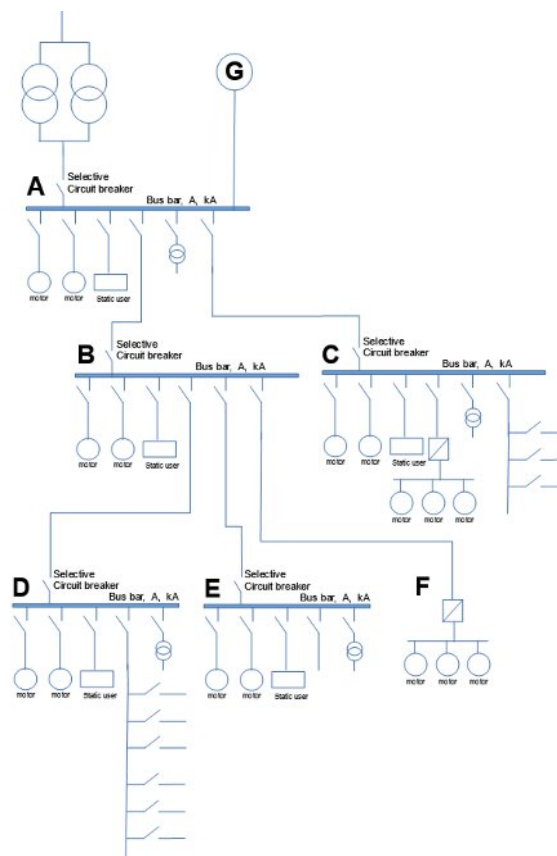


# KABEL<sup>++</sup>

## manual

Advanced and Light version



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## **1 INTRODUCTION**

### **1.1 General**

Thank you for purchasing this advanced application for calculating electrical current cable applications.

This concise manual is intended as a quick start to using the program. The manual is included with your purchase of KABEL++, but with particular focus on the advanced version, with all the options.

This manual does not go into detail on each component but describes its general use and gives an overview of the optional modules.

For other info on each component, each component, each output field, it is best to consult the help function belonging to the respective component. In the help function not only the program informs how to handle particular components or how it should be interpreted, but certainly provides electrical knowledge. You reach this help by resting the mouse on an input field and then pressing the F1 key.

Any comments, or suggestions for improvements, extra options, etc. are appreciated.

### **1.2 License**

The license is exclusive and based on annual permission to use the Kabel++ software by means of a serial number to be issued by Kabel++ B.V. that can be applied to the demo version of Kabel++. This demo version can be downloaded from <https://cablecalculation.eu/demo/> and is suitable for the Windows version currently issued and maintained by Microsoft.

The serial number is valid upon payment of fees as indicated at <https://www.cablecalculation.eu/Downloads/Orderform.php> and is valid for one year.

The license is automatically renewed annually without notice and the user will receive a new invoice.

The license is not transferable.

The serial number may not be distributed or copied.

Verification of the serial number is checked when using the software via an encrypted data file on Kabel++'s server.

The number of users is limited for one license to five users and one department and one postal-address. Use by an employee of perhaps the same department but in a different establishment is considered misuse.

#### *Verification:*

When using the software, the serial number is verified via an encrypted data file on the Kabel++ server. If an Internet connection is not available, Kabel++ will continue to function for two weeks without an Internet connection.

When using Kabel++ for the first time, you can download the demo version from the Kabel++ website and then install it on your Windows computer. After launching Kabel++, you can enter the license number and your company name -as provided to you by Kabel++- into Kabel++ via the main menu: Help > Unlock demo.

*Invoice:*

The date on the invoice counts as the start date for a license.

The invoice will be sent to the user along with the serial number after ordering and must be paid within two weeks.

*Use:*

The software is suitable for storage on a company computer network and for stand-alone PCs.

## **1.3 System requirements**

### *1.3.1 Local or in a network*

Kabel++ can be put on a corporate network or on stand-alone PCs, paying attention to the maximum number of users within the license.

