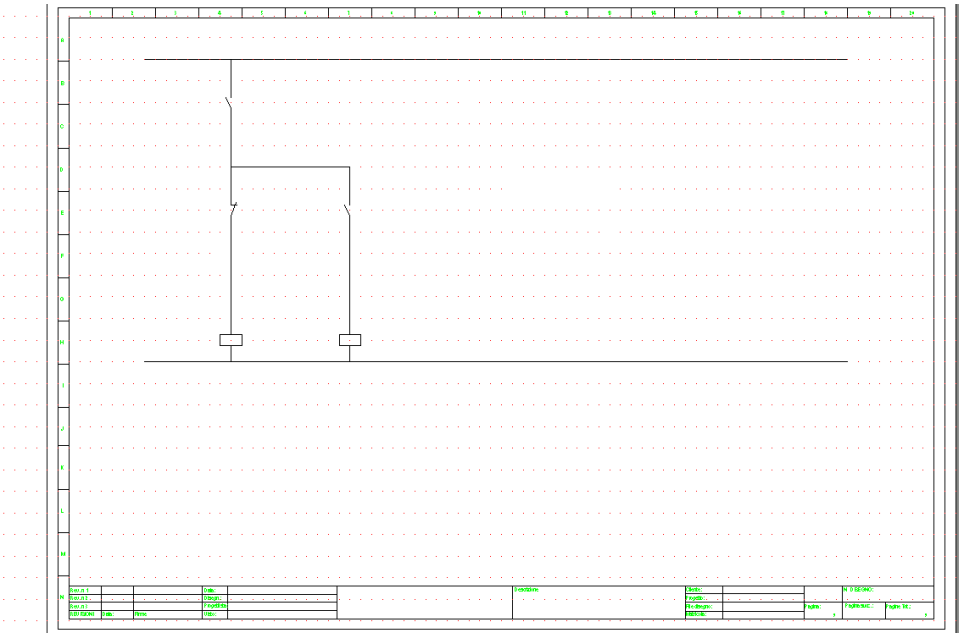


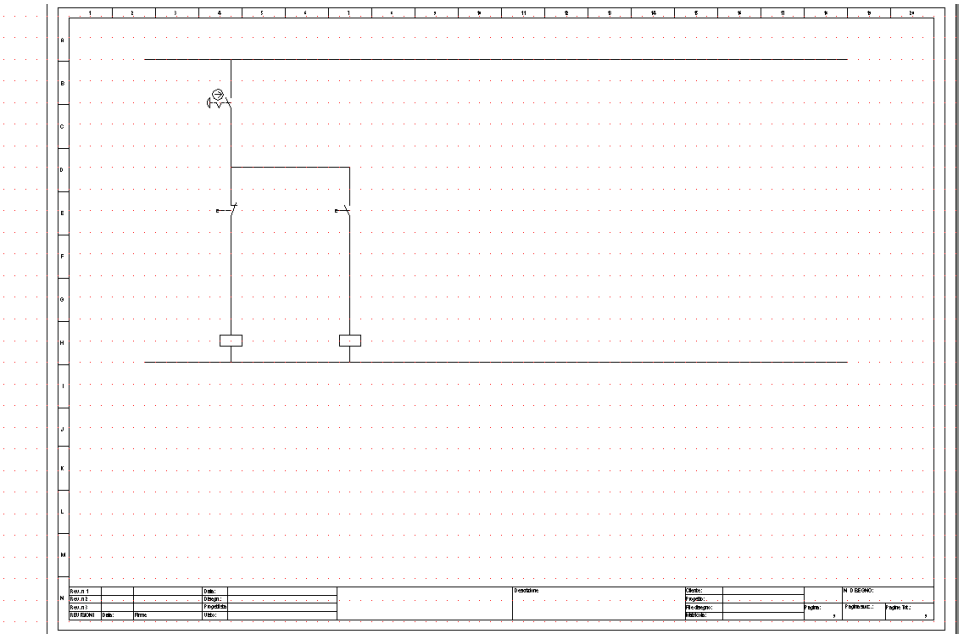
Diagram with contacts and coils

3) Close the diagram by adding "*Connections of Auxiliaries*"



Complete diagram

4) Finish the diagram by adding any "*Push-buttons*" required.



Complete diagram with push-buttons

5) Enter any explanatory texts required by means of the *"Text"* command in the *"Tools"* menu.

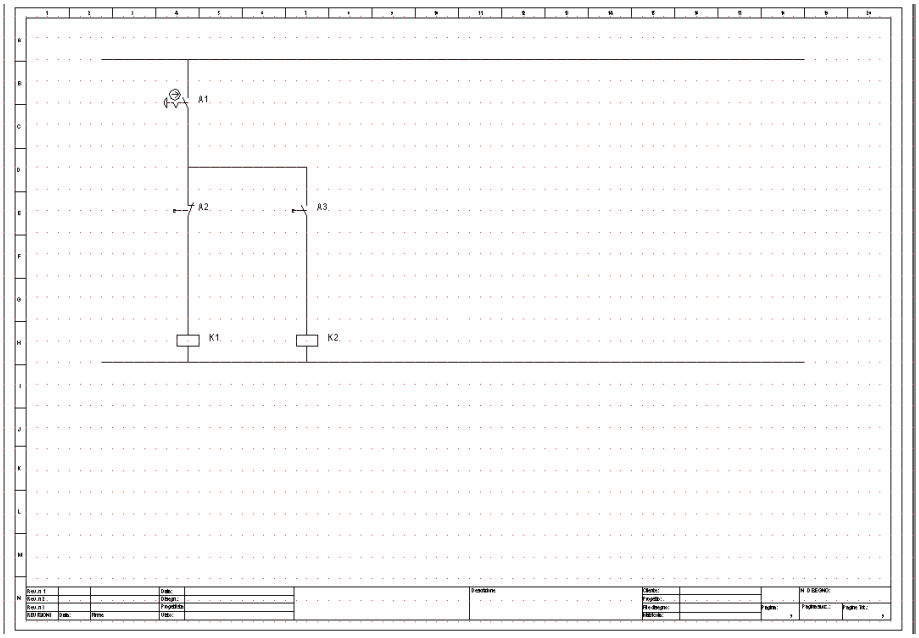
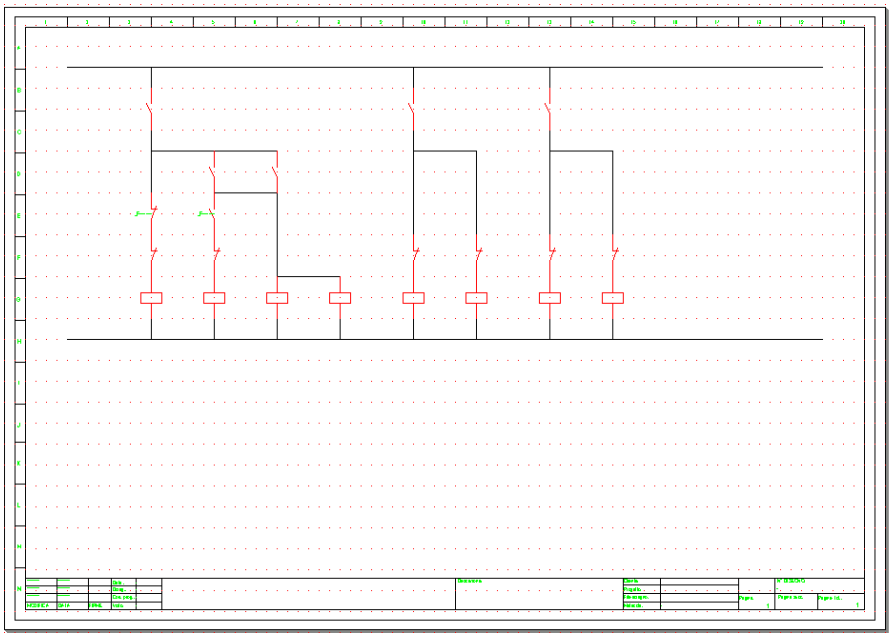


Diagram with texts



Example of motor start-up.

7. Printing of documentation and management of the design pages

This chapter describes:

- creation of documentation;
- the diagram and documentation printing functions;
- the diagram and project data exportation functions.

After reading this chapter, the user will be able to:

- use the "*Print manager*" command in Quick access;
- create the documentation of the single-line diagram;
- fill in the layouts to customize the printout;
- export the documentation in .xls format
- export the diagram and documentation in .pdf. format

Printer configuration

Before printing, you must configure your predefined printer.
Use the *"Print manager->Printer options…"* command in Quick access. The command for setting up the predefined printer is also available in the "Print manager" window

7.1. Print manager

Once the drawing, calculation and verification stages of the plant are completed, you can proceed to print the project documentation.
The printing functions are available using the "*Print manager*" command in Quick access.

With DOC, the project does not only comprise the single-line diagram, but also of other sections which can be included and then printed as you like.
The Sections available are:

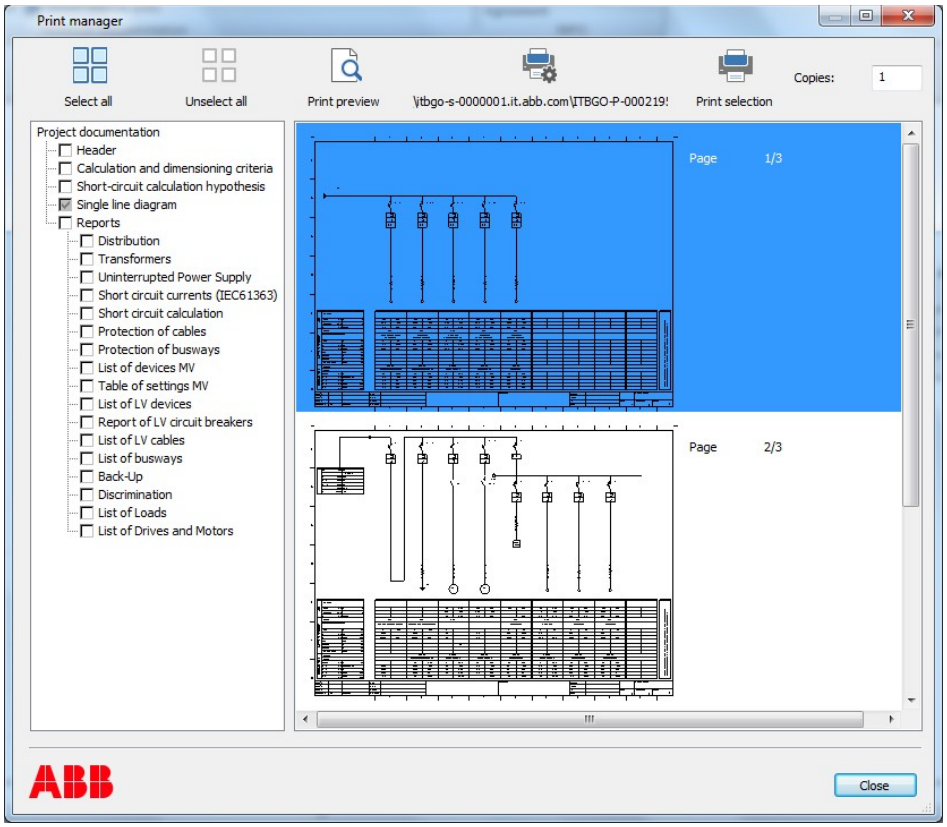
- **Header** (Cf. Chapter 7.2.1 "Header");
- **Dimensioning and verification criteria** (Cf. Chapter 7.2.2 Printout *of* "*Dimensioning and verification criteria"* section" section);
- **Short-circuit calculation hypothesis** (Cf. Chapter **Error! Reference source not found. Error! Reference source not found.** section);
- **Single-line diagram**;

and with regard to Reporting…

- **Utility**
- **Transformers**
- **UPS**
- **Short-circuit currents (IEC1363)**
- **Short-circuit calculation** (Cf. Chapter **Error! Reference source not found. Error! Reference source not found.** section);
- **Cable protection**
- **Busbar duct protection**
- **List of MV products** (Cf. Chapter 7.2.5 Printout of*Printout of the "List* of MV *devices" and "List* of LV devices" sections);
- **MV circuit-breaker-relay table** (Cf. Chapter 7.2.6 Printout of *the "List of MV Circuit-breakers and relays*" section);
- **List of LV products** (Cf. Chapter 7.2.5 Printout of *the "List of MV* devices" *and "List of LV devices"*);
- **List of LV circuit-breakers** (Cf. Chapter **Error! Reference source not found. Error! Reference source not found.**);
- **List of LV cables** (Cf. Chapter **Error! Reference source not found. Error! Reference source not found.**);
- **Busways**
- **Back-Up**
- **Discrimination**
- **Loads**

- **List of Drives and Motors**

To add a Section to the project, simply click over the ticking off box on the left of each Section. This will generate one or more pages, whose previews will be immediately visible in the central part of the *"Print manager"*.



Print manager: the list of the Sections available is visible on the left with the relative ticking off box to include / exclude them from the documentation

7.2. Creation of the project documentation

"*Print manager*" allows you to add and remove sections to and from the project document you intend to print. The sections added to the project document will be displayed in print Preview.

The program proposes three header sections for the project and seventeen technical sections for printing all the accumulated codes, calculations and verifications

A series of print examples of the project headers and certain of the more significant technical sections is given below.

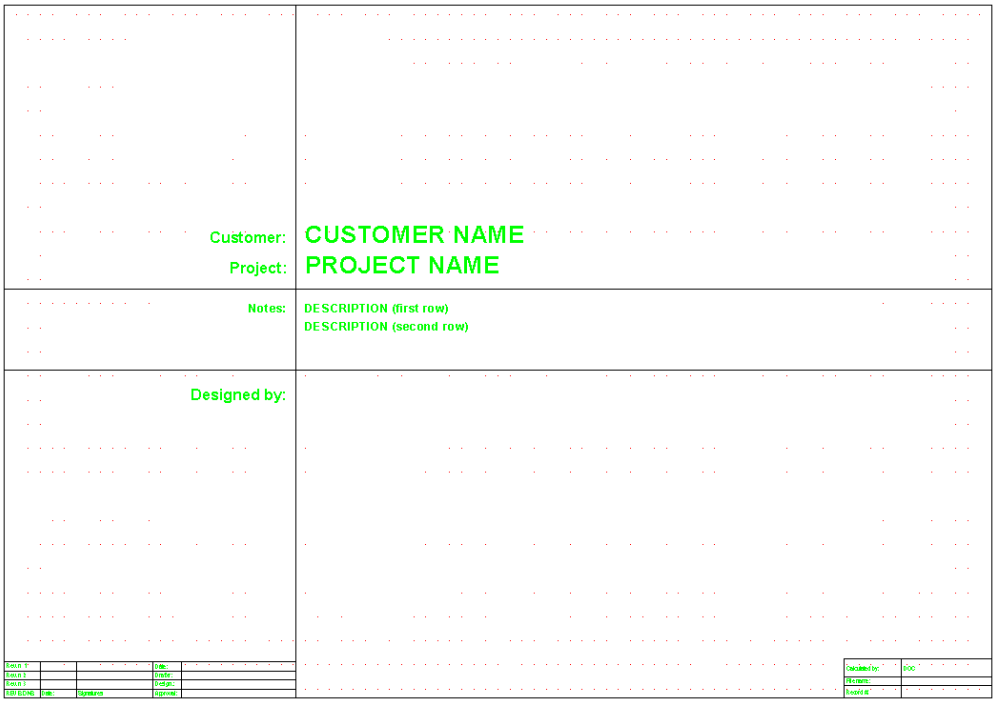
"Single-line Diagram" section

The "Single-line diagram" section is the only one that cannot be removed from the project because it is the essence of the project itself.
However, you can decide not to print it (Cf. Chapter 7.3).

7.2.1. “Header” section printout

This is the first page of the project documentation and contains the user, customer and project data.

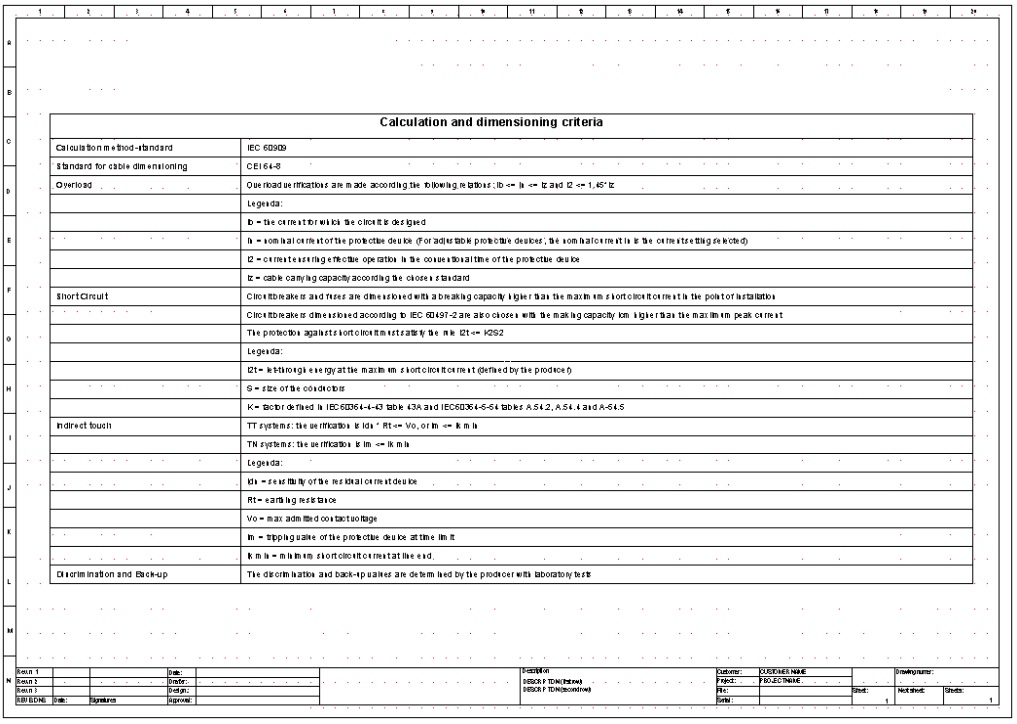
To fill in the data, see chapter 7.4.



Header

7.2.2. Printout of “Dimensioning and verification criteria” section”

Describes the Standards and the main parameters used for the calculations and verifications.
Printed together with the “Cable Verification” Section, it allows the positive outcome of the verifications to be justified.



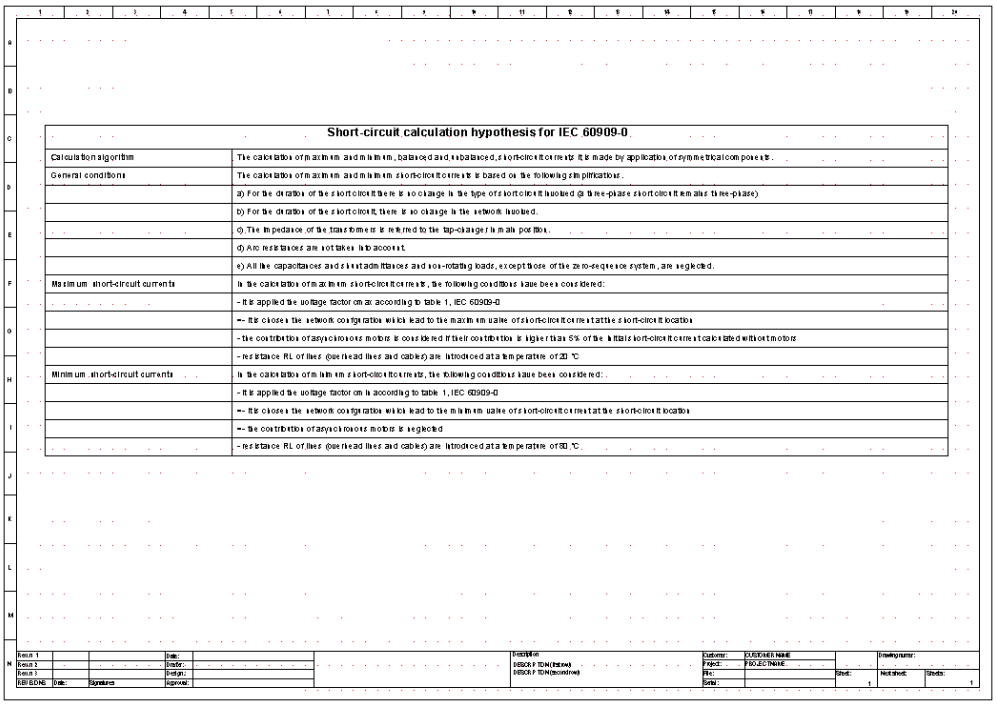
Calculation and dimensioning criteria

Calculation method-standard	IEC 60909
Standard for cable dimensioning	CEI 64-8
Overload	Overload verifications are made according the following relations: Ib <= In <= Iz and I2 <= 1,45* Iz
	Legenda:
	Ib = the current for which the circuit is designed
	In = nominal current of the protective device (For adjustable protective devices, the nominal current In is the current setting selected)
	I2 = current ensuring effective operation in the conventional time of the protective device
	Iz = cable carrying capacity according the chosen standard
Short Circuit	Circuit breakers and fuses are dimensioned with a breaking capacity higher than the maximum short circuit current in the point of installation
	Circuit breakers dimensioned according to IEC 60497-2 are also chosen with the making capacity Icm higher than the maximum peak current
	The protection against short circuit must satisfy the rule I2t <= K2S2
	Legenda:
	I2t = let-through energy at the maximum short circuit current (defined by the producer)
	S = size of the conductor
	K = factor defined in IEC 60364-4-43 table 43A and IEC 60364-5-54 tables A.54.2, A.54.4 and A-54.5
Indirect touch	TT systems: the verification is Ida * Rt <= Vo, or Im <= Ik m in
	TN systems: the verification is Im <= Ik m in
	Legenda:
	Ida = sensibility of the residual current device
	Rt = earthing resistance
	Vo = max admitted contact voltage
	Im = tripping value of the protective device at time Im t
	Ik m in = minimum short circuit current at line end.
Discrimination and Back-up	The discrimination and back-up values are determined by the producer with laboratory tests

Dimensioning and verification criteria

7.2.3. Printout of the “Short-circuit calculation hypothesis” section

The short-circuit calculation hypothesis section takes the general conditions and the calculation hypotheses for the maximum and minimum short-circuit currents from Standard CEI 11-25 (CEI EN 60909).



Short-circuit calculation hypothesis for IEC 60909-0

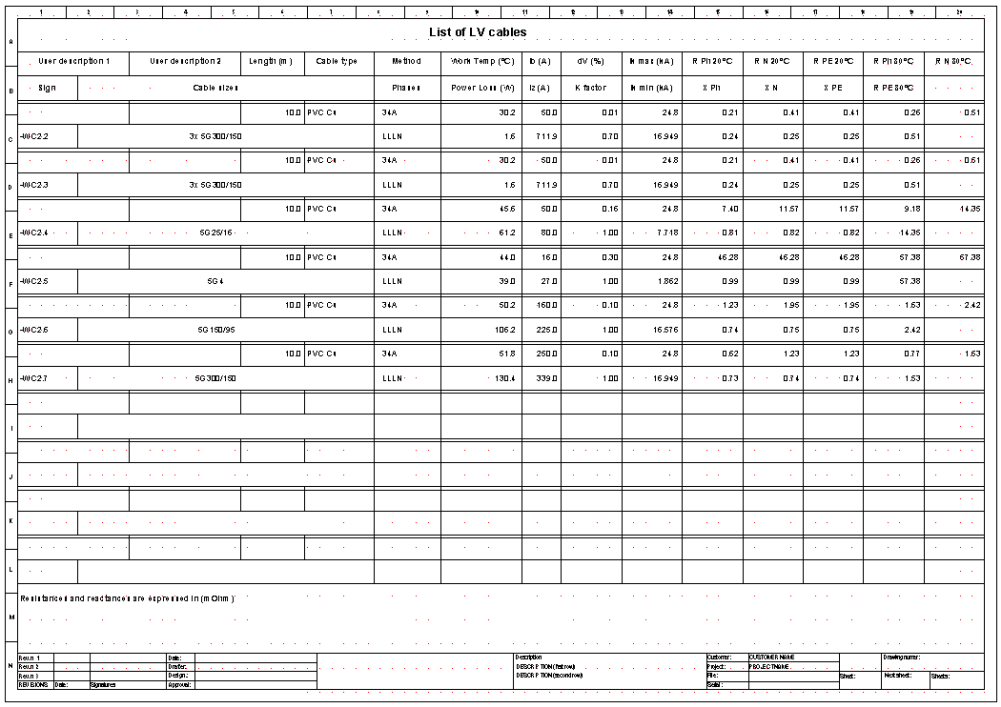
Calculation algorithm	The calculation of maximum and minimum, balanced and unbalanced, short-circuit currents it is made by application of symmetrical components.
General conditions	The calculation of maximum and minimum short-circuit currents is based on the following simplifications:
	a) For the duration of the short-circuit there is no change in the type of short-circuit involved (a three-phase short-circuit remains three-phase)
	b) For the duration of the short-circuit, there is no change in the network involved.
	c) The impedance of the transformers is referred to the tap-changer in main position.
	d) Arc resistances are not taken into account.
	e) All the capacitances and shunt admittances and non-rotating loads, except those of the zero-sequence system, are neglected.
Maximum short-circuit currents	In the calculation of maximum short-circuit currents, the following conditions have been considered:
	- It is applied the voltage factor cmax according to table 1, IEC 60909-0
	-- It is chosen the network configuration which lead to the maximum value of short-circuit current at the short-circuit location
	- the contribution of asynchronous motors is considered if their contribution is higher than 5% of the initial short-circuit current calculated without motors
	- resistance RL of lines (overhead lines and cables) are introduced at a temperature of 20 °C
Minimum short-circuit currents	In the calculation of minimum short-circuit currents, the following conditions have been considered:
	- It is applied the voltage factor cmin according to table 1, IEC 60909-0
	-- It is chosen the network configuration which lead to the minimum value of short-circuit current at the short-circuit location
	-- the contribution of asynchronous motors is neglected
	- resistance RL of lines (overhead lines and cables) are introduced at a temperature of 80 °C.

Short-circuit calculation hypothesis

7.2.4. Printout of the “List of LV cables” section

This presents the main data of the cables in the single-line diagram in a single list:

- Sections;
- Insulating material;
- Conductor material;
- Number of installations as defined in the selected Standard;
- Carrying capacity;
- Operating temperature;
- Dissipated power;
- Voltage drop percentage;
- Resistances and reactances.



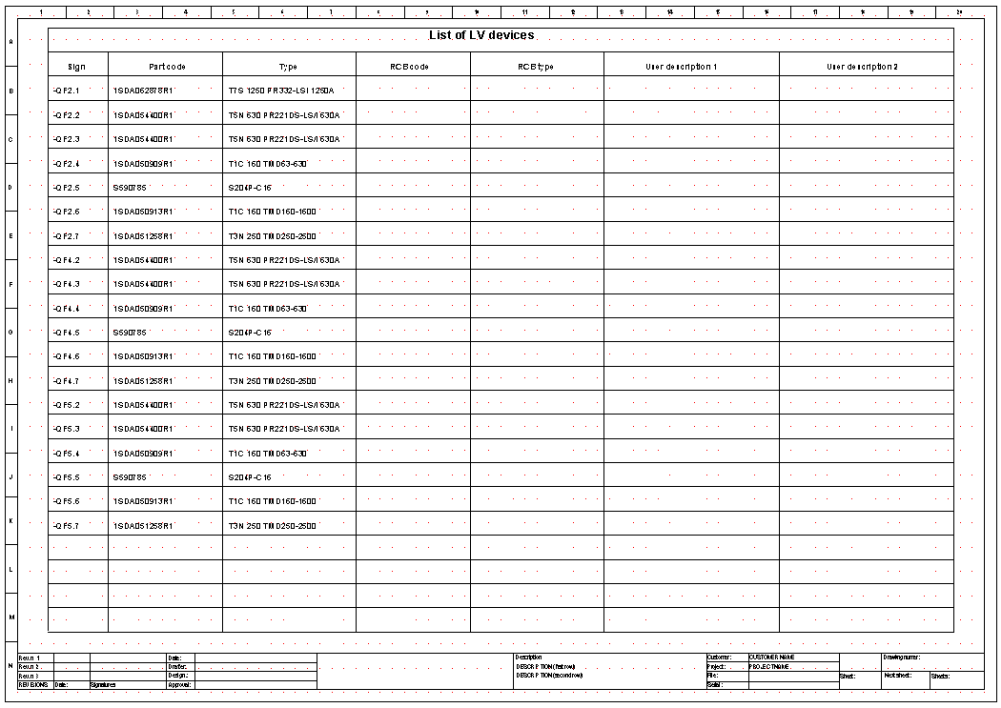
List of LV cables

User description 1	User description 2	Length (m)	Cable type	Method	Work Temp (°C)	Ib (A)	dV (%)	Ik max (kA)	R Ph 20°C	R N 20°C	R PE 20°C	R Ph 80°C	R N 80°C
Sign	Cable sizes			Phases	Power Loss (W)	Iz (A)	K factor	Ik min (kA)	Σ Ph	Σ N	Σ PE	R PE 80°C	
		10.0	PVC Cu	3+A	30.2	50.0	0.01	24.8	0.21	0.41	0.41	0.26	0.51
-MVC2.2	3x SQ300/150			LLLN	1.6	711.9	0.70	16.949	0.24	0.26	0.26	0.51	
		10.0	PVC Cu	3+A	30.2	50.0	0.01	24.8	0.21	0.41	0.41	0.26	0.51
-MVC2.3	3x SQ300/150			LLLN	1.6	711.9	0.70	16.949	0.24	0.26	0.26	0.51	
		10.0	PVC Cu	3+A	45.6	50.0	0.16	24.8	7.40	11.57	11.57	9.18	14.35
-MVC2.4	SQ25/16			LLLN	61.2	80.0	1.00	7.718	0.81	0.82	0.82	14.35	
		10.0	PVC Cu	3+A	44.0	16.0	0.30	24.8	46.28	46.28	46.28	67.38	67.38
-MVC2.5	SQ4			LLLN	39.0	27.0	1.00	1.862	0.99	0.99	0.99	67.38	
		10.0	PVC Cu	3+A	50.2	160.0	0.10	24.8	1.23	1.95	1.95	1.53	2.42
-MVC2.6	SQ150/95			LLLN	106.2	225.0	1.00	16.576	0.74	0.76	0.76	2.42	
		10.0	PVC Cu	3+A	51.8	250.0	0.10	24.8	0.62	1.23	1.23	0.77	1.53
-MVC2.7	SQ300/150			LLLN	130.4	339.0	1.00	16.949	0.73	0.74	0.74	1.53	

Resistances and reactances are expressed in (m Ohm)

7.2.5. Printout of the “List of MV devices” and “List of LV devices” section

The two Sections provide the lists of MV and LV devices in the single-line diagram, complete with ordering codes and description.

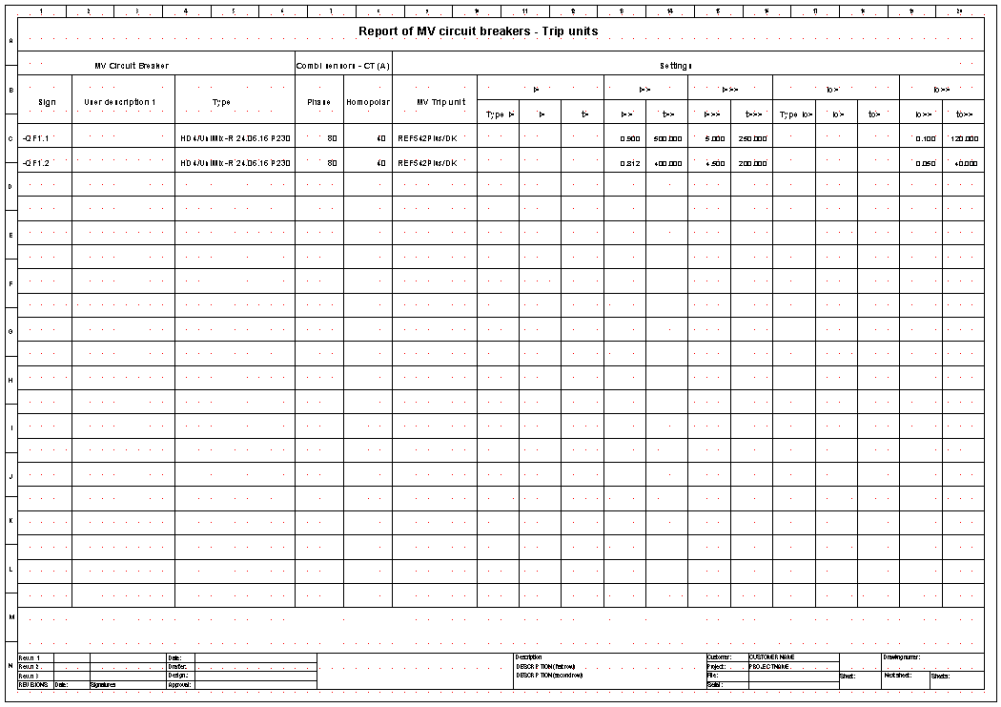


List of LV devices

Sign	Part code	Type	RCB code	RCB type	User description 1	User description 2
-Q F2.1	1SDA062878R1	TTS 1250 PR332-LSI 1250A				
-Q F2.2	1SDA054400R1	T5N 630 PR221DS-LSI 630A				
-Q F2.3	1SDA054400R1	T5N 630 PR221DS-LSI 630A				
-Q F2.4	1SDA050909R1	T1C 160 TMD63-630				
-Q F2.5	S690T86	S200P-C 16				
-Q F2.6	1SDA050913R1	T1C 160 TMD16-160				
-Q F2.7	1SDA051258R1	T3N 250 TMD250-250				
-Q F4.2	1SDA054400R1	T5N 630 PR221DS-LSI 630A				
-Q F4.3	1SDA054400R1	T5N 630 PR221DS-LSI 630A				
-Q F4.4	1SDA050909R1	T1C 160 TMD63-630				
-Q F4.5	S690T86	S200P-C 16				
-Q F4.6	1SDA050913R1	T1C 160 TMD16-160				
-Q F4.7	1SDA051258R1	T3N 250 TMD250-250				
-Q F5.2	1SDA054400R1	T5N 630 PR221DS-LSI 630A				
-Q F5.3	1SDA054400R1	T5N 630 PR221DS-LSI 630A				
-Q F5.4	1SDA050909R1	T1C 160 TMD63-630				
-Q F5.5	S690T86	S200P-C 16				
-Q F5.6	1SDA050913R1	T1C 160 TMD16-160				
-Q F5.7	1SDA051258R1	T3N 250 TMD250-250				

7.2.6. Printout of the “List of MV Circuit-breakers and relays” section

Provides the list of the “*MV Circuit-breakers*”, MV relays with relative CT and HCT and shows the setting of each individual relay grouped together by function.



Report of MV circuit breakers - Trip units

MV Circuit Breaker			Combinations - CT (A)			Settings													
						I>			I>>		I>>>		Io>			Io>>			
Sign	User description 1	Type	Phase	Homopolar	MV Trip unit	Type I>	I>	t>	I>>	t>>	I>>>	t>>>	Type Io>	Io>	to>	Io>>	to>>		
-QF1.1		HD4/Unimix-R 24.D6.16 P230	80	40	REF542Plus/DK				0.900	600.000	6.000	250.000				0.100	120.000		
-QF1.2		HD4/Unimix-R 24.D6.16 P230	80	40	REF542Plus/DK				0.812	400.000	4.500	200.000				0.050	40.000		

List of MV circuit-breakers and relays

7.2.7. Printout of the “List of LV circuit-breakers” section

Provides the list of “*LV circuit-breakers*” and the settings of the relative releases grouped together by function.

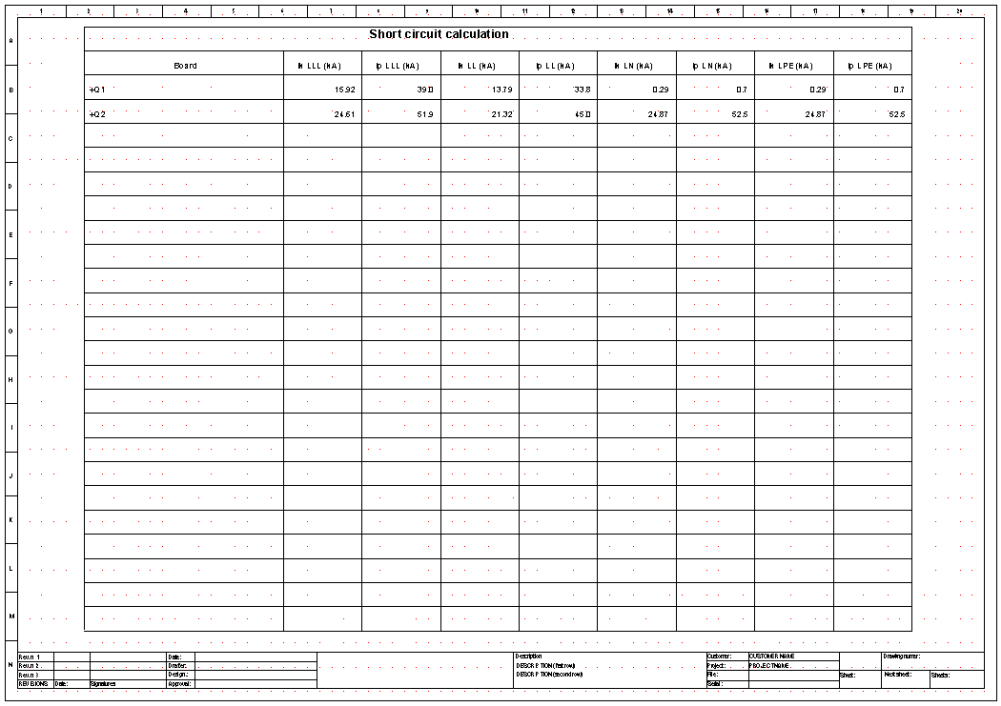
Report of LV circuit breakers

Circuit Breaker						Thermomagnetic	Electronic												RCB device	
Sign	Enclosure	Poles	In (A)	Icu-Ics (kA)	Ik (kA)	Thermal (A)	L	t1	S	t2	S2	t2-2	I	G	t4	R	t5	In/In (%)	Id (A)	Td (s)
Type			User description 1			Magnetic (A)	Curve L	t1	Curve S	t2	Curve S2	t2-2	Curve G	t4		t5		RCB type		
-QF3.1	+Q2	4P	1250.0	50.0	50.0		On	0.93	On	2.00			Off					50		
TFS 1250 PR332-LSI 1250A							1250A	18s	t constant	0.10s			4.00							
-QF3.2	+Q2	4P	630.0	36.0	0.0		On	0.40	Off				On					50		
TSN 630 PR221DS-LSI/630A								3s					4.50							
-QF3.3	+Q2	4P	630.0	36.0	0.0		On	0.40	Off				On					50		
TSN 630 PR221DS-LSI/630A								3s					4.50							
-QF3.4	+Q2	4P	66.2	25.0	25.0	50.0	On		Off									50		
TIC 160 TM D63-630						630.0														
-QF3.5	+Q2	4P	16.0	25.0	12.5	16.0	On		Off									50		
S204P-C16						120.0														
-QF3.6	+Q2	4P	168.0	25.0	25.0	160.0	On		Off									50		
TIC 160 TM D160-1600						1600.0														
-QF3.7	+Q2	4P	263.2	36.0	27.0	250.0	On		Off									50		
T3N 250 TM D250-2500						2500.0														
-QF4.2	+Q2	4P	630.0	36.0	0.0		On	0.40	Off				On					50		
TSN 630 PR221DS-LSI/630A								3s					4.50							
-QF4.3	+Q2	4P	630.0	36.0	0.0		On	0.40	Off				On					50		
TSN 630 PR221DS-LSI/630A								3s					4.50							
-QF4.4	+Q2	4P	66.2	25.0	25.0	50.0	On		Off									50		
TIC 160 TM D63-630						630.0														

Table of LV circuit-breakers

7.2.8. Printout of the “Short-circuit calculations” section

The short-circuit and peak currents for three-phase, two-phase, phase-neutral and phase-PE faults are indicated for every switchboard in the single-line diagram



Short circuit calculation

Board	Ik LLL (kA)	Ip LLL (kA)	Ik LL (kA)	Ip LL (kA)	Ik LN (kA)	Ip LN (kA)	Ik LPE (kA)	Ip LPE (kA)
+Q1	15.92	39.0	13.79	33.8	0.29	0.7	0.29	0.7
+Q2	24.61	51.9	21.32	45.0	24.87	52.5	24.87	52.5

Short-circuit calculations

How to print a short-circuit result in any point of the diagram

A “*Busbar*” Single Object must be added at the point where you want to verify the short-circuit value: DOC interprets the “*Busbar*” Single Object as a new Switchboard, which will be added to the list of Switchboards in the *“Short-circuit calculations”* Section.

7.2.9. Printout of the “Verifications table” section

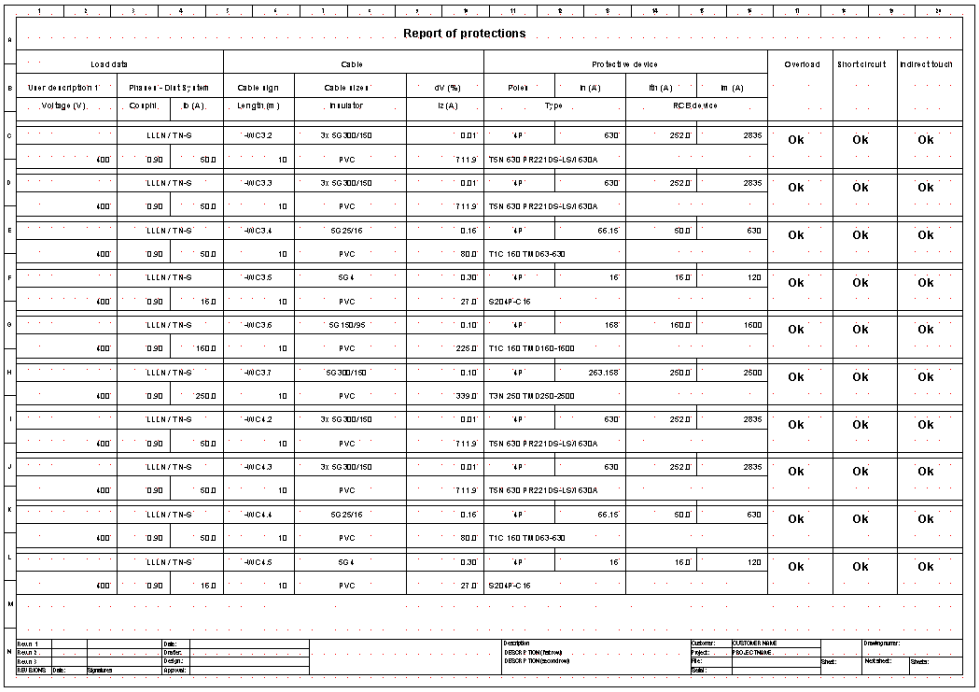
This shows the state of the verifications of the protection reports for every “*LV cable*” drawn in the single-line diagram.

The verification table consists of:

- User data
- Cable data
- Protection device data (circuit-breaker or fuse)
- State of the verification of protection against SC, CC, CI-TN, CI-TT

The state of the verifications can be:

- “*OK*” if the verification is positive
- “-“ in the case of negative verification



Report of protections

Load data				Cable			Protective device				Overload	Short-circuit	Indirect touch
User description	Phases - Dist.System			Cable sign	Cable size	dV (%)	Poles	In (A)	Ifit (A)	Im (A)			
Voltage (V)	Cosphi	Ib (A)		Length (m)	Insulator	Iz (A)	Type		RCBdevice				
	LLLN / TN-S			-WC3.2	3x SG300/150	0.01	4P	630	252.0	2835	Ok	Ok	Ok
400	0.90	50.0		10	PVC	711.9	TSN 630 PR221DS-LSI/630A						
	LLLN / TN-S			-WC3.3	3x SG300/150	0.01	4P	630	252.0	2835	Ok	Ok	Ok
400	0.90	50.0		10	PVC	711.9	TSN 630 PR221DS-LSI/630A						
	LLLN / TN-S			-WC3.4	SG 25/16	0.16	4P	66.15	50.0	630	Ok	Ok	Ok
400	0.90	50.0		10	PVC	80.0	T1C 160 TM D63-630						
	LLLN / TN-S			-WC3.5	SG 4	0.30	4P	16	16.0	120	Ok	Ok	Ok
400	0.90	16.0		10	PVC	21.0	S204P-C 16						
	LLLN / TN-S			-WC3.6	SG 150/95	0.10	4P	168	160.0	1600	Ok	Ok	Ok
400	0.90	160.0		10	PVC	225.0	T1C 160 TM D160-1600						
	LLLN / TN-S			-WC3.7	SG 300/150	0.10	4P	263.158	250.0	2500	Ok	Ok	Ok
400	0.90	250.0		10	PVC	339.0	T3N 250 TM D250-2500						
	LLLN / TN-S			-WC4.2	3x SG300/150	0.01	4P	630	252.0	2835	Ok	Ok	Ok
400	0.90	50.0		10	PVC	711.9	TSN 630 PR221DS-LSI/630A						
	LLLN / TN-S			-WC4.3	3x SG300/150	0.01	4P	630	252.0	2835	Ok	Ok	Ok
400	0.90	50.0		10	PVC	711.9	TSN 630 PR221DS-LSI/630A						
	LLLN / TN-S			-WC4.4	SG 25/16	0.16	4P	66.15	50.0	630	Ok	Ok	Ok
400	0.90	50.0		10	PVC	80.0	T1C 160 TM D63-630						
	LLLN / TN-S			-WC4.5	SG 4	0.30	4P	16	16.0	120	Ok	Ok	Ok
400	0.90	16.0		10	PVC	21.0	S204P-C 16						

Verification report

The “OK”s are not shown

When DOC fails to show the “OK”s in the report, the cable protection must be verified by accessing the curves module at least once (Cf. Chapter 5).

7.3. Print Preview

The central part of the "*Print manager*" shows the print Preview of all the pages created, both of the single-line diagram and the project document sections.
You can create selection groups consisting of one or more pages in the print Preview area.