### *1.3.2 Operating system*

Kabel++ is based on the latest version of Windows, but in practice Kabel++ also works on lower versions of Windows.

### *1.3.3 Memory*

No tests have been conducted, but no limitations are known from practical experience. The computer may slow down if there is very little RAM memory, but this is due to data swapping between the RAM memory and a reserved location on the hard disk, which is controlled by Windows.

*Screen adjust:*

Kabel++ is based on a screen resolution of 1600 x 1000 pixels and the screen scaling factor in Windows set to 100 %, but:

*At startup:*

When starting Kabel++, the program checks whether the resolution of the monitor combined with the scale factor is sufficient. If not, it zooms in proportionally. Over this, you can use the Zoom buttons to additionally enlarge or reduce the forms. The latter settings can be fixed on your computer.

*Zoom function:*

Apart from the zoom factor that Kabel++ applies during startup, you can use buttons to additionally zoom the windows in or out in increments of 15 %. You can store this zoom factor on your computer.

*Windows setting text size:*

Please note, however, that in the Windows window settings under 'Scale and layout' it is best to set the size of the text to 100 %. Kabel++ corrects for a set scale larger or smaller than 100 % but that does not always give an optimal presentation.

NB: If your PC or laptop has a screen with a high resolution, then you can set this high resolution together with a scaling of e.g. 125 %, but you can also set the screen resolution lower and the scaling to 100 %. The latter is preferable for Kabel++.

#### **1.3.4 Registry**

The user must have access to HKEY\_current\_user. Kabel++ uses this, among other things, for the most recently saved calculations.

The installation program needs access to HKEY\_classes\_root. Kabel++ does not use this itself.

#### **1.3.5 Internet access.**

In connection with your license, Kabel++ requires Internet access. Each time Kabel++ is started, Kabel++ opens a coded file from the Kabel++ website.

If an Internet connection is not available, Kabel++ will continue to function for two weeks without an Internet connection.

#### **1.3.6 Folders**

The following folder within the Windows system are used:

- The folder [C:\Users\user\AppData\Local\Temp] must be accessible. Incidentally, this location may be different for each Window setting.
- The folder [C:\Users\user\My Documents] is opened as being the default location for documents, but does not need to be used.
- The program itself defaults to the [C:\Program Files (x86)\Kabel++] folder during installation.

### **1.4 Installing Kabel++ on a PC or network**

Kabel++ can be installed on a stand-alone PC or laptop or in a network environment.

For the network environment, see also below for information on how to deal with updates.

The following steps must be followed by the user in the case of a shared stand-alone PC, and/or by the IT department in the case of a network installation:

- 1) Download the demo version of Kabel++ from:  
[https://www.kabelberekening.com/DownloadSetup/Kabel\\_advanced\\_setup.exe](https://www.kabelberekening.com/DownloadSetup/Kabel_advanced_setup.exe)  
or, if you have the Light version:  
[https://www.kabelberekening.com/DownloadSetup/Kabel\\_light\\_setup.exe](https://www.kabelberekening.com/DownloadSetup/Kabel_light_setup.exe)  
Save this demo setup, for example on your desktop. You can delete it afterwards.
- 2) Start the setup program. Kabel++ will now be installed on your computer or network.

Kabel++ is now installed.

The user must now activate the program for full use:

- 1) Start Kabel++ from the Windows Start menu.
- 2) In Kabel++, select 'Help' from the main menu.
- 3) Then select 'Unlock demo'.
- 4) Enter the serial number and company name you received from Kabel++.
- 5) Then click on 'Close'.

## 1.5 Updates

Within the license, Kabel++ checks at startup if there is an update ready to install. In addition to improvements and error corrections, an update can also contain extensions or changes because the electrical world is constantly changing.

### *Update and the user has admin rights, on the stand-alone PC*

As soon as Kabel++ displays a message upon startup that a new update is available, the user can install it by clicking on 'install update'.

### *Update and your PC/laptop is not completely closed, Microsoft Defender Vulnerability Management is active*

When installing an update, Windows checks whether the software is known. If not, the error message 'Attack Surface Reduction rule' is displayed. In that case, you can request your IT department to include Kabel++ as an 'exception' in the rules.