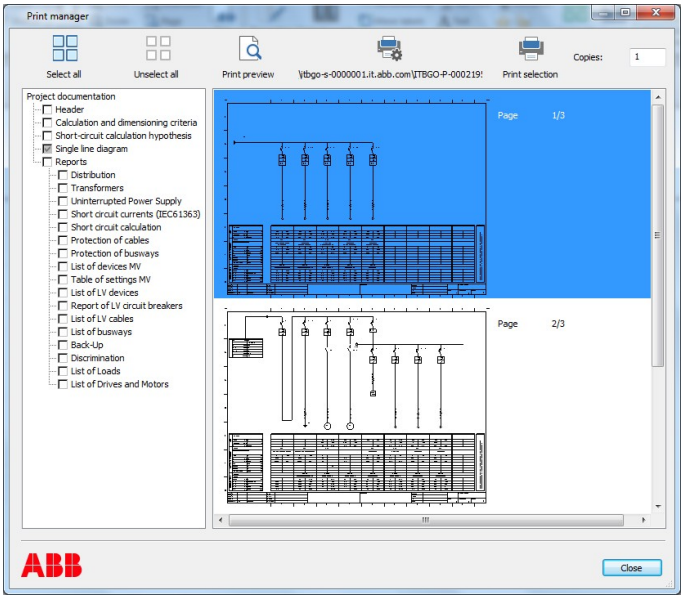
Advice about Page selection

As well as the "*Select all*" and "*Deselect all*" commands, which allow all the Pages of the project to be selected and deselected, you can use the SHIFT and CTRL keys to select several Pages, even when they are not next to each other.

Keep CTRL pressed and click over a Page, to add this latter to the list of Pages selected. If the page has already been selected, it will be deselected.

You can add several pages to the selection using the SHIFT key:

- Click over the first page you want to select;
- Keep SHIFT pressed.
- Click over the last page you want to select.



Page selected, with blue background – Page deselected, with white background

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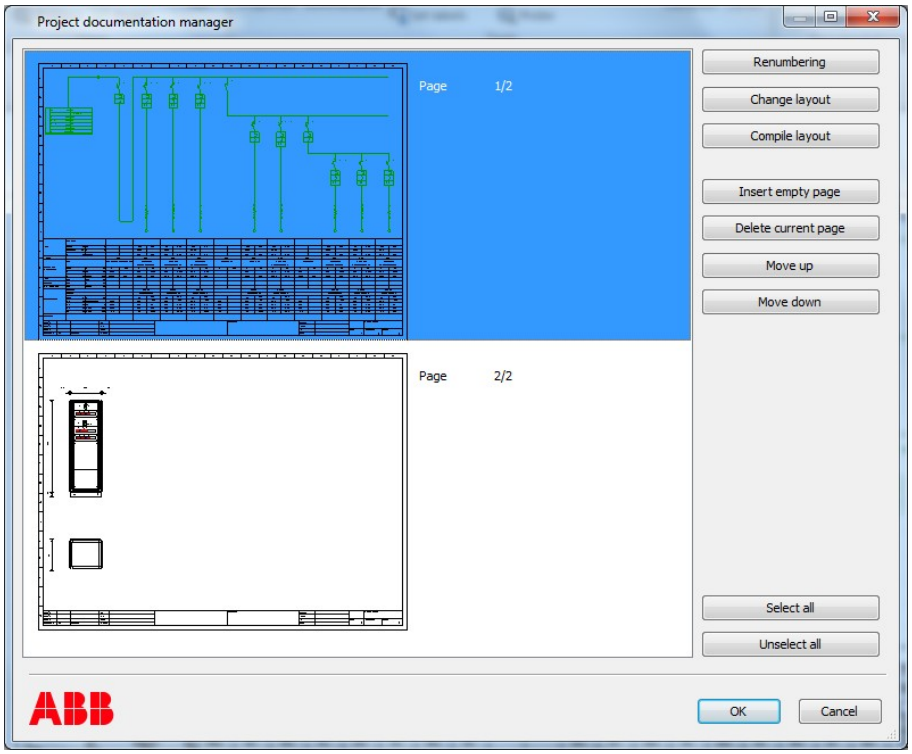
7.4. Project documentation manager window

The project documentation manager window is enabled by means of the “Document manager” command in the menu of the same name in the “HOME” tab of the ribbon area.



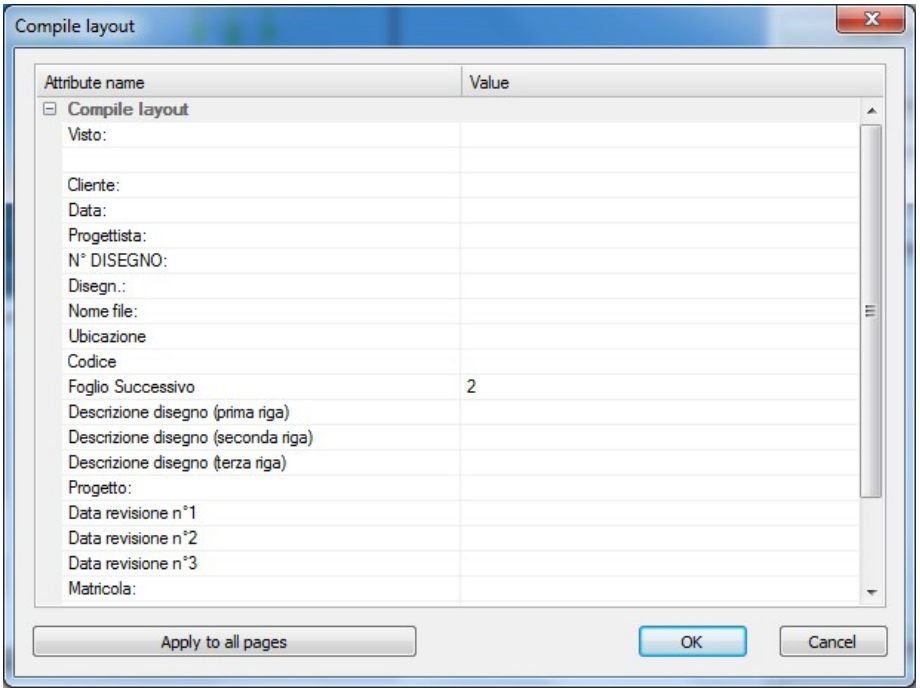
Project documentation manager window

The project documentation manager commands in this window allow you to change the project pages as defined in the DOC project context.

List and description of the commands

- **Renumber pages**: Changes the single-line diagram page numbering.
- **Layout selection**: similarly to the *“Change layout – page dimensions”* command in the *“Home”* tab of the *“Document manager”* menu, changes the layout of the Pages selected in the print preview.
- **Compile layout**: allows the layout of each Page and the “*Header*” Section to be compiled. Once the command has been launched, simply double click in the “*Present Value*” column and type in the data.

The command has effect on the selected Pages. You can therefore select all the Pages and compile them all at once.

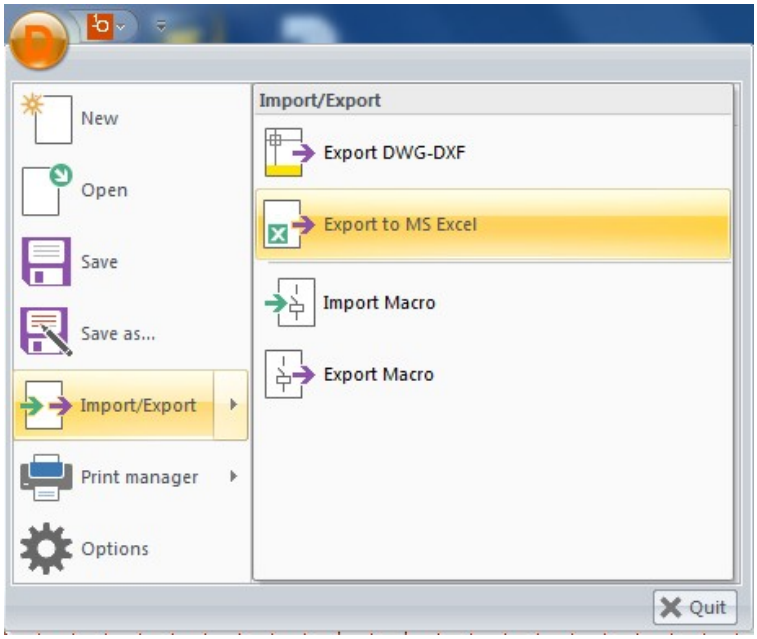


Window for compiling the layout

- **Add empty page**: Adds a page to the single-line diagram in exactly the same way as the *"Add page"* command of the *"Home"* tab in the *"Document manager"* menu**.**
- **Delete current page**: Removes all the selected pages of the single-line diagram. You are therefore advised to use this command with extreme caution. If pages have been removed by mistake, quit the project documentation manager window by clicking on the "Cancel" button: the cancelled pages will be restored.
- **Move Up – Move Down**: Allow the selected pages to be moved up or down, respectively.

7.5. Export in Excel

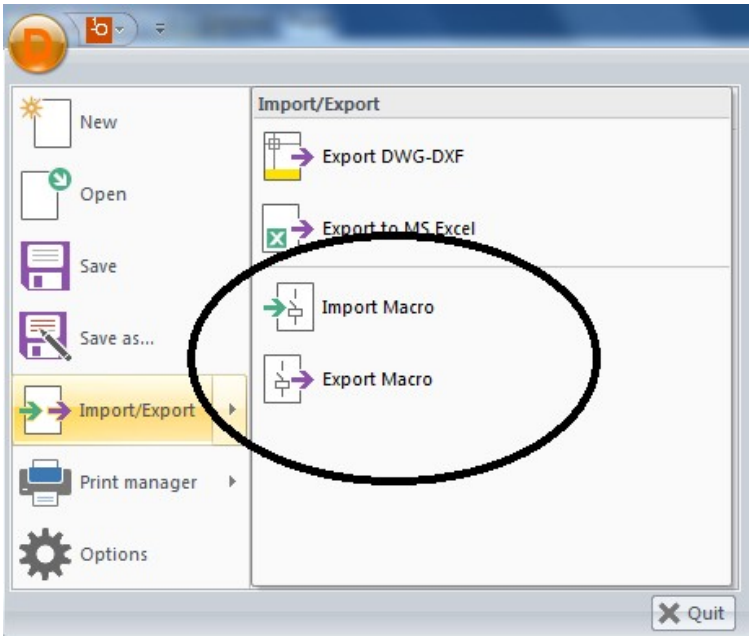
Use the dedicated command in the “Quick access” menu to export the diagram data in the .xls format.



Export to MS Excel command in the “Quick access” menu

7.6. Macro Import and Export

The Macro Import and Export functions in the “Quick access” menu allow you to reuse parts of the diagram you consider to be of particular importance.



Macro Import - Export commands in the "Quick access" menu

The **export command** allows you to save the circuit part considered of interest in a specific file in the .blk format for use later on.

The **import command** allows you to use the data in any other diagram required.

8. ANNEX A: List of Commands

This Annex includes the list and description of all the commands available in the Quick access menu and in the various different tab of DOC.

8.1. Quick access menu

This menu mainly contains the commands for managing files and for printing.

New

Creates a new project.

Before creating a new project, the program will ask you to save any changes to the present project. None of the new projects have an associated file. Use the **Save** option of the **File** menu to associate a file to a project.

Open…

Opens a previously saved file.

Before opening an old file, the program will ask you to save any changes to the present file. DOC project files have "*.e-Design" extension.

Save

Saves the present project.

If the project does not have an associated file, the program will ask you for the name and path for saving the file. DOC project files have "*.e-Design" extension.

Save as…

Saves the present project with a different file name and/or path from the present one.

Import / Export

- Exports the drawing in the CAD *.DWG or *.DXF format

Export macro

Exports the Single Objects selected in a single Macro Object. The Macro Object is saved in a *.blk file.

Import macro

Imports a Macro Object previously saved in a *.blk file.

Print manager

Configuration of the print options for the projects.

Quick print

Immediately prints the open project.

Printer options

Configuration of the printer used and of the most common printing options.

Options

Definition of the default characteristics of the program. The settings, by Single Object or by functionality, allow you to customize the calculations and results of the program.

Esc

Closes the program.

You will be asked to save the project if this has not already been done or if it has been changed

since the last time it was saved.

8.2. HOME tab

The “HOME” tab mainly contains the commands for interaction with the Single Objects in the single-line diagram.

Undo/redo MENU

Undo

Cancels the last command performed.

Redo

Re-executes the last command undone.

Clipboard MENU

Erase

Erases the Single Objects selected from the diagram. Use the Undo command if there are errors.

Cut

Cuts and deletes the Single Objects selected and makes them available for the Paste command

Copy

Copies the Single Objects selected and makes them available for the Paste command.

Paste

Pastes the Single Objects previously Cut or Copied into the diagram. It is not available (of a different color to the other commands) if no Single Object has been previously Cut or Copied.

Move

Moves the Single Objects selected.

Rotate

Rotates the Single Objects selected through 90°.

Stretch

Changes the length of Connections and Busbars.

Scale

Scales the dimensions.

View MENU

Zoom

Displays part of a drawing contained in the selection window.

Zoom +

Zooms in towards the central point of the drawing.

Zoom -

Zooms out from the central point of the drawing.

Previous

Restores the previous Zoom level.

Extension

Zoom allowing all the Single Objects in the current page to be displayed.

Pan

Drags the diagram to display only the desired part.

Page

Zooms the whole page.

Regen

Cleans the “traces” left when passing from one page to another from the screen.

Tools MENU

The *“Tools”* menu contains the commands for managing the main functionalities of DOC in terms of calculation, drawing curves. It also contains management of free texts added to the single-line diagram, the properties command and switchboards command.

Lock Objects

Locks the Single Objects selected, which will not be modified in the subsequent calculations but only verified.

Unlock Objects

Unlocks the previously locked Single Objects. An unlocked Single Object is redefined by the program during the calculation stage.

Renumber

Changes the current numbering of the codes of the Single Objects. The new numbering will be consecutive in the following order: from left to right, from top to bottom, from the first to the

last page.
It only works for Single Objects drawn in the A3, A2, A1, A0 “free” layouts. Numbering in the column layouts complies with different criteria.

Move labels

Moves the labels displayed in the single-line diagram.

Set labels

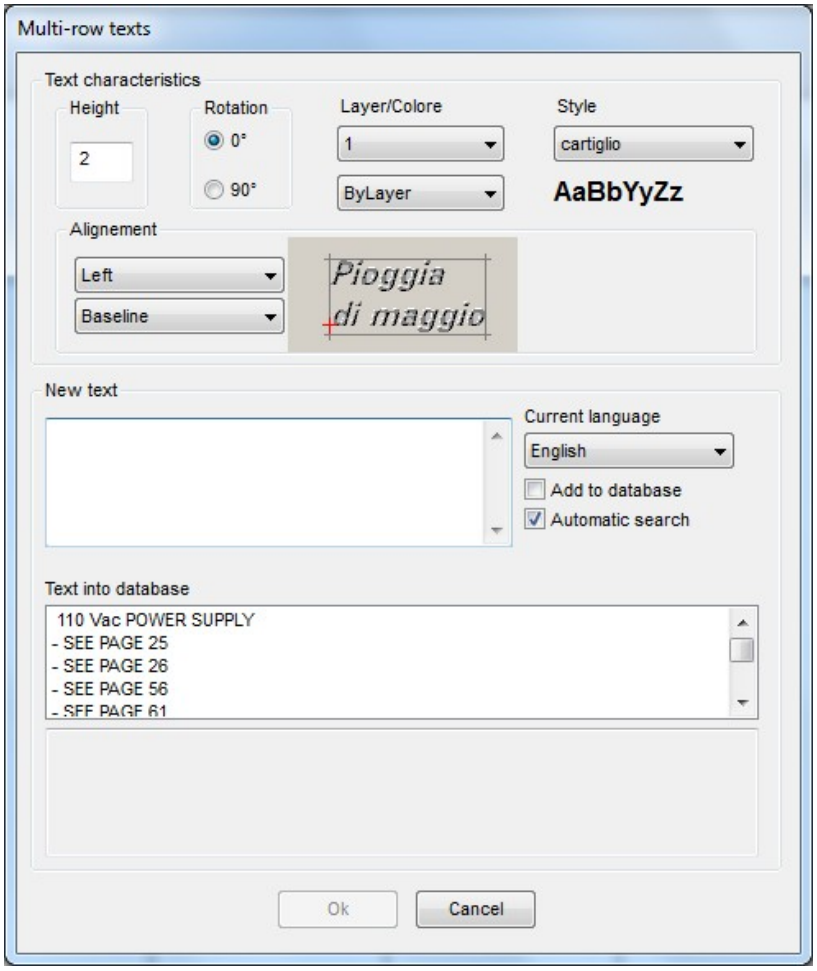
Defines which properties of which object to display in the diagram.

Properties

When performed on a Single Object, it opens the window with the relative properties.
When performed on several Single Objects, it opens the multiple property Manager window

Text

Adds a free text, defined by the user, not linked to any Single Object and which can be positioned as desired in the single-line diagram.
Text management also includes the height and the style of the text itself.



Window for the inserting text into the single-line diagram

Text stile

Command for managing text styles, their list and functions for creating/removing a text style.
A text style contains the main information about the font used for writing the free text.
To define a text style, type in the name and click over “New”.
To use a text style, select the name of the style desired and then select the “Present” option.

Probe

Must be connected to a network to display voltage, current and phase shifts at that point.

Scenarios

Opens the window for defining the network scenarios.

Compute

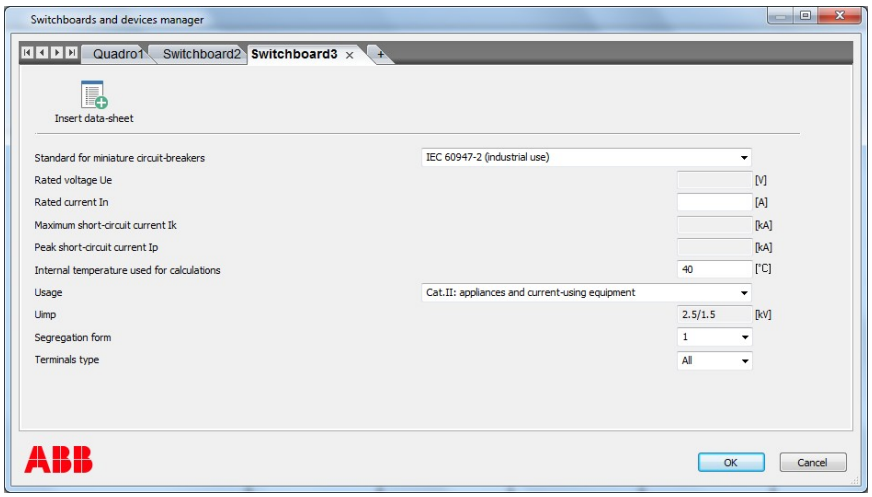
Launches the calculations, as described in chapter 4.

Curves

Displays the curves module, described in chapter 5.

Switchboards

Opens the window containing the definition of the switchboards in the single-line diagram which, by means of the “Insert product data sheet” function, allows the user to add a switchboard label in the single-line diagram context.
Switchboard numbering is provided by the program in the consecutive mode and can be customized by typing in a new switchboard name.



Switchboard manager window

Documentation manager MENU

Documentation manager

Open the project documentation manager window (see chapter 9.4.)

Add page

Adds a page to the single-line diagram.

Delete page

Removes the present page from the single-line diagram. To cancel page removal, use the “Cancel” command in the “undo/Redot” menu.

Change layout – page dimensions

Changes the layout and consequently the dimensions of the page for the current page only.

Access project Navigator to change several pages.

Previous page

Displays the previous page.

Next page

Displays the next page.

8.3. LV SYMBOLS tab – single objects

The main commands in the "LV SYMBOLS" tab are listed below. They mainly refer to objects used for creating LV single-line diagrams and dimensioning the relative networks.

Power Suppliers MENU

UPS

Draws the "UPS" Single Object.

Generator

Draws the "*Generator"* Single Object.

Transformer 2 windings

Draws the "*Transformer with 2 windings"* Single Object.

Wiring MENU

Cable

Draws the "*LV cable"* Single Object.

Busway

Draws the "*Busway"* Single Object

Impedance

Draws the "*Generic impedance"* Single Object.

Connections MENU

Busbar

Draws the "*Busbar"* Single Object.

Connections

Draws the "*Connection"* Single Object.

Dashed Connections

Draws the "*Dashed connection"* Single Object.

Link to vertical page

Draws the "*Link to vertical page"* Single Object.

Vertical page arrival

Draws the "*Vertical page arrival"* Single Object.

Link to horizontal page

Draws the "*Link to horizontal page"* Single Object.

Horizontal page arrival

Draws the "*Horizontal page arrival"* Single Object.

Power devices MENU

Thermal-magnetic circuit-breaker

Draws the "*LV circuit-breaker*" Single Object equipped with release for protection against overload and short-circuit.

Thermal-magnetic residual current circuit-breaker

Draws the "*LV circuit-breaker*" Single Object equipped with release for protection against overload, short-circuit and residual current block.

Magnetic only circuit-breaker

Draws the "*LV circuit-breaker*" Single Object equipped with release for protection against short-circuit only.

Magnetic only residual current circuit-breaker

Draws the "*LV circuit-breaker*" Single Object equipped with release for protection against short-circuit and residual current block only.

Residual current circuit-breaker

Draws the "*Residual current circuit-breaker*" Single Object.

Fuse

Draws the "*LV Fuse*" Single Object.

Switch-Fuse

Draws the "*LV Switch-fuse*" Single Object.

Disconnector

Draws the "*LV Disconnector*" Single Object.

Contactor

Draws the "*LV Contactor*" Single Object.

Loads MENU

Generic load

Draws the "*Generic load*" Single Object.

Motor

Draws the "*Motor*" Single Object.

Lighting load

Draws the "*Lighting load*" Single Object.

Capacitor bank

Draws the "*Capacitor bank*" Single Object.

8.4. MV SYMBOLS tab – single objects

The main commands in the "MV SYMBOLS" tab are listed below. They mainly refer to objects used for creating MV single-line diagrams and dimensioning the relative MV-LV networks.

Devices MENU

MV Cable

Draws the "*MV Cable*" Single Object.

MV circuit-breaker

Draws the "*MV circuit-breaker*" Single Object.

MV Disconnector

Draws the "*MV Disconnector*" Single Object.

MV Earth switch

Draws the "*MV Earth switch*" Single Object.

MV Disconnector+ fuse

Draws the "*MV Disconnector*" and "*MV fuse*" Single Objects.

MV Switch Disconnector on load

Draws the "*MV Switch Disconnector on load*" Single Object.

MV Switch Disconnector on load + Fuse

Draws the "*MV Switch Disconnector on load*" and "*MV Fuse*" Single Objects.

CT

Draws the purely Graphic "*CT*" Object.

HCT

Draws the purely Graphic "*HCT*" Object.

VT

Draws the purely Graphic "*VT*" Object.

Combisensor

Draws the purely Graphic "*Combisensor*" Object.

Voltage divider

Draws the purely Graphic "*Voltage divider*" Object.

Rogowski Coil

Draws the purely Graphic "*Rogowski Coil*" Object.

MV generic Load

Draws the "*Generic load*" Single Object predefined with a specific symbol for Medium voltage.

8.5. "INFO" Tab

The "INFO" tab includes the guides for using the program and its recommendations.

User guide in the *"Help"* menu

Contains the guides to using DOC, Curves and OTC.