### *Update and closed PC/laptop*

If you are installing an update and your computer does not have administrative rights, you will need to contact your IT department for approval.

### *Update management ICT department*

Upon request, you can receive an email notification when a new version is available. This is primarily intended for ICT departments that manage application endpoints using tools such as RMM/N-central/Intune/NinjaOne/Chocolately. To be included in the mailing list, please send a request to sales@kabelpp.com.

To prevent the user from unnecessarily seeing the initial startup screen with the disclaimer and standard voltage and such, the following settings can be made in the registry during distribution, hold in a the script:

HKEY\_CURRENT\_USER\Software\Kabel\

|                             |        |                                                         |
|-----------------------------|--------|---------------------------------------------------------|
| vrijgave_serienummer        | REG_SZ | encrypted number, to be requested separately by Kabel++ |
| vrijgave_bedrijfsnaam       | REG_SZ | company name provided by Kabel++                        |
| updatemelden                | REG_SZ | 'never' (user cannot select informed for new update)    |
| regwordtingestelddoorafdICT | REG_SZ | 'yes' (initial setup screen is no longer displayed)     |
| language                    | REG_SZ | 1 (set language to 0=Dutch 1=Englisch 2=German)         |
| logo_emptylines             | REG_SZ | FALSE                                                   |
| logo_filename               | REG_SZ | c:\.....\...\logo...jpg                                 |
| logo_hor_pos                | REG_SZ | value (default 0.7)                                     |
| logo_hor_pos_land           | REG_SZ | value (default 1.1)                                     |
| logo_hor_scale              | REG_SZ | value (default 0.25)                                    |
| logo_repeatlogo             | REG_SZ | value (default FALSE)                                   |
| logo_ver_pos                | REG_SZ | value (default 0.06)                                    |
| logo_ver_scale              | REG_SZ | value (default 0.3)                                     |

Please note that with these settings, the user will no longer receive the disclaimer, which means that the responsibility for communicating this to users now lies with ICT.

To assign the .KBL extension to Windows, the Setup program makes the following settings in the registry in HKEY\_classes\_root

|                            |        |                                                             |
|----------------------------|--------|-------------------------------------------------------------|
| .kbl                       | REG_SZ | kblfile                                                     |
| kblfile                    | REG_SZ |                                                             |
| kblfile\DefaultIcon        | REG_SZ | C:\Program Files (x86)\Kabel++\Pictures\kabel.ico (example) |
| kblfile\shell\open         | REG_SZ |                                                             |
| kblfile\shell\open\command | REG_SZ | C:\Program Files (x86)\Kabel++\kabel.exe "%1" (example)     |

## 1.6 Language

The program can be set for Dutch, German and English. There are 3 options for the language selection:

1. Language of the menu and windows.
  - a. per calculation to be set in the main menu under 'View' and then language choice (Dutch: kijktal, German: Ansicht-Sprache). This setting is saved when saving the calculation in the .KBL file.
  - b. Fixed after installing Kabel++. This setting can also be adjusted in the main menu under settings. This setting is saved when saving the calculation in the .KBL file, and is also saved in the program itself so that this language is set again the next time it is restarted.
2. Language to the printer. This can be set with every print job. Exception is the network module. This follows the setting of the menus.

## 2 FILE MANAGEMENT

### 2.1 Buttons

You can save the entered data in every calculation sheet using this button:



The main menu contains shortcuts to open file, save, etc.:



### 2.2 Saving

When you use the “Save As” command, you will be prompted to enter a file name. All parameters from all modules are saved in a file with the **.KBL** extension.

### 2.3 Project Data

If you print the calculation, the program will ask for information such as the project name. This data is saved in a separate file named **Kabel++projectdata.prj**, which is stored in the same folder as the **.KBL** file.