Technical guides in the "*Technical documentation*" menu

Contains the versions in pdf format of the ABB Technical Application Notebooks, i.e.:

- "QT1 - Low voltage discrimination with ABB circuit-breakers";
- "QT2 - MV/LV Substations: theory and examples of short-circuit calculation"
- "QT3 - Distribution systems and protection against indirect contacts and earth faults"

But also other technical documents, i.e.:

-"Coordination tables", i.e. technical documentation concerning Back-up, discrimination and other
-Italian edition of the "Electrical Installation Handbook"
-a document concerning "*Unisec typical units*" for Medium Voltage secondary distribution
-a document concerning the assembly options of ABB apparatus in System pro E Power segregated switchboards, called "*Segregation forms for circuit-breakers"*
-a document explaining the segregation and design rules of System pro E Power switchboards entitled *"System pro E Power segregations"*

Other guides and commands in the "INFO" menu

-Using the "Warnings" command, DOC will display the recommendations for use of the program, as in chapter **Error! Reference source not found.**.

-The "UTE certification" item displays the program's certification for calculations and dimensioning issued by the French standard authority UTE, regarding standard NFC15-500.

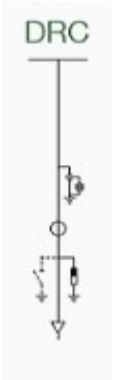
-The "INFO" pusu-button opens a window with the version of the program, to be notified when the Assistance service is contacted.

8.6. MV SYMBOLS tab – Macro objects

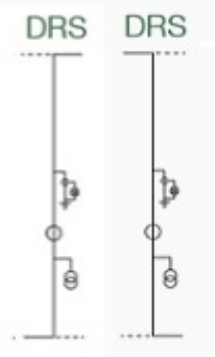
A list of the main Medium Voltage Macro Objects in DOC is given below.
Every Macro Object represents a typical unit of ABB's Unisec secondary distribution switchboards

Unisec switchgear menu

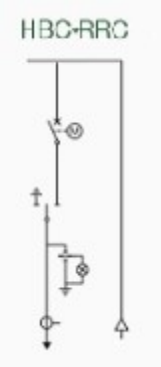
BME Unit
Metering and busbar earthing unit



DRC Unit
Direct incoming with measuring and busbar earthing

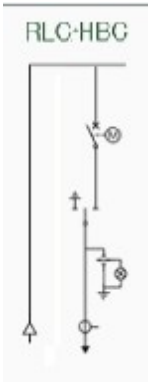


Left and right DRS Unit
Riser unit with measurement

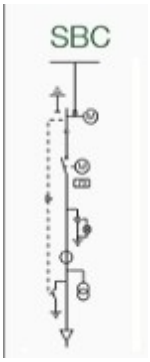


HBC-RRC Unit
Unit with built-in circuit-breaker and disconnector + Cable inlet on the right

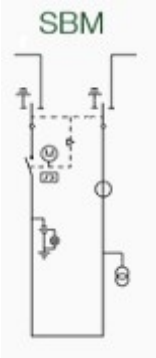
HBC Unit
Unit with built-in circuit-breaker and switch-disconnector



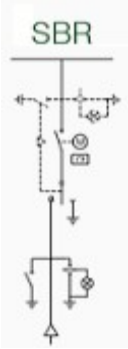
RLC-HEC Unit
Cable inlet on the left + Unit with built-in circuit-breaker and switch-disconnector



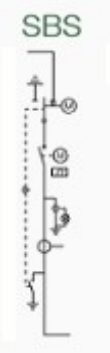
SBC Unit
SBC Circuit-breaker with switch-disconnector



SBM Unit
Isolating unit with measurements, circuit-breaker and double switch-disconnector

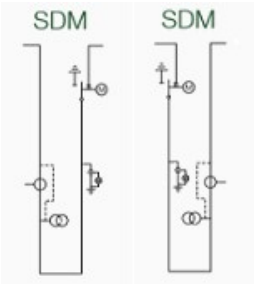


SBR Unit
Reversed feeder unit

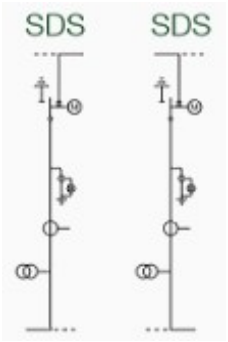


SBS Unit
Switch breaker – sectionalizer unit

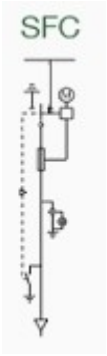
SDC Unit
Unit with switch-disconnector



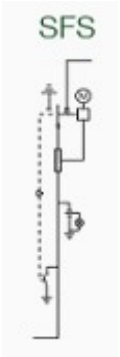
SDM Unit
Measure panel with switch-disconnector



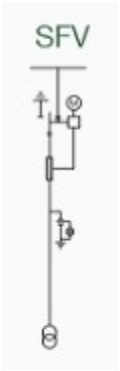
Left and right SDS Unit
Switch-disconnector - sectionalizer unit



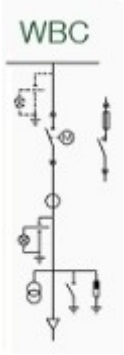
SFC Unit
Unit with switch-disconnector and fuses



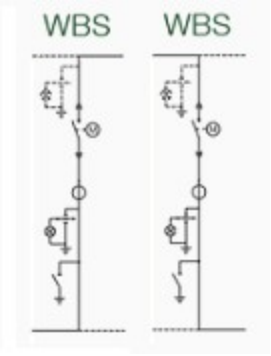
SFS Unit
Switch fuse sectionalizer unit



SFV Unit
Switch-disconnector with fuses - measurement



WBC Unit
Unit with withdrawable circuit-breaker



WBS Unit
Unit with withdrawable circuit-breaker - sectionalizer

Box trafo Unit
Draws the "*Transformer box*" Macro Object.

8.7. LV SYMBOLS tab – Macro Objects

A list of the main Low Voltage Macro Objects in DOC is given below.
The Low Voltage Macro Objects have been made to allow users to create the majority of types of low voltage plants.
Further information about drawing with Macro Objects is available in chapter 3.2.

Main Menu

Main thermal magnetic residual current circuit-breaker

Draws the "*Main thermal magnetic residual current CB*" Macro Object.

Main thermal magnetic circuit-breaker

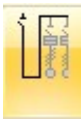
Draws the "*Main thermal magnetic CB*" Macro Object.

Main fuse

Draws the "*Main fuse*" Macro Object.

Main switch-fuse

Draws the "*Main switch-fuse*" Macro Object.

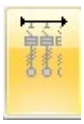


Main disconnector

Draws the "*Main disconnector*" Macro Object.

Line without main device

Draws the "*Line without main device*" Macro Object.



Line with links

Draws the "*Line with links*" Macro Object

Link to page

Draws the "*Link to page*" Macro Object.

Sub-level Menu

Main second level thermal magnetic residual current circuit-breaker

Draws the "*Main second level thermal magneticresidual current CB*" Macro Object.

Main second level thermal magnetic CB

Draws the "*Main second level thermal magnetic CB*" Macro Object.

Main second level residual current CB

Draws the "*Main second level residual current CB*" Macro Object.

Main second level fuse

Draws the "*Main second level fuse*" Macro Object.

Main second level switch-fuse

Draws the "*Main second level switch-fuse*" Macro Object.

Main second level disconnector

Draws the "*Main second level disconnector*" Macro Object.

Feeders Menu

Feeder line to thermal magnetic residual current circuit-breaker sub-board

Draws the "*Feeder line to thermal magnetic residual current CB sub-board*" Macro Object.

Feeder line to thermal magnetic circuit-breaker sub-board

Draws the "*Feeder line to thermal magnetic CB sub-board*" Macro Object.

Feeder line to switch-fuse sub board

Draws the "*Feeder line to switch-fuse sub board*" Macro Object.

Feeder line to fuse sub board

Draws the "*Feeder line to fuse sub board*" Macro Object.

Thermal magnetic residual current feeder with generic load

Draws the "*Thermal magnetic residual current feeder with generic load*" Macro Object.

Thermal magnetic feeder with generic load

Draws the "*Thermal magnetic feeder with generic load*" Macro Object.

Switch-fuse feeder with generic load

Draws the "*Switch-fuse feeder with generic load*" Macro Object.

Switch-Fuse + residual current feeder with generic load

Draws the "*Switch-fuse + residual current feeder with generic load*" Macro Object.

Feeder - fuse with generic load

Draws the "*Feeder - fuse with generic load*" Macro Object.

Fuse + residual current feeder with generic load

Draws the "*Fuse + Residual current feeder with generic load*" Macro Object.

Thermal magnetic feeder with power factor correction unit

Draws the "*Thermal magnetic feeder with power factor correction unit*" Macro Object.

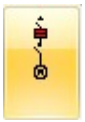
Thermal magnetic circuit-breaker with power factor correction unit in switchboard

Draws the "*Thermal magnetic CB with power factor correction unit in switchboard*" Macro Object.

Motors Menu

Motor feeder with solely magnetic motor protector and thermal relay

Draws the "*Motor feeder with solely magnetic motor protector and thermal relay*" Macro Object.



Motor feeder with thermal magnetic motor protector

Draws the "*Motor feeder with thermal magnetic motor protector*" Macro Object.

Motor feeder with fuse and thermal relay

Draws the "*Motor feeder with fuse and thermal relay*" Macro Object.

Motor feeder with solely magnetic moulded-case CB and thermal relay

Draws the "*Motor feeder with solely magnetic moulded-case CB and thermal relay*" Macro Object.

Motor feeder with moulded case CB with MP release

Draws the "*Motor feeder with moulded case C with MP release*" Macro Object.

Star-Delta motor feeder with solely magnetic motor protector and thermal relay

Draws the "*Star-Delta motor feeder with solely magnetic motor protector and thermal relay*" Macro Object.

Star-Delta motor feeder with thermal magnetic motor protector

Draws the "*Star-Delta motor feeder with thermal magnetic motor protector*" Macro Object

Star-Delta motor feeder with fuse and thermal relay

Draws the "*Star-Delta motor feeder with fuse and thermal relay*" Macro Object.

Star-Delta motor feeder with solely magnetic moulded-case CB and thermal relay

Draws the "*Star-Delta motor feeder with solely magnetic moulded-case CB and thermal relay*" Macro Object.

Star-Delta motor feeder with moulded-case CB with MP release

Draws the "*Star-Delta motor feeder with moulded-case CB with MP release*" Macro Object.

9. ANNEX B: List and Description of Single Objects and their relative control panels

The following Annex includes the list and description of the windows of all the Single Objects in the “MV SYMBOLS” and “LV SYMBOLS” tabs.

9.1. Windows of MV Single Objects (“MV SYMBOLS”)

This Annex contains the list and description of the windows of MV Single Objects, available only with the Professional profile and only in projects that begin with an “MV utility”.

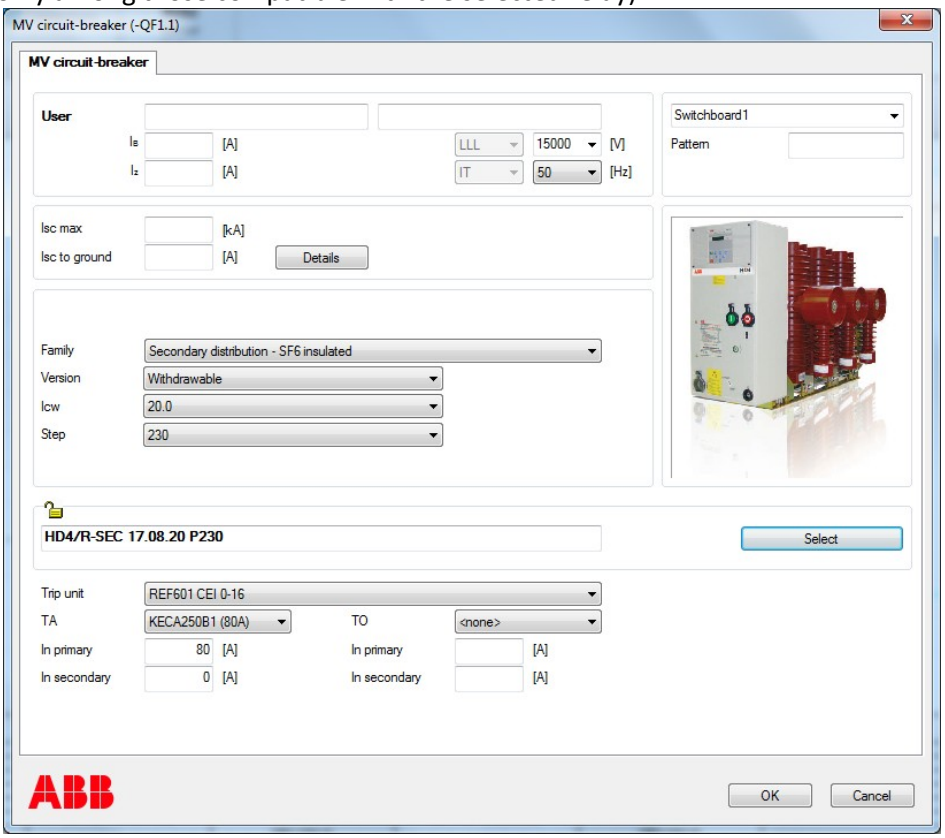
The windows of each Single Object can be displayed in two ways:

- By a double click over the Single Object symbol in the single-line diagram.
- Using the “*Properties*” command in the tools menu of the “HOME” tab

MV circuit-breaker

The following data can be defined in the “*MV circuit-breaker*” control panel:

- Description of the User, on two lines.
- Circuit-breaker family.
- The relay to be associated with the circuit-breaker.
- The CT (only among those compatible with the selected relay).
- The HCT (only among those compatible with the selected relay)

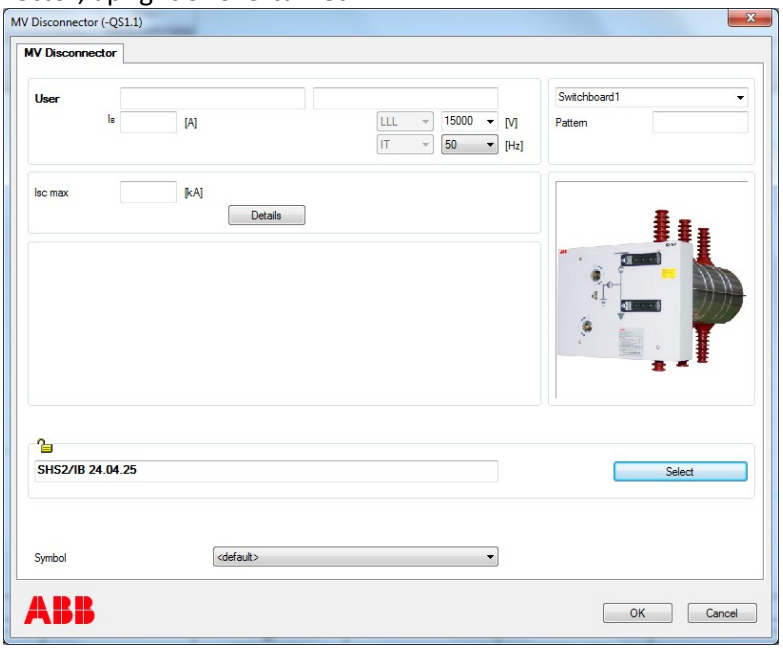


Main MV circuit-breaker window

MV disconnector

The following data can be defined in the "*MV disconnector*" control panel:

- Description of the User, on two lines.
- The Symbol of the disconnector, upright or overturned

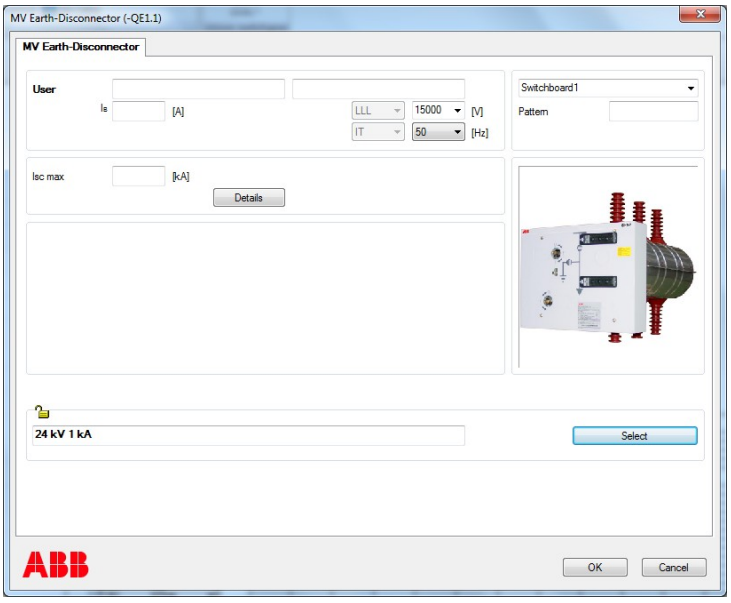


Main MV disconnector window

MV earthing switch

The following data can be defined in the "*MV Earthing switch*" control panel:

- Description of the User, on two lines.

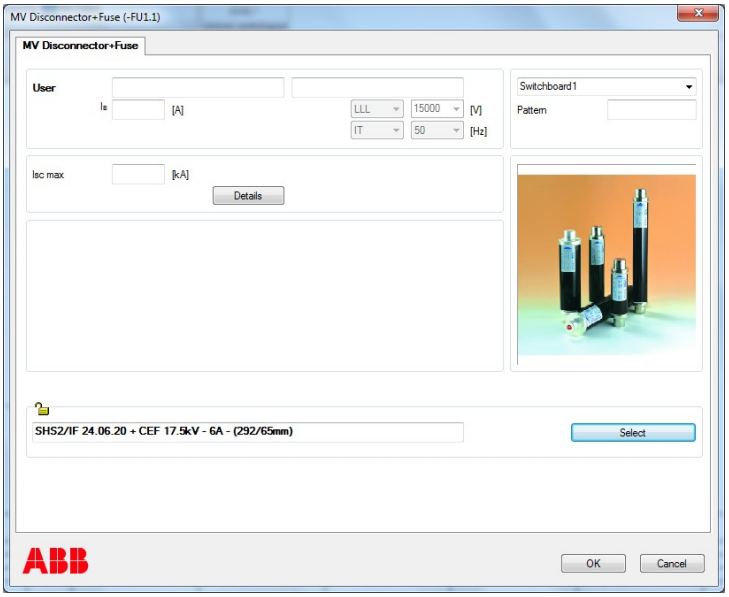


Main MV earthing switch window

MV disconnector with fuse

The following data can be defined in the "*MV disconnector and fuse*" control panel:

- Description of the User, on two lines.

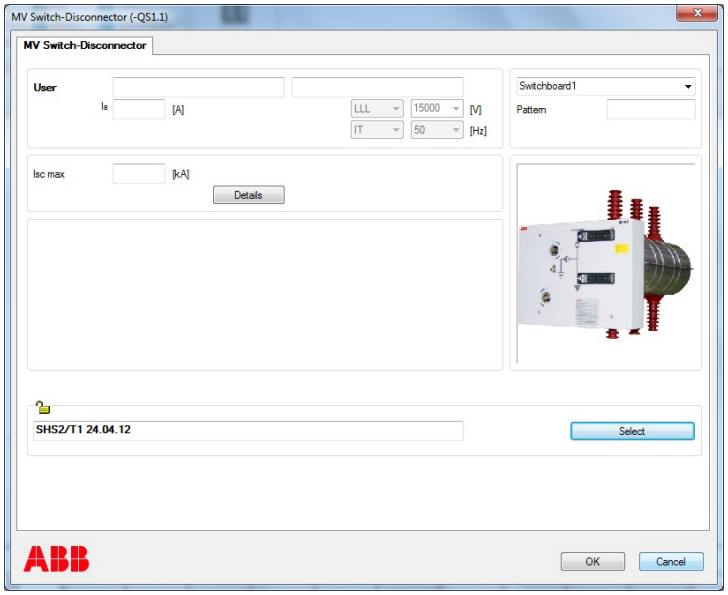


Main MV disconnector and fuse window

MV switch-disconnector on load

The following data can be defined in the "*MV switch-disconnector*" control panel:

- Description of the User, on two lines.

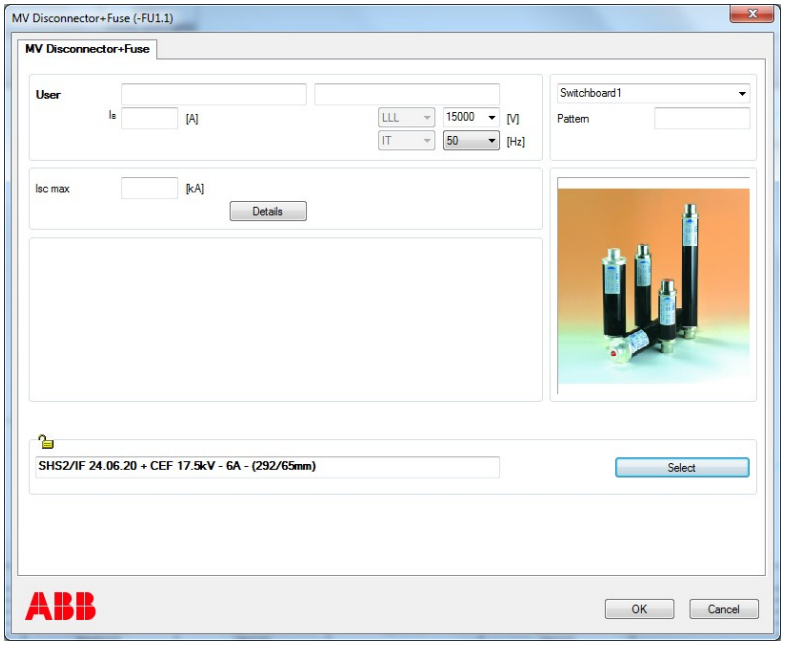


Main MV switch-disconnector window

MV switch-disconnector with fuse

The following data can be defined in the "*MV switch-disconnector and fuse*" control panel:

- Description of the User, on two lines.

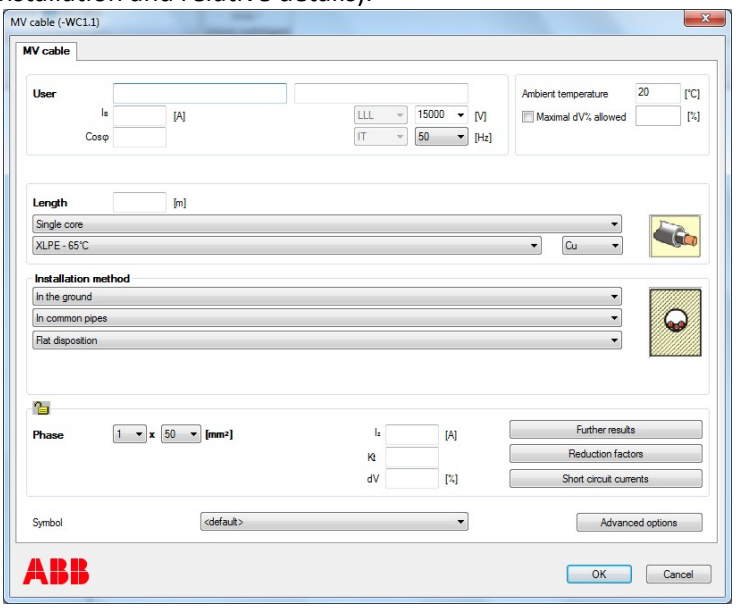


Main MV switch-disconnector and fuse window

MV cable

The following data can be defined in the "*MV cable*" control panel:

- Description of the User, on two lines.
- Ambient temperature.
- Maximum Cdt% in the length of cable.
- Length.
- Type of cable (Single-core – Multi-core).
- The maximum service temperature of the insulation (XLPE at 65°C – XPLE at 90°C).
- The installation method (Overhead installation and relative details – Underground installation and relative details).

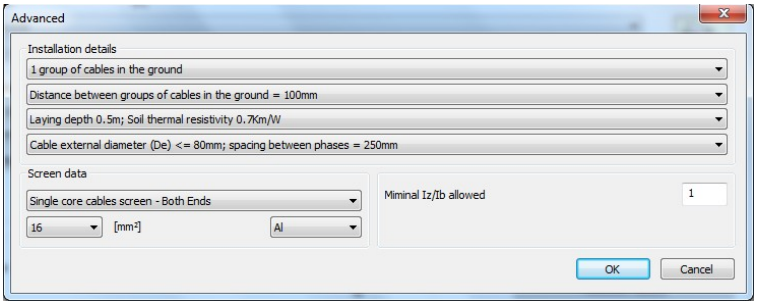


Main MV cable window

Advanced options >>>

The "*Advanced Options >>>*" button allows those data which can change the carrying capacity of the cable, to be defined as correction factors:

- Installation details (adjacent circuits – installation depth)
- Screen data (Type and Section)
- Minimum Iz/Ib ratio

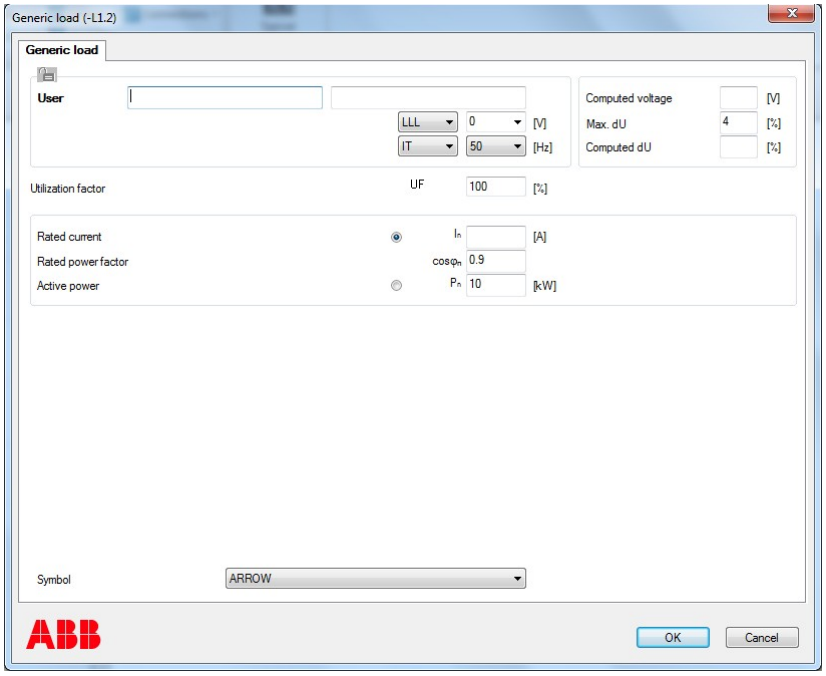


Advanced Options for the MV cable

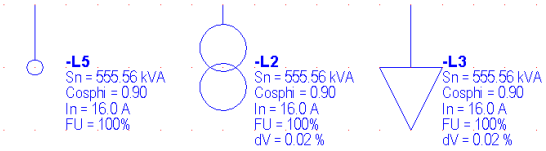
MV Load

The following data can be defined in the "*MV Load*" control panel:

- Description of the User, on two lines.
- Consumption as a function of Load current and Power factor.
- Consumption as a function of Power consumed and Power factor.
- Symbol with which the load will be displayed (a small ball - an arrow - a transformer).



Main MV Load window



Graphic symbols of the MV Load

9.2. Windows of LV Single Objects ("LV SYMBOLS" tab)

This Annex contains the list and description of the windows of LV Single Objects.

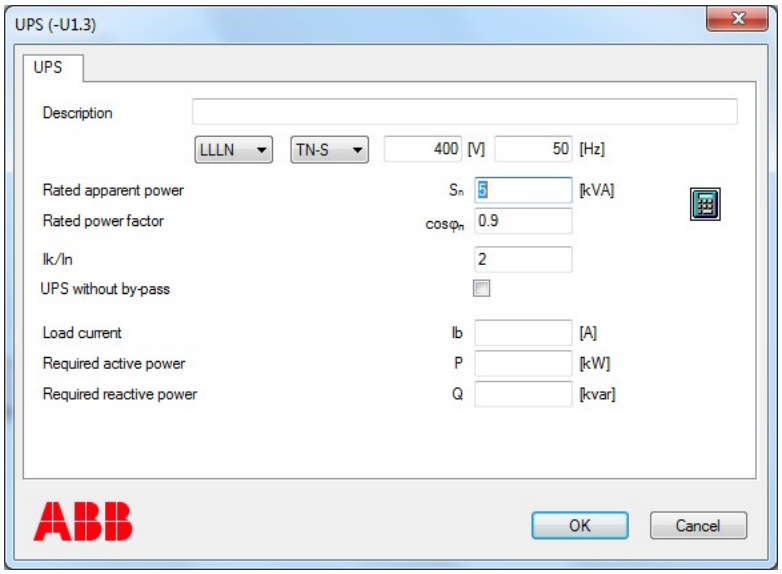
The windows of each Single Object can be displayed in two ways:

- With a double click over the Single Object symbol in the single-line diagram.
- Using the "Properties" command of the Tools menu of the tab "HOME" tab.

UPS

The following data can be defined in the "*UPS*" control panel:

- Description.
- Apparent rated Power, Rated Power factor of the UPS (these two data items allow the program to find how much active power Pn and reactive power Qn it is able to supply to the network).
- The ratio between the short-circuit current and rated current, with which the program calculates the contribution to the UPS fault.



Main UPS window

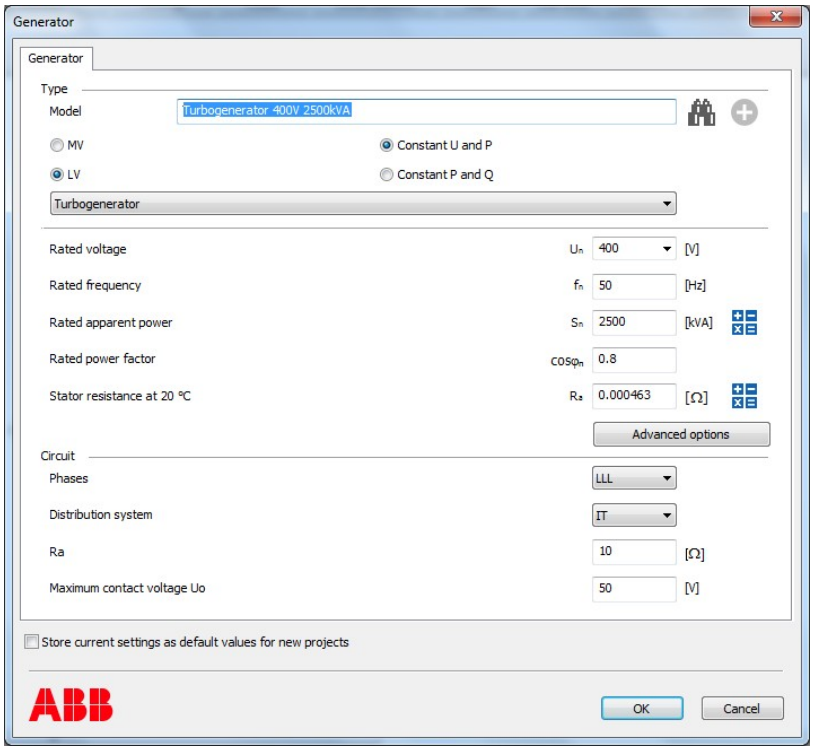
Generator

The following data can be defined in the "*Generator*" window:

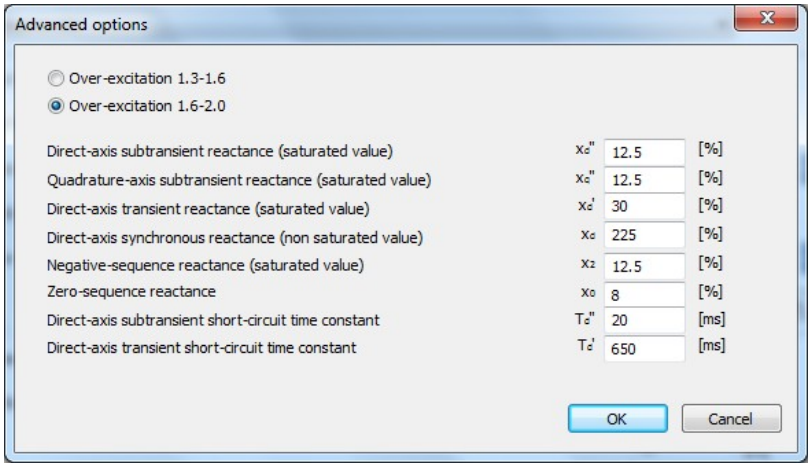
- Description of the type of generator (Model).
- The type of source, PV or PQ.
  A "PV" generator will always keep the active Power and reference Voltage at its terminals constant. Consequently the reactive Power supplied to the network will depend on the current required by the network.
  A "PQ" generator will always keep the active Power and reactive Power constant. Consequently the Voltage at the network terminals will depend on the current required by the network.
- "< Browse database" allows you to search for a generator in the program database.
- ">Add to database" allows the currently defined generator to be saved in the program database. To be able to save a generator its Model must be written.

The following rating plate data:

- Rated apparent Power and rated Power factor (these two data items allow the program to find out how much active power Pn and reactive power Qn it is able to supply to the network).
- Loss participation factor: only for PV sources and with several generators in parallel; this factor decides how much a generator will be loaded.
- Armature resistance in [Ω] or in [ms] of the time constant Ta.
- The Reactances can also be defined, within the scope of the "advanced options": Subtransient (direct axis and quadrature), Transient, Synchronous, Inverse Sequence and Homopolar.
- The time constants: Subtransient and Transient.



Main Generator window



Generator advanced options window

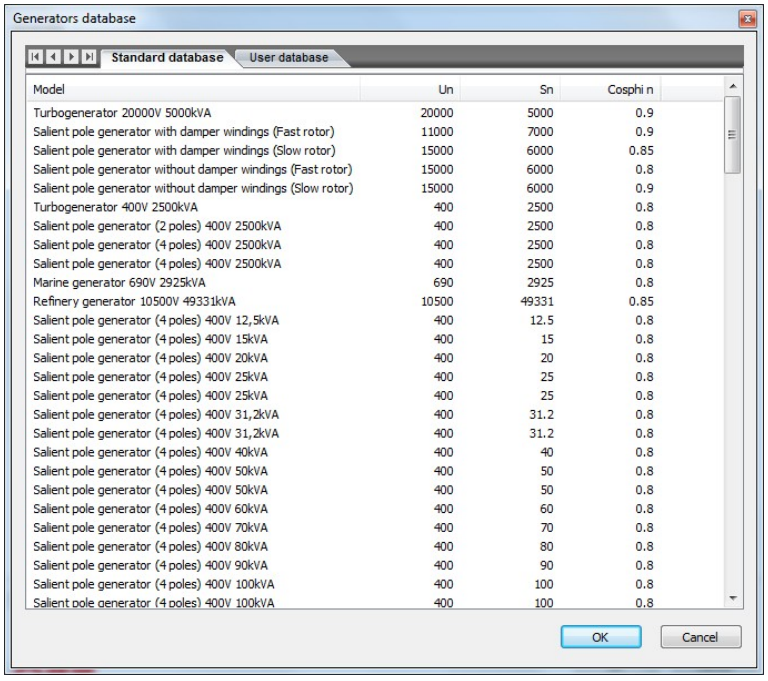
The rating plate data defined in the generator are used in the network and short-circuit calculations.

Data not defined, or defined incorrectly, can produce results far from realty.

When these data are not known, or availability of data is incomplete, it is advisable to select the generator with the characteristics most similar to your own generator from the DOC generator database, and if necessary change the characteristics provided by the program using the data in your possession.

<u>Standard database and user database of the generators</u>

DOC provides users with an extensive generator database that is easily displayed by clicking on the binoculars at the top right of the "Generator" window.



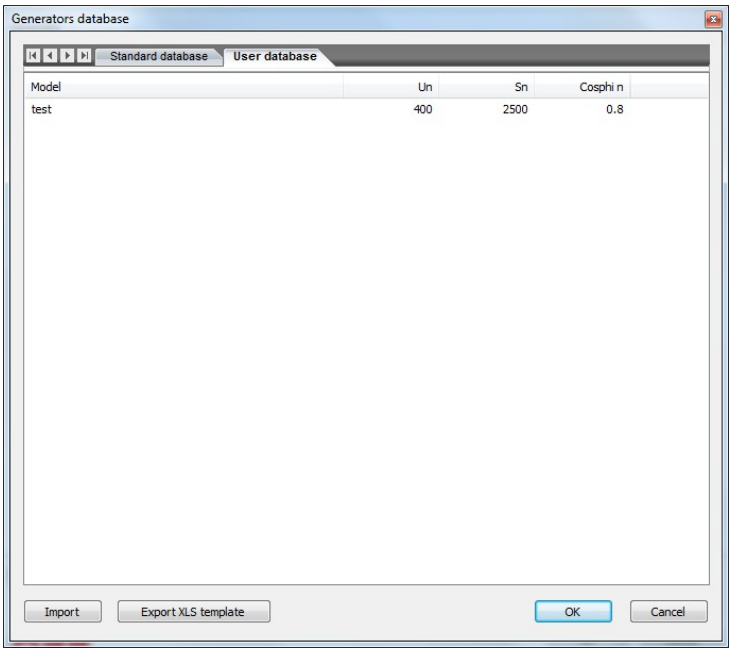
Standard generators database window

A customized generators database can also be created to suit one's personal requirements if necessary.
To do this, proceed as follows:

Step 1: export the data model in the Excel format using the "*Export model XLS*" at the bottom right of the "*User database*" window.

Step 2: complete the data model obtained with the data of your generators

Step 3: using the "Import" command at the bottom right of the "*User database*" window, re-import the XLS model file complete with all the data.



Generators user database window

Trasformer with 2 windings

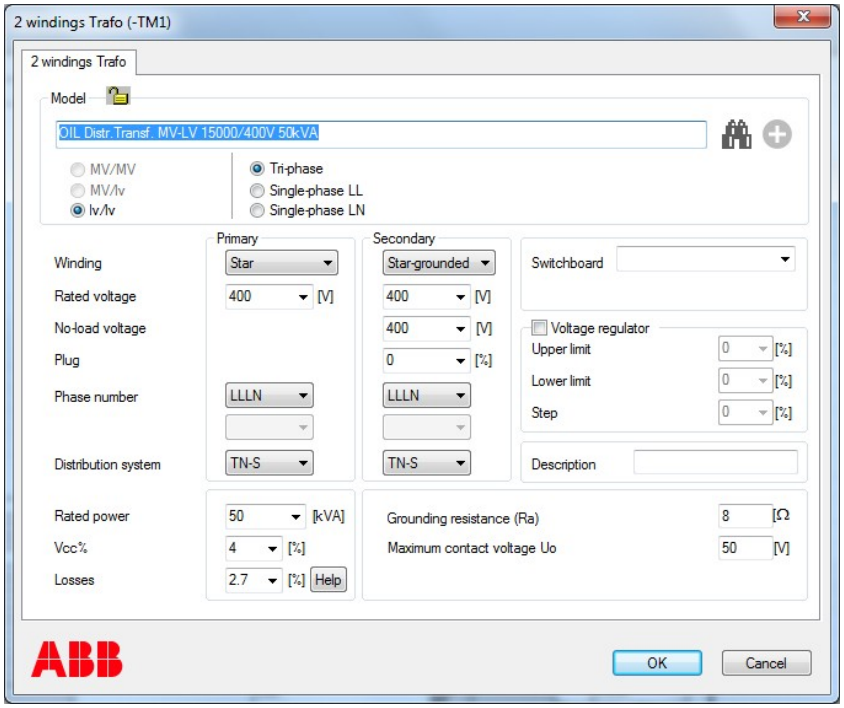
The "*Transformer with 2 windings*" window allows you to define:

- Description of the type of transformer (Model).
- "< Browse database" allows you to search for a transformer in the program database.
- ">Add to database" allows you to save the currently defined transformer in the program database. To be able to save a transformer, its Model must be written.
- The voltage levels: MV/MV, MV/LV, LV/LV (the latter can be three-phase, two-phase or single-phase).

- Rated power.
- Short-circuit impedance.
- Loss in the copper, defined as a percentage of the rated power or as an absolute value in [kW] (from which the resistive modulus of the transformer impedance is found).

For the Primary and Secondary windings:

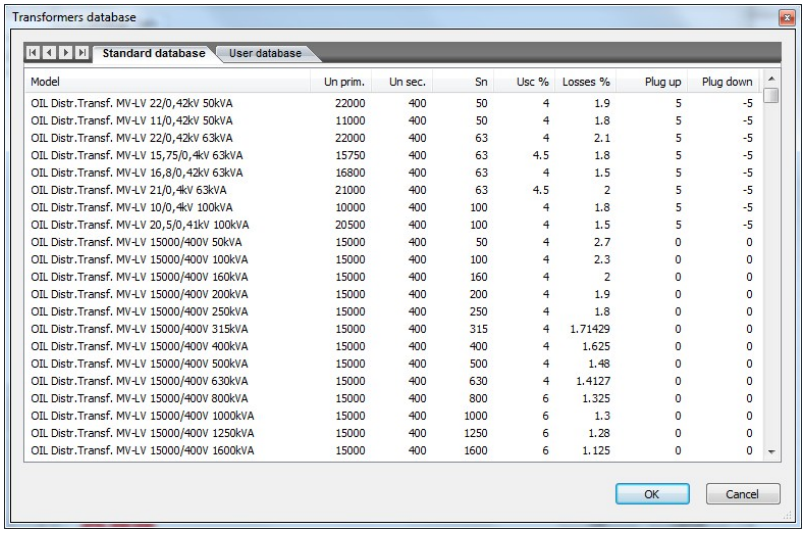
- The type of winding, only for three-phase transformers (Star, Earthed neutral, Delta).
- The rated voltage of the relative side of the plant.
- The no-load voltage, i.e. the voltage that the transformer would supply to the terminals of the secondary winding if no load was connected.
- Definition of the sockets and any set socket.
- The number of phases.
- The distribution system.



Main window of the Transformer with 2 windings

Standard database and user database of the transformers

DOC provides users with an extensive transformer database that is easily displayed by clicking on the binoculars at the top right of the "Transformer with 2 windings" window.



Trasformers standard database window

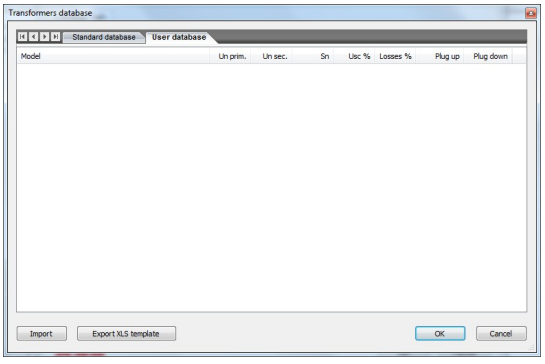
You can also create a customized transformers database to suit your personal requirements if necessary.

To do this, proceed as follows:

Step 1: export the data model in the Excel format using the "*Export model XLS*" at the bottom right of the "*User database*" window.

Step 2: complete the data model obtained with the data of your transformers

Step 3: using the "Import" command at the bottom right of the "*User database*" window, re-import the XLS model file complete with all the data.

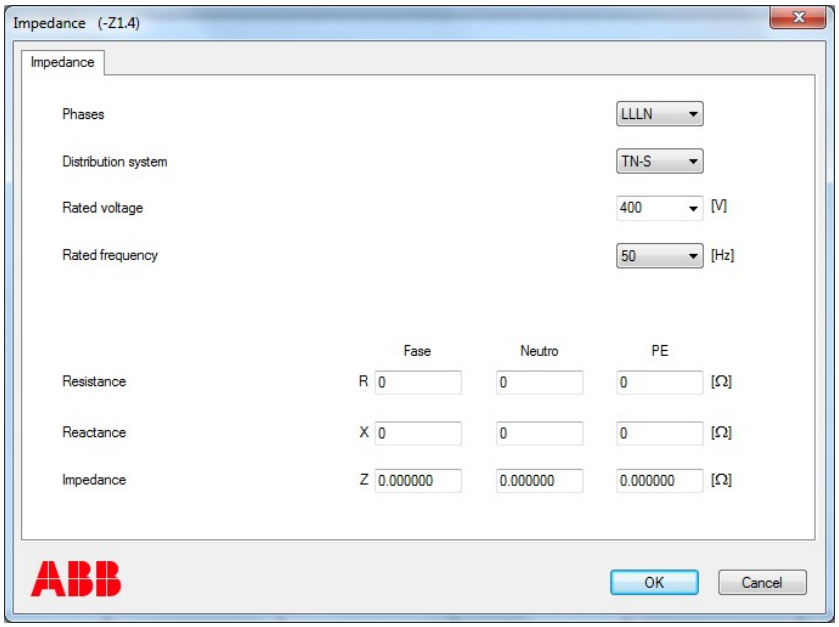


Trasformers user database window

Generic Impedance

"*Generic impedance*" is used for calculating a short-circuit in which the resistance and reactance characteristics of a cable or a busway are already known. You can therefore define:

- Phase Resistance and Reactance.
- Neutral Resistance and Reactance.
- PE Resistance and Reactance.



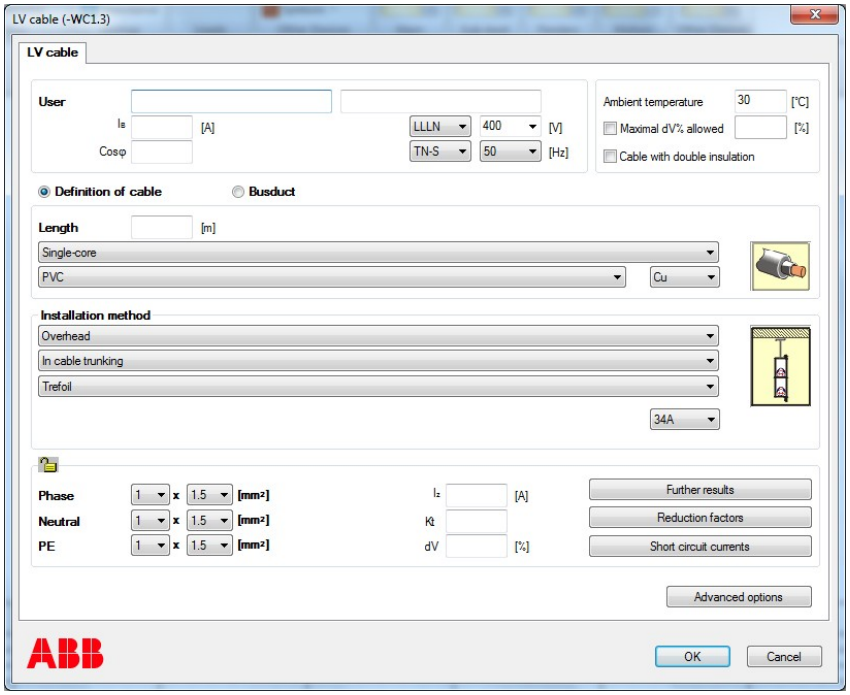
Main generic impedance window

LV cable

The following data can be defined in "*LV cable*":

- Description of the User, on two lines.
- Ambient temperature, to which a relative correction factor will be associated.
- The maximum Cdt% with which the single cable will be dimensioned.
- The "Cable in double insulation (Class II)" option. A cable in class II will not be verified for protection against indirect contacts.
- Cable length.
- Type of cable, defined as
  Single-core cable with sheath, single-core cable without sheath, multi-core cable,
  PVC, EPR/XPLE Insulation, Mineral Insulation,
  Conductor material, in Copper (Cu) or Aluminium (Al).
- The installation method, where the multiple selections serve to direct you to one of the methods defined in the reference Standard. Each method corresponds to different Current Carrying Capacities, available Sections, correction Factors.