### 2.4 Backup

The program has two different backups:

- With every 'save file' command, when overwriting a previous calculation, the filename of this previous calculation is changed to the **.BAK** extension.
- When starting a calculation, a file is saved with the **.BK** extension. However, the notes are not saved in this backup.

### 2.5 Parameter Set

In the network module, you can save a parameter set. This has the **.PRM** extension.

### 2.6 User protection device curve

Applies if you have Module K. A curve can be entered for a specific type of safety. The file extension for the file with the entered curve is **.UPD**. (user protection device).

### 2.7 User cable specifications

Applies if you have the K module. You can enter specific specifications for a custom cable type. The file extension for a file with these cable specifications is **.UCF** (user cable file).

### 3 QUALITY ASSURANCE

#### 3.1.1 *With regard to the calculation results*

Kabel++ B.V. makes every effort to maintain the reliability of the calculation results. However, it cannot avoid a disclaimer as indicated on page 2, and unfortunately it has not been possible to certify the software with, among others, TUV because such a notified body cannot fully understand the software. However, the production of the software is considered separately from the test procedures. Changes in the software are only released after the tests have been passed.

Nevertheless, the user of Kabel++ must ensure with each calculation that the calculation result corresponds to what can be expected from experience and must carefully check all data in the calculation printout. Kabel++ B.V. accepts no liability and gives no guarantee.

#### 3.1.2 *With regard to administration*

Incoming and outgoing email traffic relating to orders and deliveries is stored as PDF files in a document management system. This system is synchronized with Dropbox. For information about the security of Dropbox, please refer to [www.dropbox.com](http://www.dropbox.com).

#### 3.1.3 *GDPR, General Data Protection Regulation.*

Kabel++ BV is committed to complying with the GDPR. Only the names and addresses of licensees are stored in an encrypted data file on our website. Further details of licensees, such as email addresses and telephone numbers, are stored in an internal spreadsheet for our own use, primarily for invoicing purposes. Kabel++ does not engage in mailing or other cold acquisition activities.

### 3.2 ICT security and quality assurance

#### 3.2.1 *Certification*

*Kabel+ BV does not have external certification such as ISO 9001 (quality), ISO 27001 (information security), or NIS2 (European Network and Information Security Directive). One of the reasons for this is that the company is sufficiently small and straightforward.*

#### 3.2.2 *Quality assurance*

Changes to the software are tracked in the update protocol.

Changes are tested after the design and implementation phase and, once approved, are included in a new update. Updates are released approximately once a month.

#### 3.2.3 *Security, Cyber security*

The following precautions have been taken:

- Employees are instructed to be vigilant about phishing and similar threats.
- Kabel++ does not have a network of connected computers, but relies on the security of Dropbox.
- Anti virus and firewall: Every computer or laptop is based on Windows and equipped with Microsoft Defender for anti virus and network protection.
- The computers on which the Kabel++ application is developed are additionally equipped with HP Wolf security.
- Software development application: The latest version of Delphi RAD Studio is always used for the (<https://www.embarcadero.com>).
- Installation program: The latest version of InnoSetup is used for the. (<https://jrsoftware.org/isinfo.php>).

- Certificate: GlobalSign is used for the certificate in the setup. (<https://www.globalsign.com>).
- Company Wifi: Asus Zenwifi with AiProtection. Access to this router is prohibited against USB sticks or attached storage. Also “The wireless router is currently using a private WAN IP address. This router may be in a multiple-NAT environment, and accessing AiCloud from WAN does not work”

#### 3.2.4 *Anti-virus*

Kabel++ does everything in its power to prevent viruses from accidentally entering the software. However, experience has shown that even if there is no virus present in the software, the user's anti-virus application may still flag it as a virus. This is because the anti-virus program encounters a series of codes that are also found in a virus. Vigilance in this regard is therefore required.

#### 3.2.5 *Access to the Internet*

Due to license verification, Kabel++ requires access to the Internet when the program is started. This involves downloading an encrypted license file. No further data exchange with the Internet takes place.

#### 3.2.6 *Disclaimer*

Kabel++ does not provide any guarantee, either explicit or implicit, against the occurrence of viruses, hacks, spyware, or other types of cyber attacks or malpractice. Under no circumstances will Kabel++ be liable for consequential damage in this regard.

The user must take all necessary security measures themselves, such as using antivirus and anti-phishing software, providing instructions, and so on.

## 4 SCOPE OF APPLICATION

### 4.1 Range in voltage and current

- AC voltage and DC voltage,
- maximum current throughput about 4000 A. The limitation includes the maximum number of cables in parallel. This number is otherwise adjustable,
- very low voltage to high voltage approx. 30 kV,
- frequency from DC to 'kHz.
- power up to approx. 3 MW.
- distances up to about 1 km.

### 4.2 Methodologies and standards used

Electrical conventions were basically established by the IEC. After a first congress took place in Paris in 1881, the commission was established in 1906 between British and American engineers. Virtually all countries in the world are members of or affiliated with this commission, and have aligned their electrical installation standards with it. In Europe, the commission CENELEC is responsible for standardization. IEC 60364 is listed by CENELEC as harmonized document HD 60364.

Kabel++ is based on the European standardized IEC 60364. The national standards such as the Arei, BS7671, CEI, NEN1010, NF C 15-100, NIN/SN 411000/SEV 1000, OVE E 8100, VDE 0100/0298, are harmonized on this. (Would it be an idea to eliminate all national standards?) In addition, there is a strong reliance on electrical engineering formulas and calculations which obviously do not depend on standards and regulations.

The allowable thermal load of cables used by Kabel++ is based on the tables indicated in the national standard (BS, NEN, OVE, VDE, excluding the Arei), and which in turn are calculated based on the calculation methods of the IEC 60287.

A single difference between the national requirements is, for example, the allowable voltage drop. Similarities are the tables for thermal load, the maximum duration of a short circuit. Another difference is that in America in particular, cable cross sections are standardized differently ( $\text{mm}^2$  versus AWG). By the way, these are also included in Kabel++.

Regarding standards:

- Short-circuit calculations are based on, for example, IEC 60909 although it must be said that this is actually a representation of electrical engineering and not so much something to be agreed upon.
- Various settings that can be made such as maximum simultaneous load of switches (IEC 64139, 60204), fuses, cables (70 % in IEC 60364), intermittent operation with cables in the ground (IEC 60853), intermittent operation in cable compartments (ship's standard IEC 60092) are laid down in standards and can be found in the program.
- In addition, there are harmonized documents to which Kabel++ refers, such as, in particular, HD 60228 in which the minimum amount of copper or aluminum is prescribed. Importantly, some cables from China that do not comply with this standard are factorized in Kabel++.
- The net cross-sectional area of the shield is of particular concern. In principle, this is standardized in HD 603, 604, 620 (high voltage), but various manufacturers deviate from this in order to keep a cable

cheap.

Exceptions for some countries:

- Exception in the Belgian AREI: touch safe is always prescribed and in addition the current load tables from the IEC 60364 are not adopted but reference is made to good workmanship with the exception of cabling in households.
- England: For now, in drama of the Brexit, it has been decided that the BS will continue to follow the European standards.
- Japan: It mainly follows the IEC standards, but has more cross sections in mm<sup>2</sup>.
- USA: The low voltage standard is the NEC. The cross sections are indicated as AWG dimensions. Furthermore, there are differences in the way, as well as additional requirements, in which an electrical panel is set up.

As far as cable calculation is concerned, and everything related to it, no further differences are known per country.

### 4.3 The BS 7671 and more

Electrical engineering goes beyond the 7671. The 7671 establishes various agreements that would be desirable in the Netherlands. This follows the IEC 60364 as indicated above. But because Kabel++ includes all facets of engineering, more standards and formulas are used than the 7671 knows. This causes some confusion for some who are not aware of other standards and formulas. The use of the cyclic factor in IEC 60853 is an example of this.

### 4.4 Current tables from norms, standard and component suppliers

Standards, but also suppliers form motors or circuit breakers etc., supply tables for cable cross-sections by a given size of the protection device. These cross section may differ from the calculation results of Kabel++ due to that Kabel++ reckons with many more parameter.