- The number and the section of the Phase, Neutral and PE conductors (or PEN, in TN-C systems).

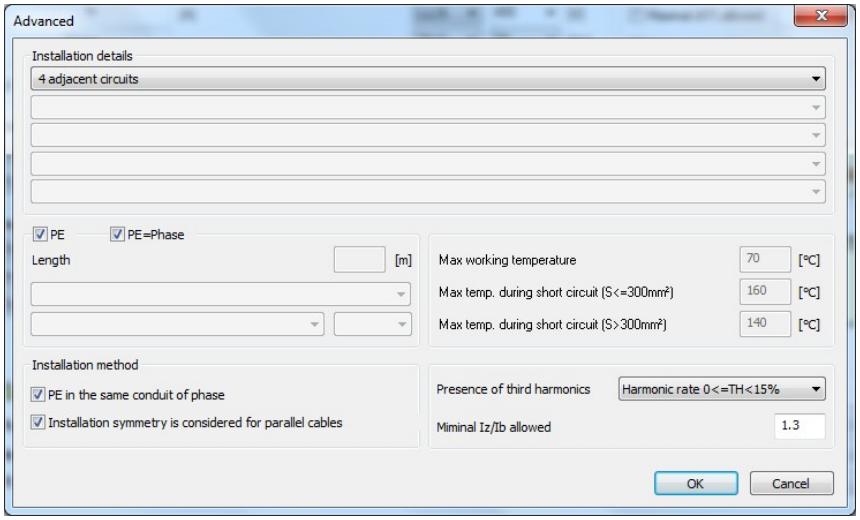


Main LV cable window

Advanced options >>>

The "*Advanced Options >>>*" button allows you to define the data that can change the carrying capacity of the cable:

- Installation details (adjacent circuits for several cables in the same duct or the installation depth for underground cables).
- Presence and Data of the PE, if different from the phase and Neutral conductors.
- Temperature performance of the insulation, to which different K^2S^2 values and working temperature correspond.
- The PE option laid in the same conduit as the phases determines the K^2S^2 of the PE.
- Installation symmetry considered in the reactance calculation.
- Presence of third harmonics, which will correspond to possible over-dimensioning of the Neutral conductor.
- The minimum Iz/Ib ratio to be taken into consideration when dimensioning the cable.

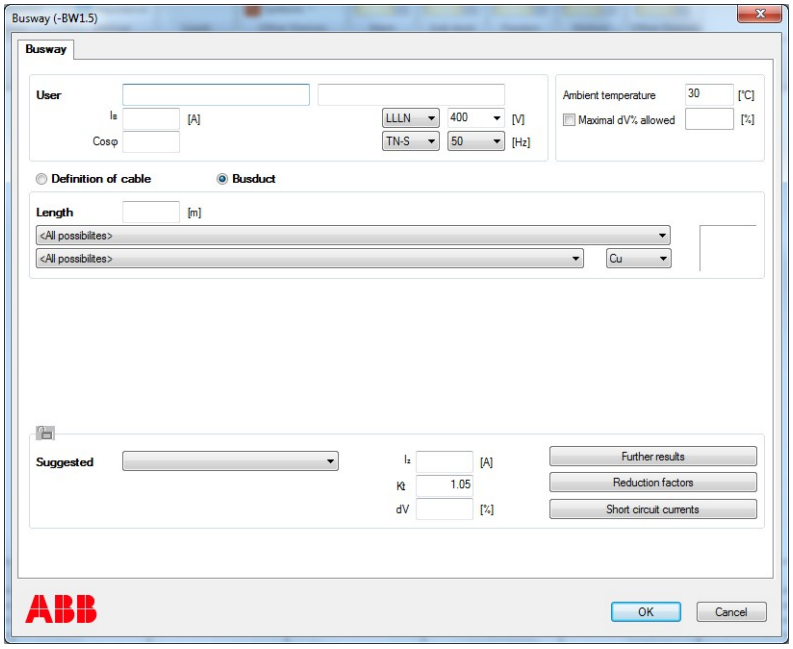


LV cable Advanced Options

Busway

The following data can be defined in "*Busway*":

- Description of the User, on two lines.
- Ambient temperature, to which a relative correction factor will be associated.
- The maximum Cdt% with which the busway will be dimensioned.
- The "Cable in double insulation (Class II)" option. A cable in class II will not be verified for protection against indirect contacts.
- Length of the cable.
- The type of busway, defined as
  Neutral section at 50% or 100%
  PE in the same enclosure as the phases or in a dedicated enclosure
- The type of busway selected.



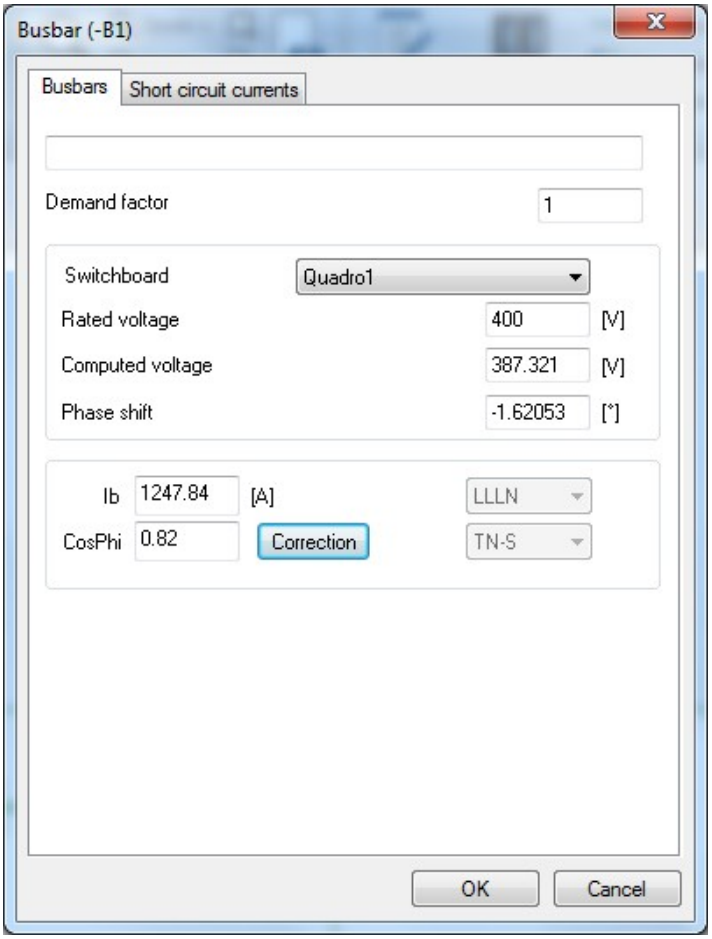
Main Busway window

Busbar

The "*Busbar*" window serves to display the values calculated by the program at a point of the network, as well as to connect several feeders to a single main circuit-breaker. The values displayed on the Busbar page are:

- Rated voltage.
- Calculated voltage.
- Phase shift between distributed voltage and calculated voltage.
- Load current Ib.
- Power factor.
- Phases and Distribution system to the busbar, inherited from the branch by which it is supplied.

The busbar window is also used to set the Demand Factor (DF) of all loads connected to the busbar considered.

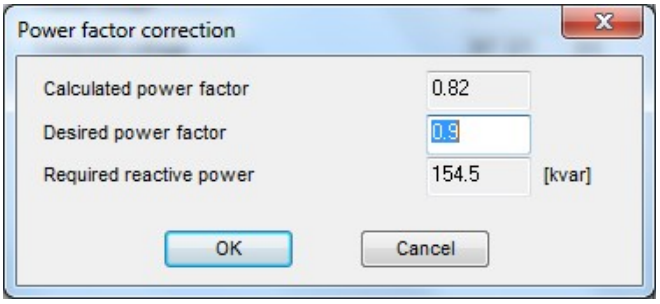


Busbar Window

Corrections

The "Corrections" button allows you to calculate:

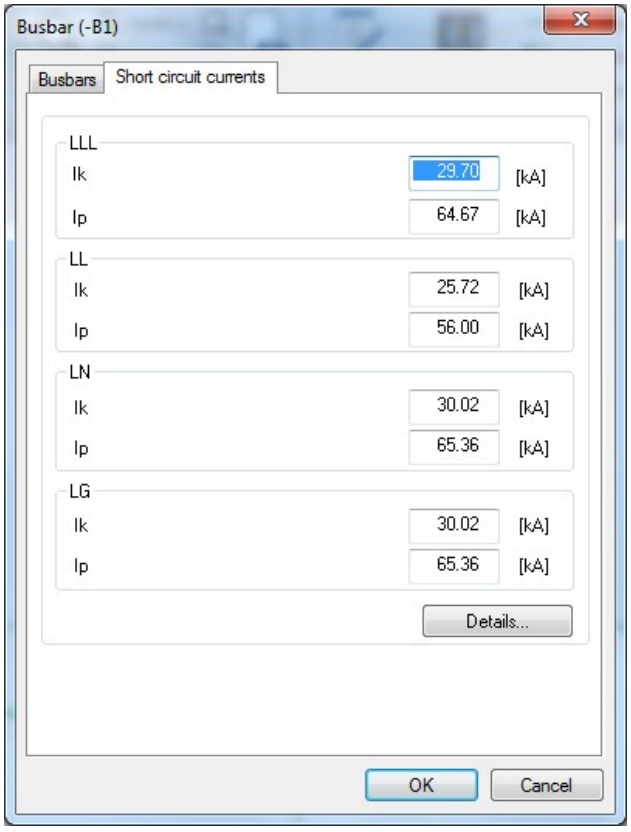
- The capacitive reactive Power required to correct the power factor of all the loads connected to the busbar in question to a new Power factor.
- The Power factor which will be reached depending on the capacitive reactive Power installed.



Power factor correction Window

The values displayed in the Short-circuit currents page are:

- Short-circuit Ik and peak Ip current for Three-phase (LLL), Line-to-line (LL), Line-to-neutral (LN) and Line-to-Earth (LPE) faults.

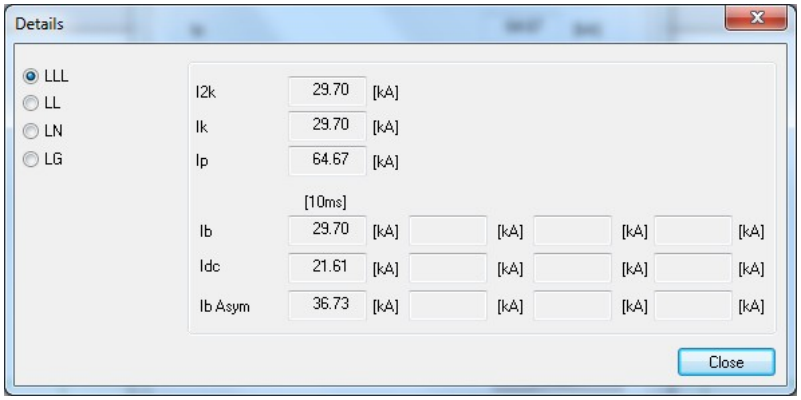


Short-circuit currents Window

You can also display the "Details…" of the short-circuit calculations:

- Short-circuit Ik and peak Ip current for Three-phase (LLL), Line-to-line (LL), Line-to-neutral (LN) and Line-to-earth (LPE) faults.

The details show all the components of the short-circuit defined in the selected calculation Standard.

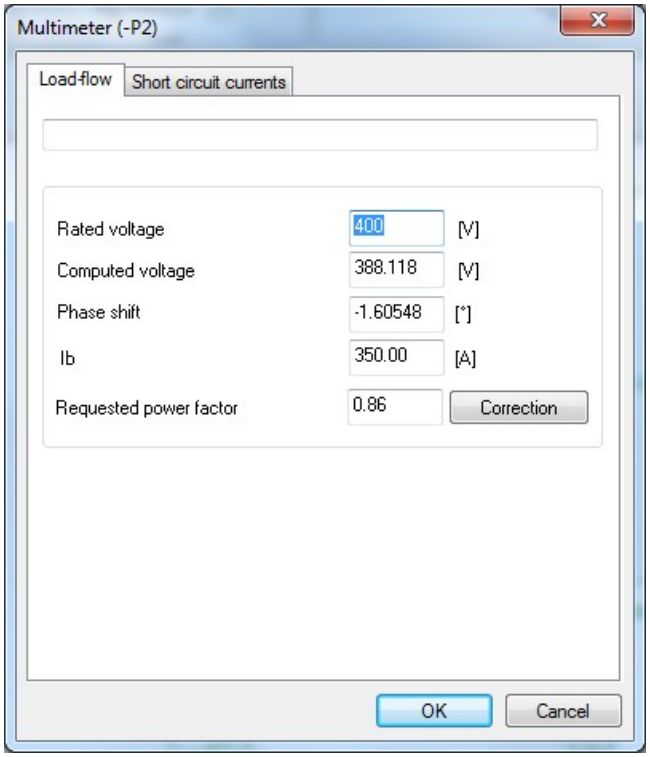


Window with Details of the Short-circuit currents

Virtual probe

The "*Virtual probe*" window displays the values calculated by the program in any point of the network. The values displayed in the Load-Flow page are:

- Rated voltage.
- Calculated voltage.
- Phase shift between distributed voltage and calculated voltage.
- Load current Ib.
- Power factor.

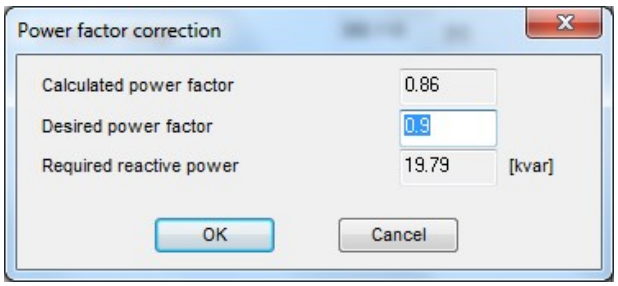


Multimeter Load-Flow window

Corrections

The "Corrections" push-button allows you to calculate:

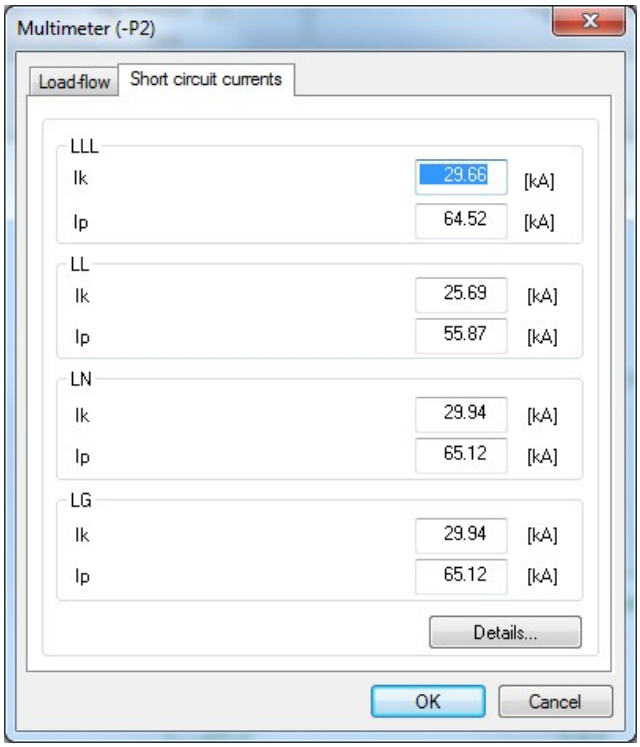
- The capacitive reactive Power required to correct the power factor of all the loads connected to the busbar in question to a new Power factor.
- The Power factor which will be reached depending on the capacitive reactive Power installed.



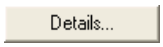
Power factor correction window

The values displayed in the Short-circuit currents page are:

- Short-circuit Ik and peak Ip current for Three-phase (LLL), Line-to-line (LL), Line-to-neutral (LN) and Line-to-earth (LPE) faults.



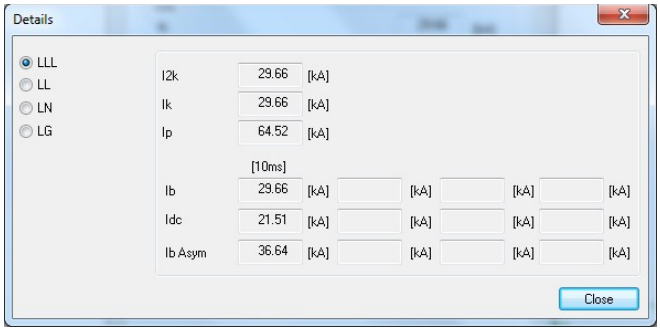
Short circuit currents Window



You can also display the "Details…" of the short-circuit calculations:

- Short-circuit current Ik and of peak Ip for faults Three-phase (LLL), Line-to-line (LL), Line-to-neutral (LN) and Line-to-earth (LPE).

The details show all the components of the short-circuit defined in the selected calculation Standard.



Window with Details of the Short-circuit currents

CB (LV circuit-breaker)

The "CB" (*LV circuit-breake)*" window displays the data used by the program to dimension the circuit-breaker itself. Filters are also available to help the program to select the most suitable circuit-breaker for the user's requirements.

You can also define:

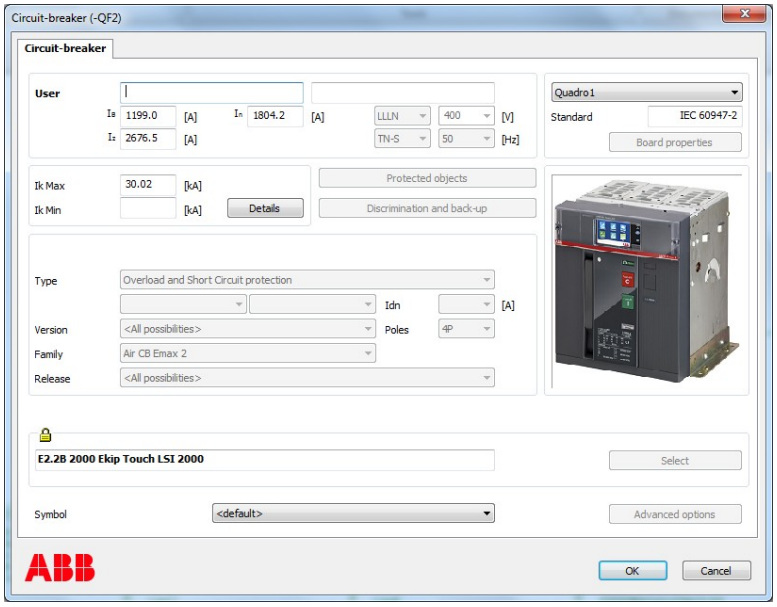
- Description of the User, on two lines.

The values used for selecting the circuit-breaker are:

- Load current Ib which passes through the circuit-breaker, used to determine the size Iu of the circuit-breaker itself.
- Carrying capacity of the cable Iz, used to select the circuit-breaker with a set current Ith lower than Iz.
- The Standard for use of the circuit-breaker (Industrial or IEC 60497-2; Civil or IEC 60898).
- Maximum fault current Max Icc, used to select the Breaking capacity
- Minimum fault current Min Icc, used to select magnetic setting Im of the circuit-breaker (if the circuit-breaker is not equipped with a residual current lock).

The following filters are available:

- Type: circuit-breaker with thermal magnetic release, thermal magnetic with residual current, solely magnetic, solely magnetic with residual current. This field is predefined according to the symbol drawn in the single-line diagram.
- Data of the accessorized residual current type:
  Waveform of the leakage current detected (A, AC, B).
  Tripping Characteristic (Instantaneous, Selective, Anti-disturbance).
  Rated sensitivity IΔn.
- Version: Fixed, Withdrawable, Plug-in.
- The Poles (1P, 1P+N, 2P, 3P, 3P+N, 4P).
- Circuit-breaker family: Moulded-case Tmax, Modular System Pro M Compact, Air Emax.
- Release: Thermal magnetic or Electronic.

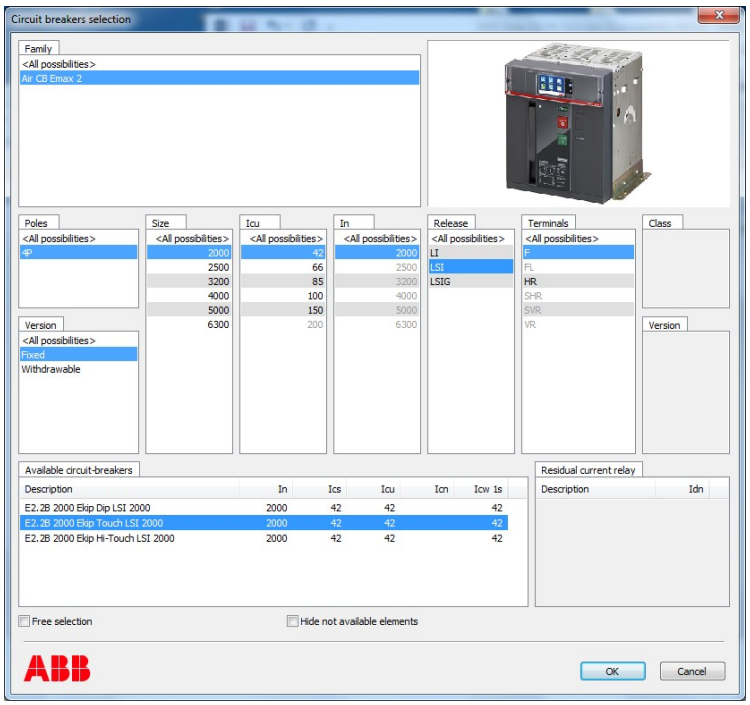


Main LV circuit-breaker window

The “Select >>” push-button allows you to select the desired circuit-breaker from a tree structure.

The filters set in the main window are:

- Maintained during product selection if “Apply filters” has been selected.
- Not considered during product selection if “Free selection” has been selected.