For the current load -ampacity- tables, the maximum current capacity for other types of material is determined on the basis of the XLPE insulated cable tables that have been taken from the BS norms, and for other materials except EPR and PVC, the calculation is based the XLPE tables, corrected for the thermal resistance, maximum operating temperature of that isolation material, and formulas noted in the IEC 60297. For the most common used kind of cable isolations the values of the thermal resistant and temperatures are known in the program.

### 4.5 Tolerances

In calculations in Kabel++ there are hardly any margins/reserve taken for e.g. shut-off values of the short-circuit current compared to the characteristics of the release. The reason for this is that margins have already been included in the characteristics of the protection devices. If Kabel++ did that in this case, it would be done twice. However, a tolerance is taken into account among other things in the mains voltage. This value can be set using the file 'Kabel.def' under Busbar System.

## 5 QUICK START

### 5.1 General

In the advanced version, a selection menu is displayed after startup. In this selection menu, one can use the indicated buttons to start the corresponding calculation sheet, or load a previous calculation.

After the program has been started, the main menu is displayed. Here any relevant calculation window can be invoked by using the buttons, as indicated.

The first time it is recommended to start with the module single-cable calculation.

In this sheet, blue panels indicate the basic operations. By entering a value in the fields indicated by the arrows, these blue panels disappear successively.

The screenshot shows the main input area of the KABEL++ software. On the left, there is a 'Type of load' dropdown menu currently set to 'Supply static [input current]'. Below it are three input fields: 'Design current I<sub>b</sub>' with a value of 700 A, 'Voltage (phase-phase)' with a value of 400 V, and 'nr of phases/DC' with a value of 3 ~. On the right, there is a 'Result' field showing 'mm²'. Two blue callout boxes with arrows point to the 'Type of load' dropdown and the 'Design current I<sub>b</sub>' input field. The first callout says '1) Start here to choose the type of the load,' and the second says '2) then here to enter the correct power consumption or nominal design current,'.

Advanced version:

At first start, all panels are grayed out and not all fields are visible. Only the most necessary for a quick cable calculation. Apart from a quick cable calculation, this gives a quick impression of the structure and operation of this cable calculation sheet for the first time. If you click the [Advanced] button, in addition many more fields becoming visible and the color palette will be adjusted.

The basic idea behind all modules is to enter the power that the cable must pass through, select what the cable will be protected with, and then click on the calculate button.

## 5.2 The following color scheme is maintained

### Advanced version

| Adjustment fields                 | Color        |
|-----------------------------------|--------------|
| Input of number                   | Creamy white |
| Fields with selection from a list | White        |
| Result fields                     | Pink         |
| Panels                            |              |
| Short circuit data                | Light red    |
| Cable data                        | Light blue   |
| Energy-adjustments                | Olive green  |
| Protection devices                | Yellow       |