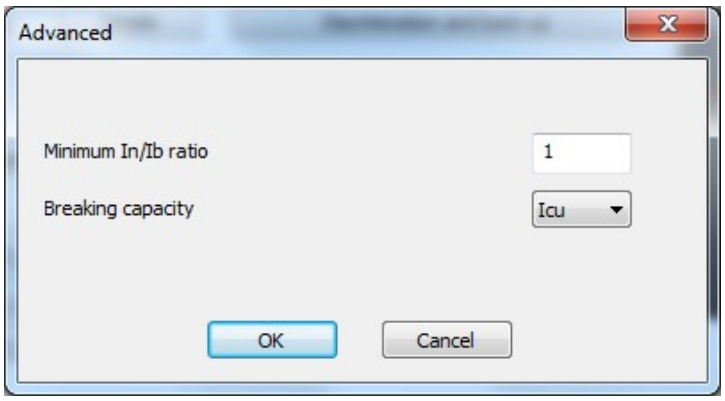


LV circuit-breaker Selection Window

Advanced options >>>

The "*Advanced Options >>>*" button allows you to define further criteria that become part of circuit-breaker selection:

- Number of adjacent circuit-breakers, introduces derating of the carrying capacity of the miniature circuit-breakers.
- Breaking capacity, selected between Icu or Ics. It is important to underscore that the breaking capacity refers to the circuit-breaker functioning at the service voltage of the plant.
- Definition of a minimum Icw short-circuit withstand.
- The list of protected objects
- The discrimination and back-up functionalities



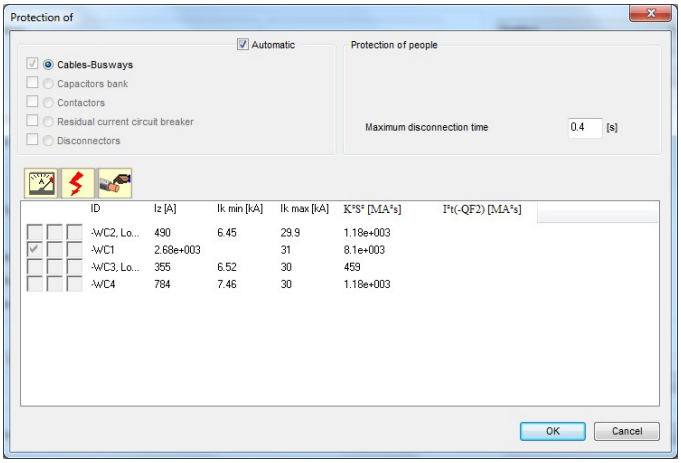
LV circuit-breaker Advanced Options Window

Protected objects

The "*Protected Objects*" push-button, in the "*Advanced Options >>>*" of the "*LV circuit-breaker*" allows you to display and, if necessary, assign the protections of cables, busways, switch-disconnectors, residual current circuit-breakers and contactors to the circuit-breaker.

The "*Protection of people*" data are taken from the General plant properties (chapter 2.1), and can be modified. These data are used for selecting the magnetic device and/or a possible residual current lock.

The short-circuit protections of residual current circuit-breakers, switch-disconnectors and contactors are established according to the values and the rules defined in the ABB coordination Tables.



Window of Objects Protected by a LV circuit-breaker

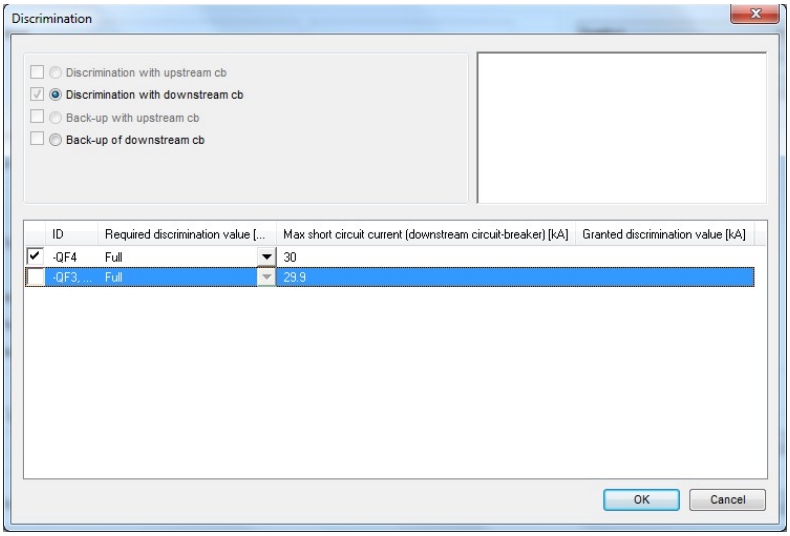
Discrimination and back-up

The "*Discrimination and back-up*" push-button in the "*Advanced Options >>>*" of the "*LV circuit-breaker*", allows two or more circuit-breakers with discrimination and back-up restrictions to be associated.

The discrimination and back-up values used for selecting the circuit-breakers are given in the ABB "*Coordination Tables*".

The fields displayed in the definition of discrimination are:

- Level desired: short-circuit value up to which discrimination must be verified. "Total" means: up to calculated Icc.
- Calculated Icc: short-circuit value of the circuit-breaker on the load side.
- Level: value of discrimination between the currently selected circuit-breakers.



LV circuit-breaker Discrimination and Back-up Window

Rc CB (Residual current circuit-breaker)

The data used by the program to dimension the residual current circuit-breaker are displayed in the "Rc CB" (*Residual current circuit-breaker)* window. Filters are also available to help the program to select the most suitable product for the user's requirements.

You can define:

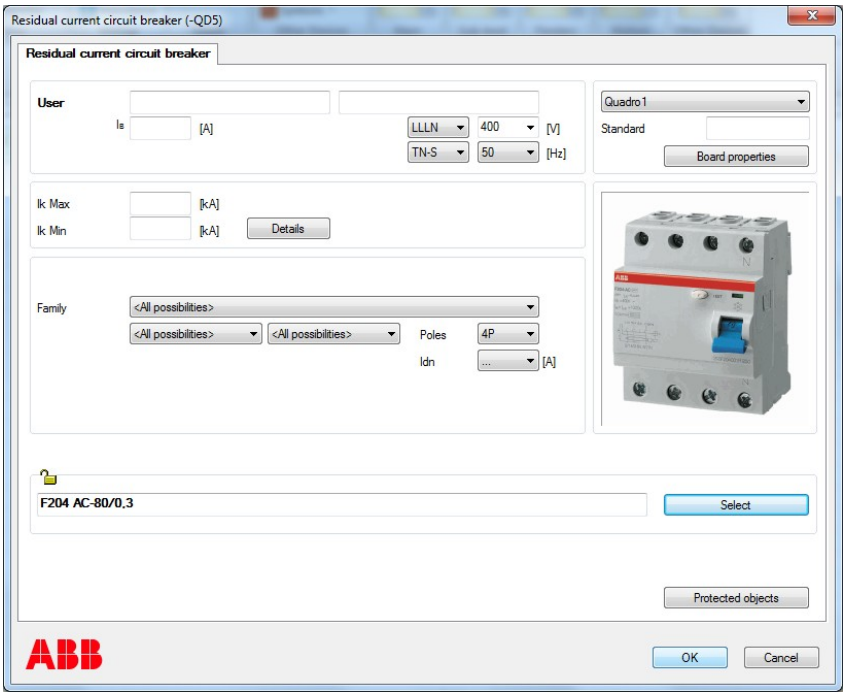
- Description of the User, on two lines.

The values used for selecting the circuit-breaker are:

- Load current Ib which passes through the residual current circuit-breaker, used to determine the size of the circuit-breaker itself.

The following filters are available:

- Circuit-breaker Family: Modular System Pro M Compact, Modular System Pro M.
- Residual current data:
  Waveform of the leakage current detected (A, AC, B).
  Tripping characteristic (Instantaneous, Discriminative, Anti-disturbance).
  Rated sensitivity IΔn.
- Poles (2P or 4P).

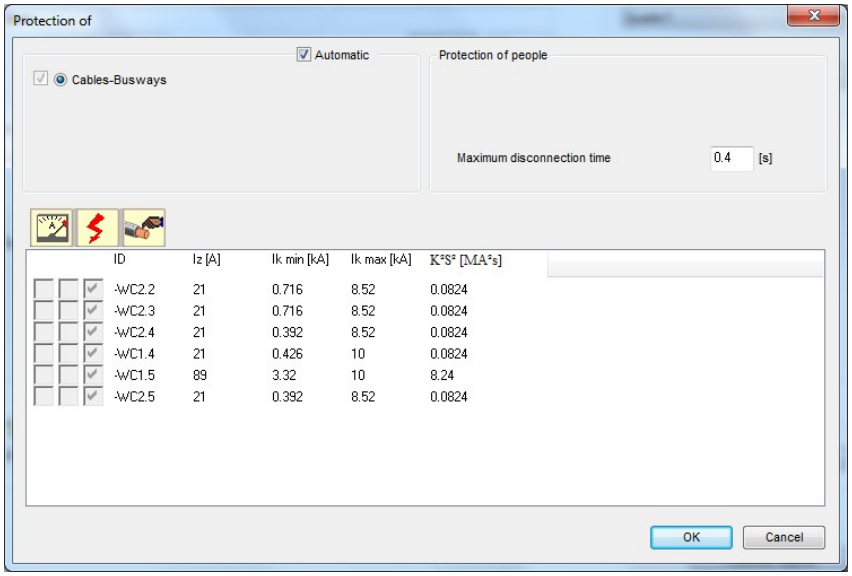


Main Residual current circuit-breaker window

Protected objects

The "Protected Objects" push-button allows you to display and, if necessary, assign the protections against indirect contacts of cables and busways.

The "Protection of people" data are taken from the General plant properties (chapter 2.1), and can be modified. These data are used for selecting residual current sensitivity.



Window of the Objects Protected by a residual current circuit-breaker

Fuse

The data used by the program to dimension the fuse are displayed in the "*Fuse*" window. Filters are also available to help the program to select the most suitable fuse for the user's requirements.

You can define:

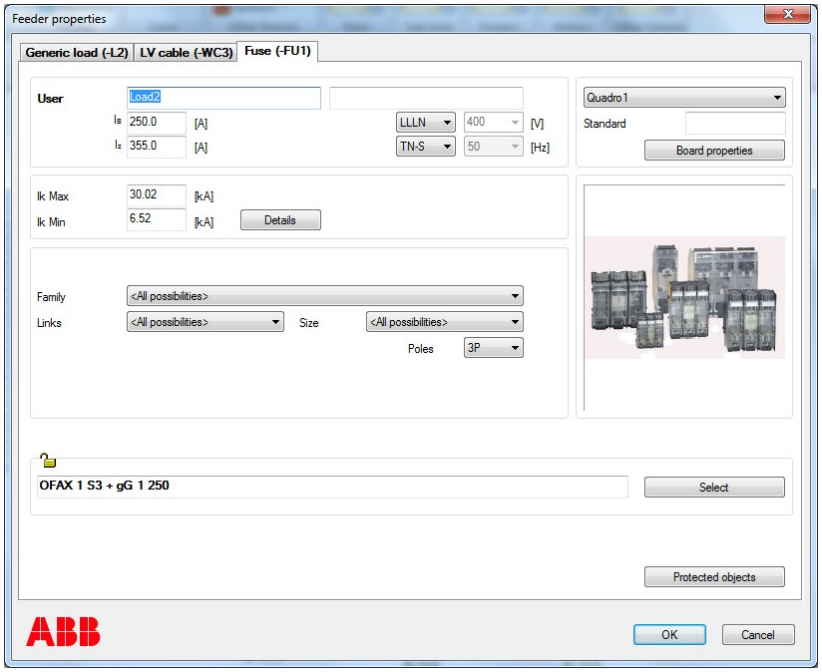
- Description of the User, on two lines.

The values used for selecting the fuse are:

- Load current Ib which passes through the fuse, used to determine the rated current In of the fuse itself.
- Carrying capacity of the cable Iz, used to select the fuse with a rated current In lower than the Iz.

The following filters are available:

- Fuse-holder base family: closed or open bases.
- Fuse data:
  Cartridge: gG for general use or aM for motor protection
  Cartridge size: 00, 0, 1, 2, 3
- Poles of the fuse-holder base (1P, 2P, 3P).

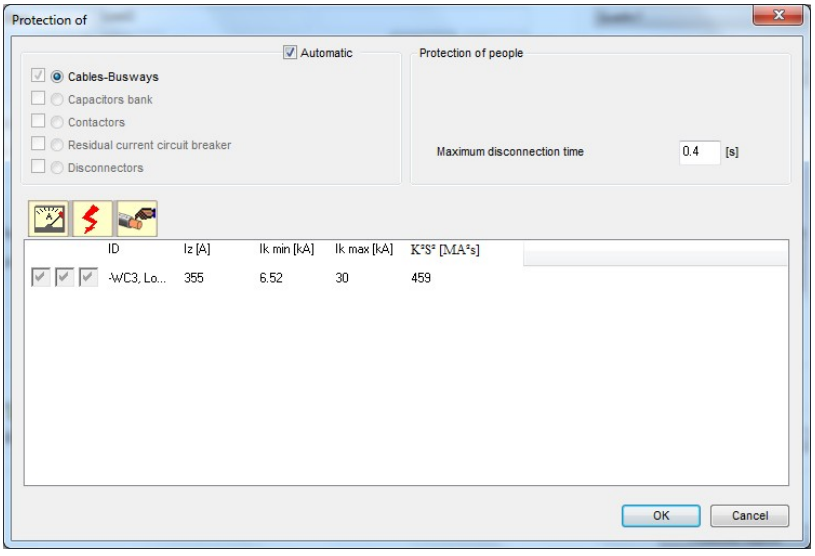


Main LV Fuse window

Protected objects

The “Protected Objects” push-button of the *Fuse* window allows you to display and, if necessary, assign cable protections, busways, switch-disconnectors, residual current circuit-breakers and contactors to the circuit-breaker.

The “protection of people” data are taken from the General plant properties (chapter 2.1), and can be modified.



Window of the Objects Protected by an Fuse

Switch-fuse

The data used by the program to dimension the switch-fuse are displayed in the "*Switch-fuse*" window. Filters are also available to help the program to select the most suitable fuse for the user's requirements.

You can define:

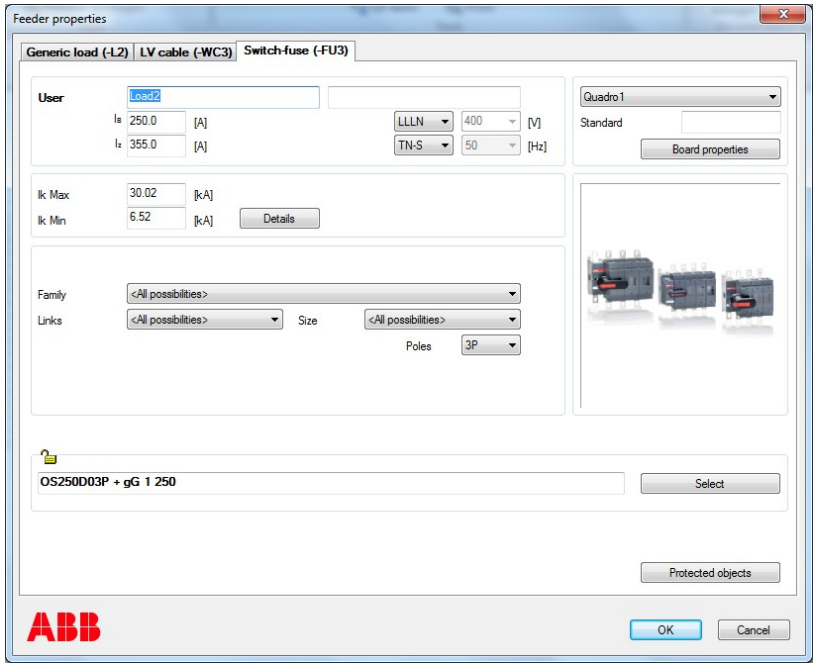
- Description of the User, on two lines.

The values used for selecting the fuse are:

- Load current Ib which passes through the switch-fuse, used to determine the rated current In of the fuse.
- Carrying capacity of the cable Iz, used to select the switch-fuse with a rated current In lower than Iz.

The available filters are:

- Switch-fuse family: E930, OS, OESA.
- Fuse data:
  Cartridge: gG for general use or aM for motor protection
  Cartridge size: 00, 0, 1, 2, 3
- Poles of the switch-fuse (1P, 1P+N 2P, 3P, 3P+N, 4P).

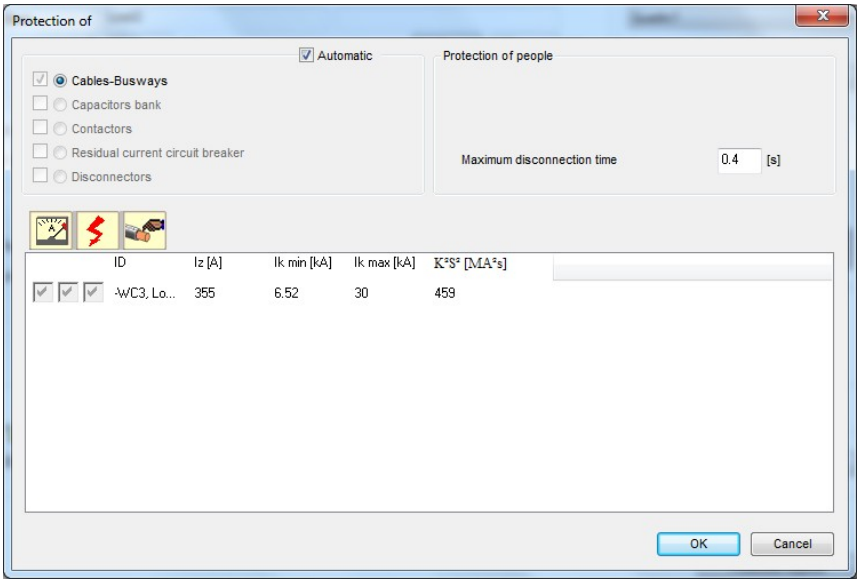


Main Switch-fuse window

Protected objects

The "Protected Objects" push-button of the *Switch-fuse* window allows you to display and, if necessary, assign cable protections, busways, switch-disconnectors, residual current circuit-breakers and contactors to the circuit-breaker.

The "protection of people" data are taken from the General plant properties (chapter 2.1), and can be modified.



Window of the Objects Protected by a Switch-fuse

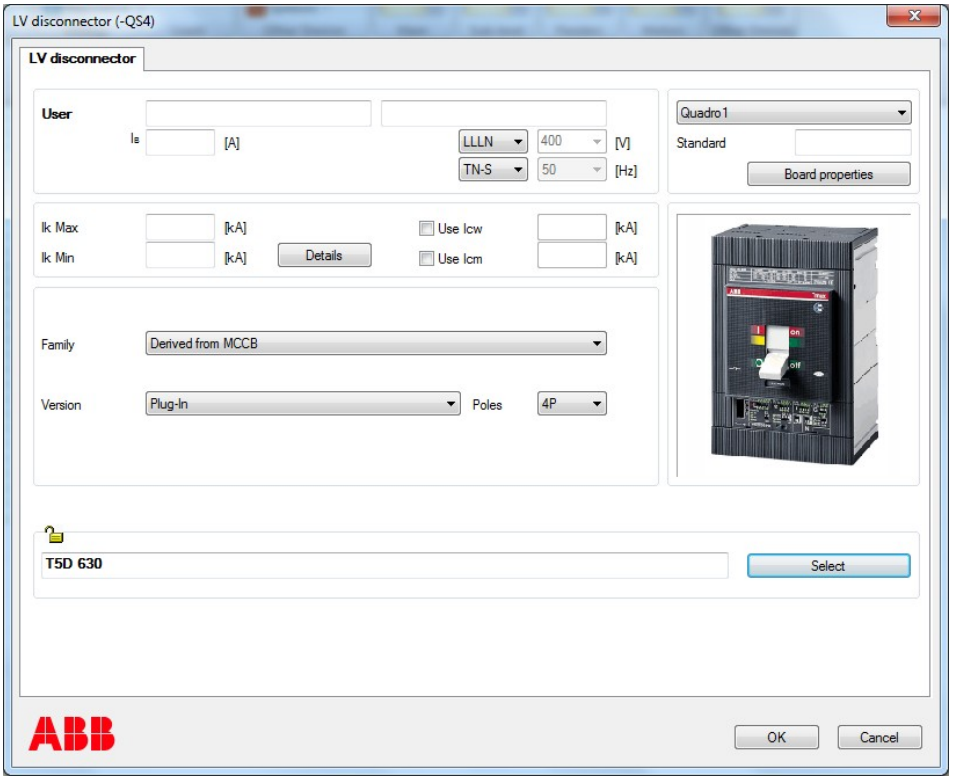
Disconnector

The following data can be defined in the "*LV Disconnector*" window:

- Description of the User, on two lines.
- Load current Ib which passes through the disconnector, used to determine the size Iu of the disconnector itself.

The following filters are available:

- Disconnector family: Standard Disconnector, or derived from an Moulded-case circuit-breaker or derived from an Air Circuit-breaker.
- Version: Fixed, Plug-in, Withdrawable
- Disconnector poles (3P, 4P).
- "Use Icw" and "Use Icm" serve to dimension the disconnector according to it's short-circuit withstand (Icw) and closing under short-circuit (Icm) characteristics. When both the boxes are disabled, the program dimensions the LV disconnector by trying to protect it with the first circuit-breaker on the supply side, using the data in the ABB coordination Tables.



Main Disconnector window

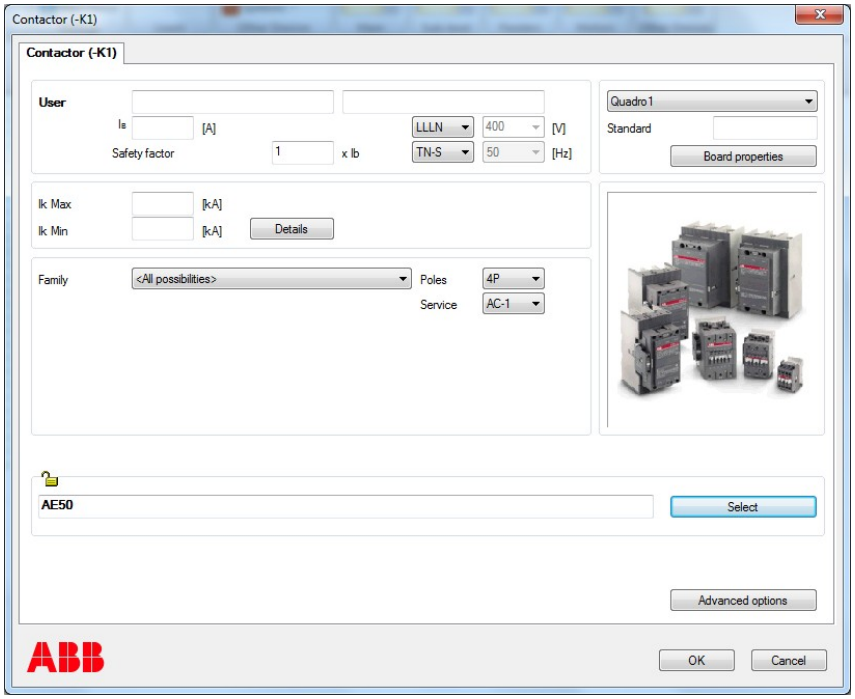
Contactor

The following data can be defined in the "*LV Contactor*" window:

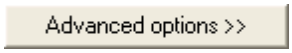
- Description of the User, on two lines.
- Load current Ib which passes through the contactor, used to determine the carrying capacity Ie of the contactor itself.

The following filters are available:

- Contactor Family: Industrial Contactors type A – AF,
- Contactor poles (3P, 4P).
- Contactor service: AC-1 (resistive loads), AC-3 (inductive loads).

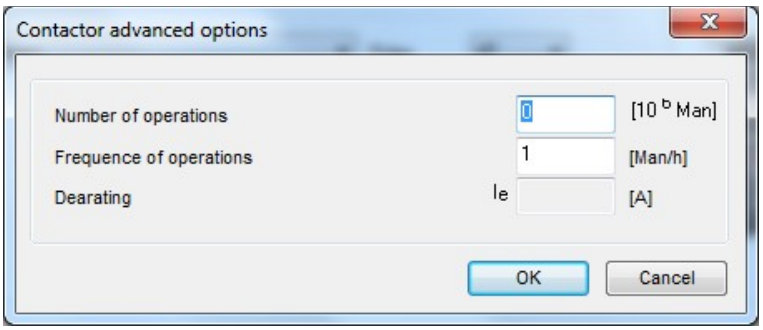


Main Contactor window



The "*Advanced Options >>>*" push-button allows you to define further criteria for selection of the contactor according to the number and frequency of operations.