### Light version

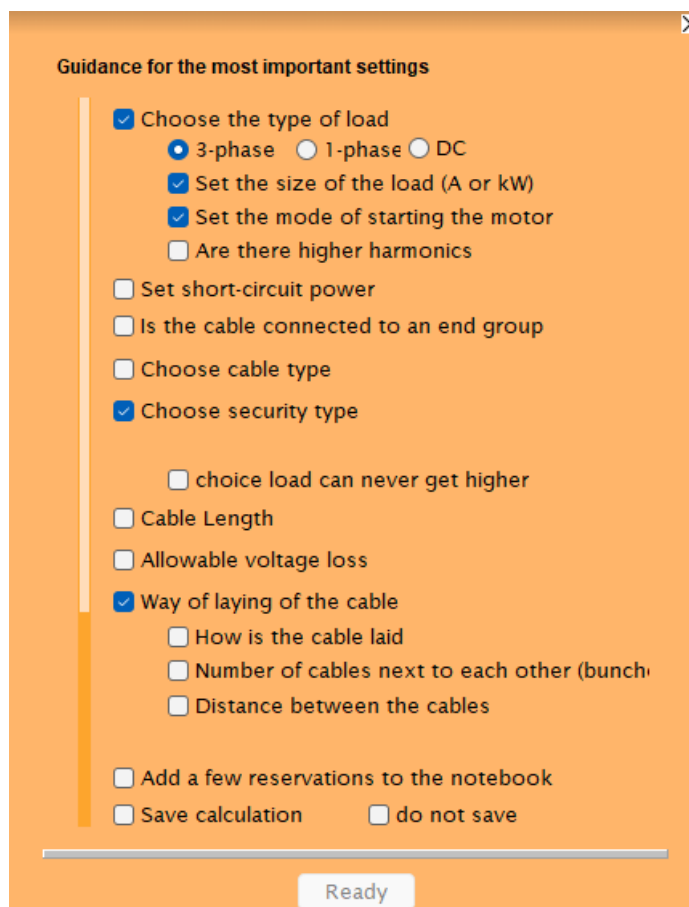
| Adjustment fields  | Color      |
|--------------------|------------|
| Input of choices   | White      |
| Result fields      | Dark Grey  |
| Panels             |            |
| Short circuit data | Light grey |
| Cable data         | Light grey |
| Energy-adjustments | Light grey |
| Protection devices | Light grey |

### 5.3 Color usage in the advanced version

|                                            |                                                                                                                                                                             |
|--------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Area's concerning short circuit strength   |                                                                                          |
| Area's concerning discrimination           |                                                                                          |
| Area's concerning protection, motorstarter |                                                                                                                                                                             |
| Area's concerning the cable construction   | <br> |
| Area's concerning the cable route          |                                                                                                                                                                             |
| Area's concerning cable parameters         |                                                                                                                                                                             |
| Area's concerning energy                   |                                                                                        |
| Calculated outputfields                    |                                                                                        |

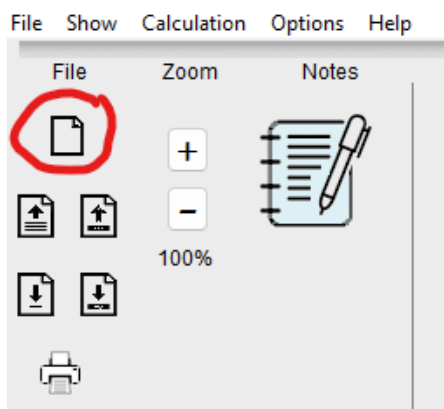
## 5.4 New calculation

After starting the program and selecting to calculate a single cable, this single calculation module opens, in which an orange panel is displayed:



You can view this orange panel as a companion or guide to walk you through the most important parameters.

You can start a new calculation from the main menu via:



## 5.5 General program settings

After installation, you can make the following changes:

- When you did install the demo version before, then it may only sometimes (Windows Vista sometimes) be necessary to uninstall the demo version prior to the installation of this full version. If necessary use an uninstaller such as Revo uninstaller. But normally an uninstall is not necessary.
- Default settings for KABEL++ can be changed by editing the 'Kabel.def' file.  
Note that the duration of a short-circuit follows the 5 second rule, after which period the Protection device mechanism shuts off. In most countries, allowing 5 seconds before shutting off a dangerous situation is acceptable for industrial installations. However, in some countries, as well as in domestic installations, this is not allowed and the dangerous situation must be shut off once a voltage (high enough to cause electrocution) is reached. This is generally considered to be around 50 V. The maximum safe touch voltage parameter is controlled by changing the "touch safe" value.
- You can set the default language to your own preference, by making that change in the main menu under adjustment language.
- The blue start hints can be prohibited within the file 'Kabel.def', line "Show start here hint".
- You can find further information in the 'Readme\_al.txt' and 'Copyright-disclaimer\_al.txt' files. These files cannot be changed.