Derating will show the carrying capacity Ie of the contactor.

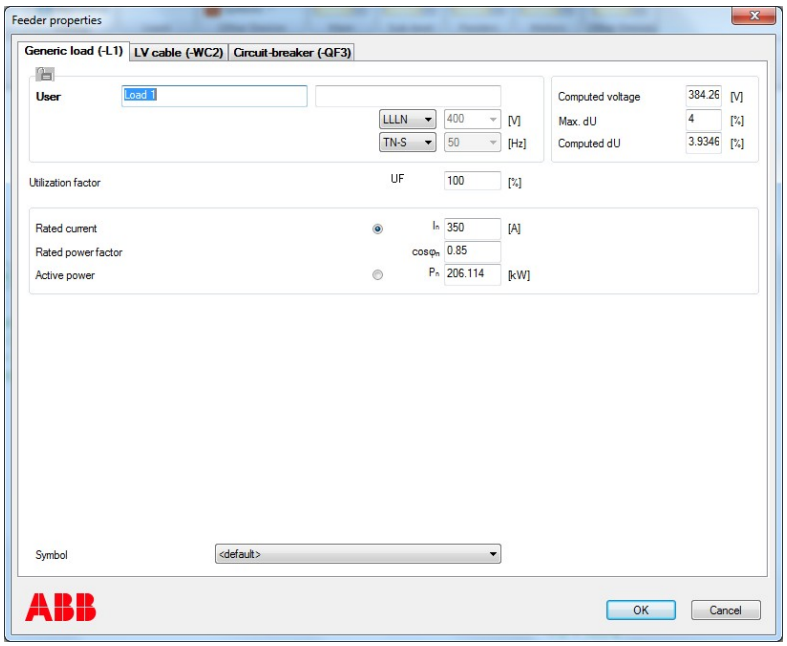


Contactor Advanced Options Window

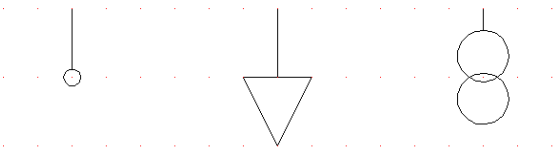
Load

The following data can be defined in the "*Generic load*" control panel:

- Description of the User, on two lines.
- The utilization factor (UF). A 100A load with 50% UF will generate a 50A current load Ib.
- Rated load current and Power Factor.
- Rated Power and Power Factor.
- Symbol with which the load will be displayed (a ball - an arrow - a transformer).



Main Load window



Graphic symbols of the Generic load

Motor

The following data can be defined in the "*Motor*" control panel:

- Description of the User, on two lines.
- The utilization factor (UF). A 100A motor with 50% UF will generate a 50A load current Ib.
- Motor model.
- Rated voltage
- Rated apparent Power
- Efficiency
- Rated power factor

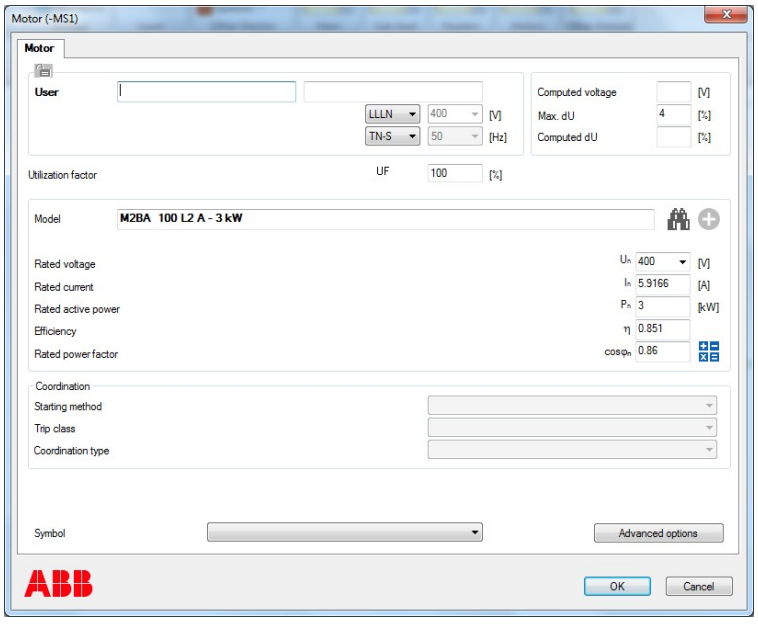
The rated current will be calculated from these data.

A motor database is also available:

- "< Load from database…" allows you to load a motor from the DOC motor database
- "> Add to database" allows you to save the motor currently defined in the DOC motor database. To be able to save a motor, the Model field must be filled in.

The coordination fields are only available if the motor is supplied from the Single Objects in one of the ABB coordinations, as in the Motor Feeder Macro Objects (chapter 3.2).
These fields include:

- Type of starting: Direct (DOL) or Star/Delta (YD).
- Starting class: normal (class 10) or heavy-duty (class 30).
- Type of coordination: Type 1 or Type 2.



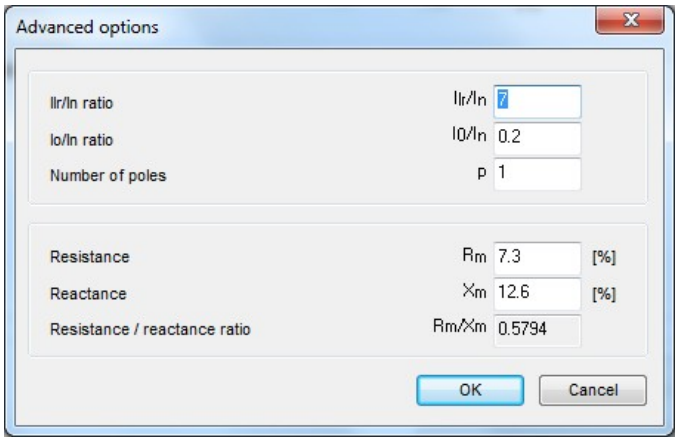
Main Motor window

Advanced options >>

The *"Advanced Options >>>"* push-button allows you to define other motor parameters.

These parameters are:

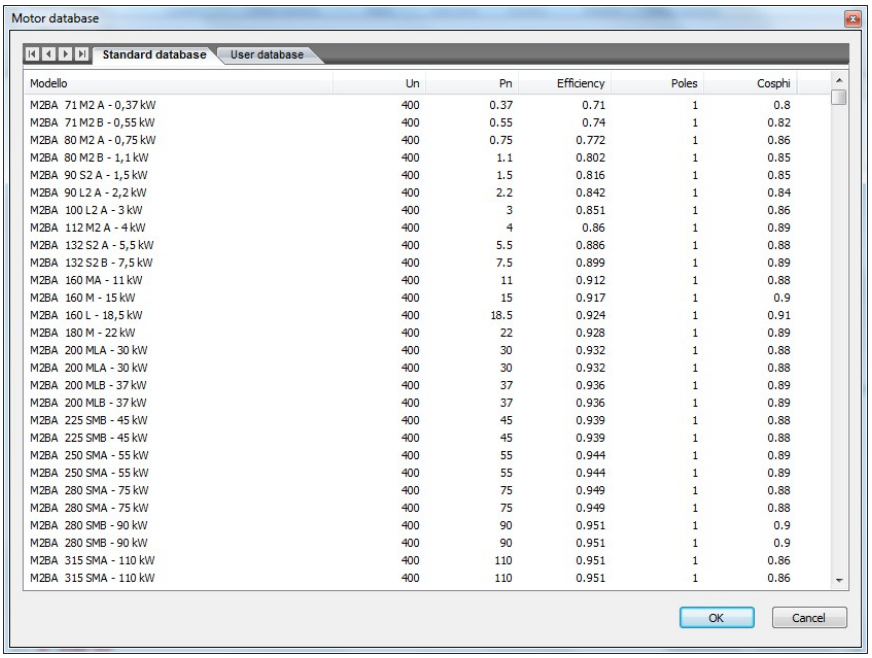
- The ratio between starting current and rated current Ilr/In
- The number of poles
- The Rotor and Stator resistances and the reactances, in 'per unit' (p.u.).



Motor Advanced Options Window

Standard database and user database of the motors

DOC provides users with an extensive motor database that is easily displayed by clicking on the binoculars to the right of the "Model" option of the "Motors" window.



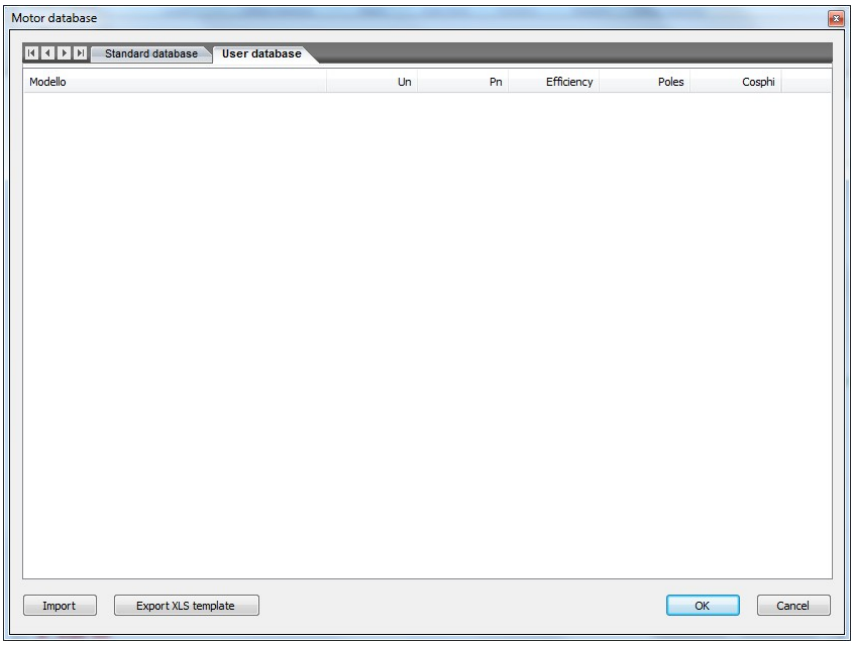
Standard motor database window

You can also create a customized motors database to suit your personal requirements if necessary.
To do this, proceed as follows:

Step 1: export the data model in the Excel format using the "*Export model XLS*" at the bottom right of the "*User database*" window.

Step 2: complete the data model obtained with the data of your motors

Step 3: using the "Import" command at the bottom right of the "*User database*" window, re-import the XLS model file complete with all the data.

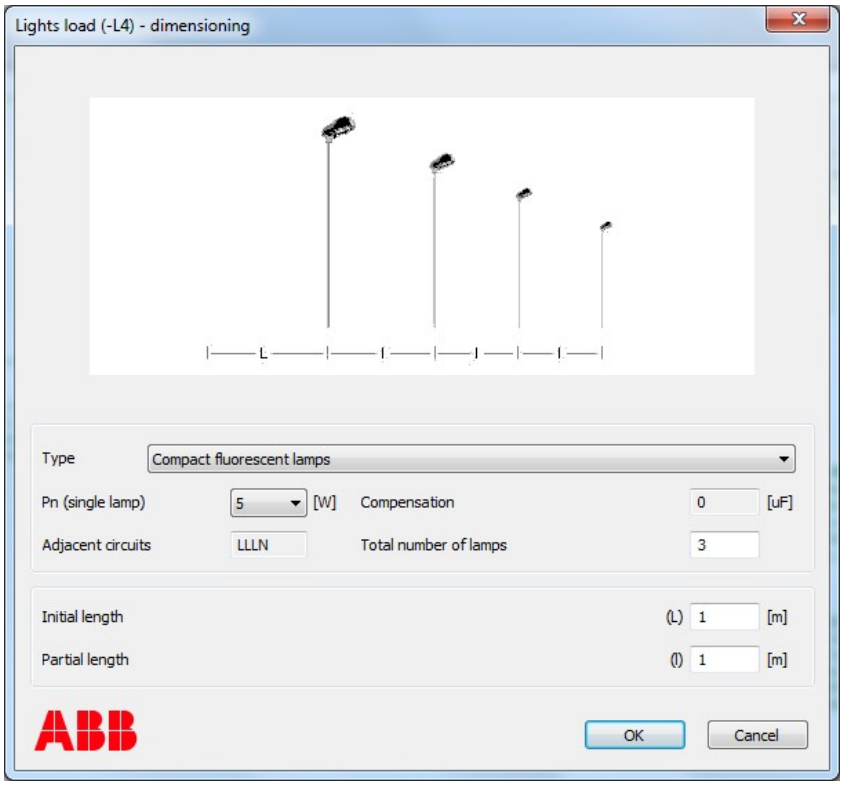


User motor database window

Lights (load)

The "*Lights*" considers both the load part and the cable part of a lighting plant. The following data are defined on the load side:

- Type of lamps.
- Rated power of each single lamp.
- The Phases loaded by the lamps.
- Number of lamps per phase.
- The length of the initial cable section as far as the first lamp.
- The distance between each lamp.

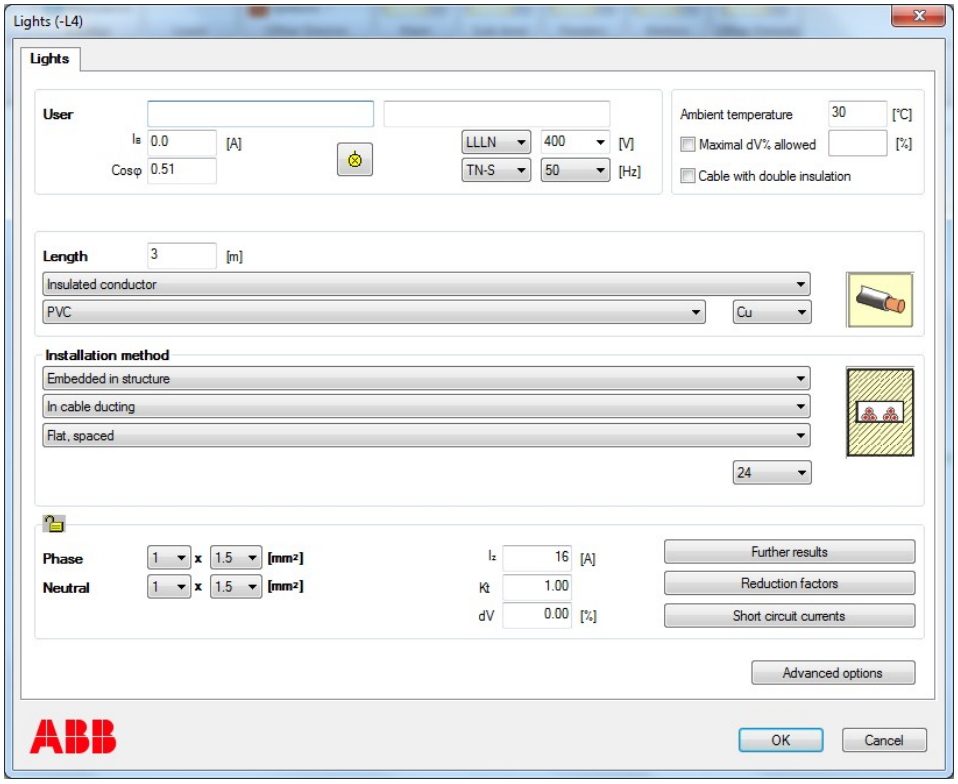


Lights window, load definition

Verify the "C*able*" Single Object described in this section for the cable side.

The length of the cable will be the result of "Initial length + (Number of lamps * Distance between each lamp)".

The lamp data on the cable side can be changed by clicking over the lamp-shaped icon.

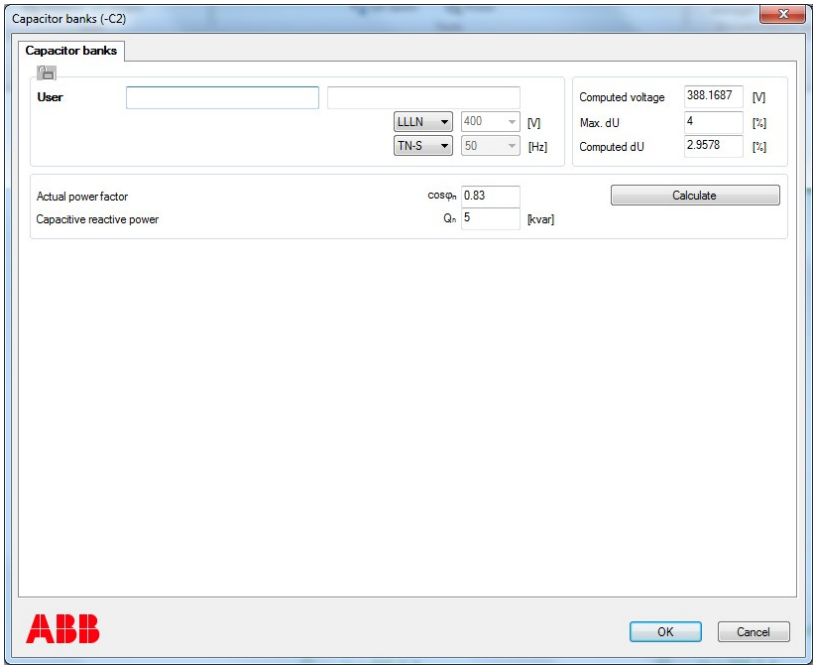


Lights Window, cable definition

Capacitor

The "*Capacitor*" allows the power factor to be corrected at a point in the network. In its window, you can:

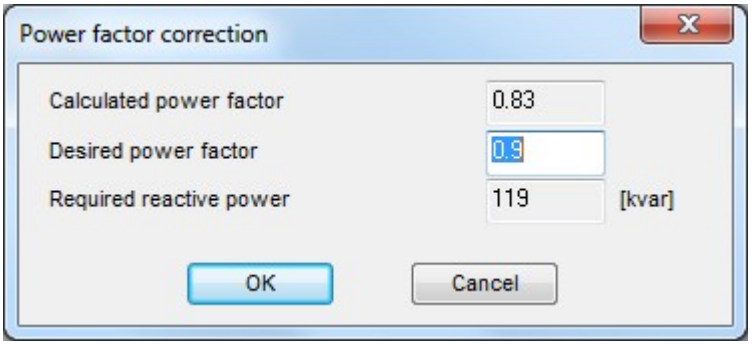
- Display the present Power factor of the busbar to which it is connected .
- Set any capacitive reactive Power value.



Capacitor window

The "Calculate" push-button allows the program to automatically select the capacitive reactive Power required to reach a given Power factor, starting from the present value.

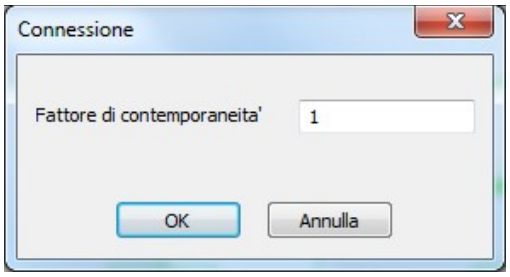
By confirming the calculation with "Ok", the calculated capacitive reactive Power will be added to the Capacitor.



Window for automatic power factor correction

Connection – Dashed Connection

The "*Connection*" and "*Dashed Connection*" Single Objects are used for connecting different Single Objects together. The demand factor can then be defined.

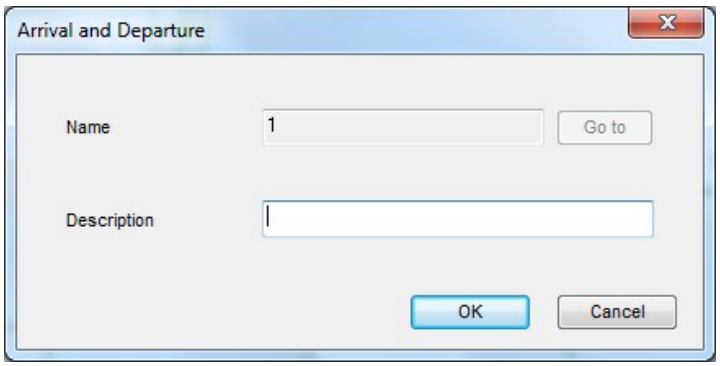


Connection and Dashed Connection Window

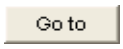
Horizontal and Vertical departure line

The "*Horizontal departure line*" and the "*Vertical departure line*" Single Objects connect Single Objects on different pages together.

The label that identifies each departure line is assigned automatically by the program, while the user can add a description.



Departure line Window

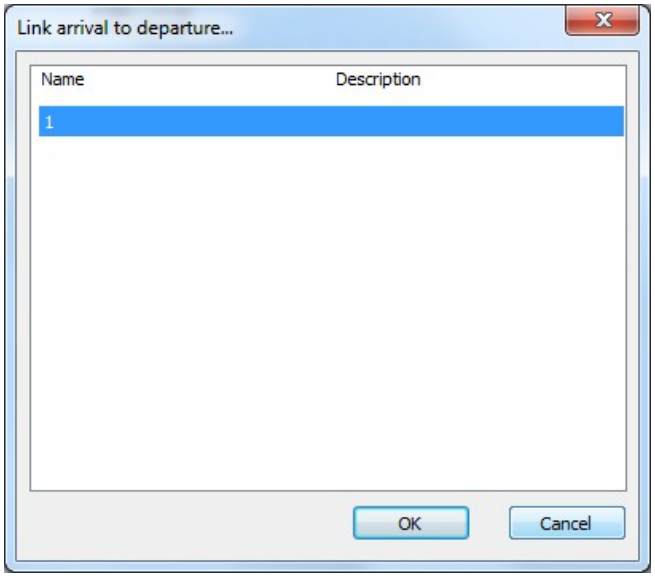


The "Go to" push-button links you directly to the connected arrival line.

Horizontal and Vertical arrival line

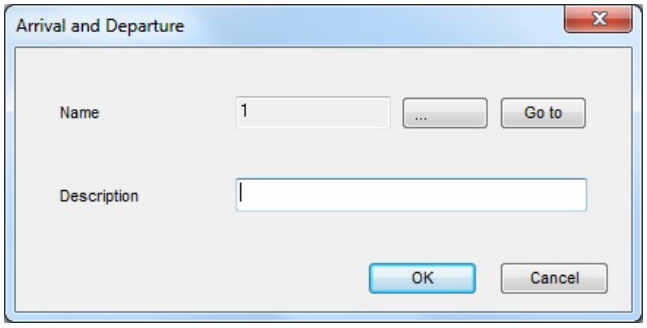
The "*Horizontal arrival line*" and the "*Vertical arrival line*" Single Objects connect Single Objects on different pages together.

The label that identifies each arrival line is assigned by the user by means of the "Link arrival to departure…" window.

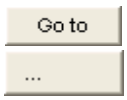


"Link arrival to departure…" window

The user can add a description.



Arrival line Window



The "Go to" push-button links you directly to the connected departure line.

The "…" button re-opens the "Link arrival to departure…" window.

10. End User License Agreement

The End User License Agreement (EULA) is available online at this location. (http://search.abb.com/library/Download.aspx?DocumentID=9AKK106103A2575&LanguageCode=en&DocumentPartId=&Action=Launch).