## 5.6 Modules overview (advanced version)

For the proper use of the package it wise to get notice of the overview of the software. Not only how to use the buttons and fields, but how the modules in the package are linked to each other and how it is build to a total installation. So is the short circuit the main module. The other modules are as you may say a child from that. The other modules, cable module, the trunk cable module and the network module can be connected to the short circuit in order to pass over the attenuation of the short circuit current and voltage drop, due to the impedances of the transformer, to the out-going cables.

When you only purchased the basic advanced module this doesn't apply.

## 5.7 Help texts

Information is provided from multiple sources on component backgrounds or calculations:

### *Help key:*

All buttons, input fields and calculation fields are provided with further information. You can call this up by pressing the F1 key when the mouse is on the desired component.

### *Start hints:*

The blue start prompts that are visible in each calculation window immediately after starting the program.

### *Hints:*

Many input fields and result fields show a so-called hint if the mouse is on that component for a few seconds.

## 5.8 Messages

Kabel++ provides notifications in the event of errors occurring, as well as tips and notifications for information.

### *Error messages:*

An error message will be displayed when:

- an overflow of a calculation,
- or from entered settings that are not possible,
- or from entered institutions that are not common.

### *Information messages:*

Depending on the calculation, the program gives tips on settings or points of interest. Various comments are for information only and can be set to be displayed only once after clicking on 'do not show again'.

### *Symbols in a notification or message:*

[Tip] Information:

Not necessarily connected to the current topic.

[ i ] Information :

An i is shown if only information is given to the user.

Often it is offered the option of not showing this message again the next time.

[ ! ] Message:

If it concerns important information that, for example, requires a correction in the settings.

Often it is offered the option of not showing this message again the next time.

[ X ] Error:

Occurs if Kabel++ encounters an error during a calculation.

Sometimes a suggestion for a solution is given.

[ ? ] Question:

Kabel++ needs further information.

## 5.9 Some small buttons next to input fields



button to start a Wizard.



button with three dots opens a form with additional settings.



button to open a form for changes on standard values.



button to open a form containing all settings related to this item.

### 5.10 Note block

You can make a note with each calculation. This note text is saved together with the calculation. It is wise to use this facility to record assumptions, which may be needed at a later stage if questions are raised as to why a cable is so thick or so thin.

Two notes are available. You can optionally take these with you when printing a calculation.

### 5.11 Printing

A calculation can be printed from any module.

It is advisable to make a printout of each calculation to a pdf printer and to save this printout with your project data (construction file machine directive).

After giving a print order, a setting sheet is displayed.

To this end, a button has been added in the setting sheet that compiles a file name based on the file name of the calculation. This is a handy way to have a file name in the clipboard when printing to a PDF printer.

It is possible that texts do not appear well aligned. This then, however, has to do with settings in your PDF printer or can it not handle them properly.

| Querschn Sicherung |      |
|--------------------|------|
| [qmm]              | [A]  |
| 4x150              | 250  |
| 4x120              | 200  |
| 4x4 / 4            | 13,0 |

#### Logo

When starting a print, you can also adjust the logo to your company logo when setting up data before printing. Two things are of interest here, namely a .JPG or .PNG file that displays your company logo, and secondly the correct position on the print.

Notice the remember the setting for your logo while the settings are overwritten by a next update.

Please note that the size of the file with your logo is less than approximately 3000x1000 pixels.

### 5.12 Voltage

During initial start-up of the program you are asked for the default voltage in you country. You may change this setting in the main menu.

In this document sometimes middle voltage is mentioned and also you will see high voltage. In the norms however only high voltage is textually used.

Kabel++ is primarily designed for voltages up to 30 kV.

### 5.13 Decimal dot or comma

Because a decimal point is used in English-speaking countries and a decimal point in Dutch and German,

Kabel++ intercepts both the comma and the dot. Depending on the language, a dot or a comma is displayed in the calculation result.

## 6 PROGRAM OVERVIEW (ADVANCED VERSION)

Depending on which modules you have ordered, Kabel ++ has multiple modules. Together these form a whole to come to:

### 6.1 Current flow schematics

Transformer module:

See also § 10

Single cable calculation:

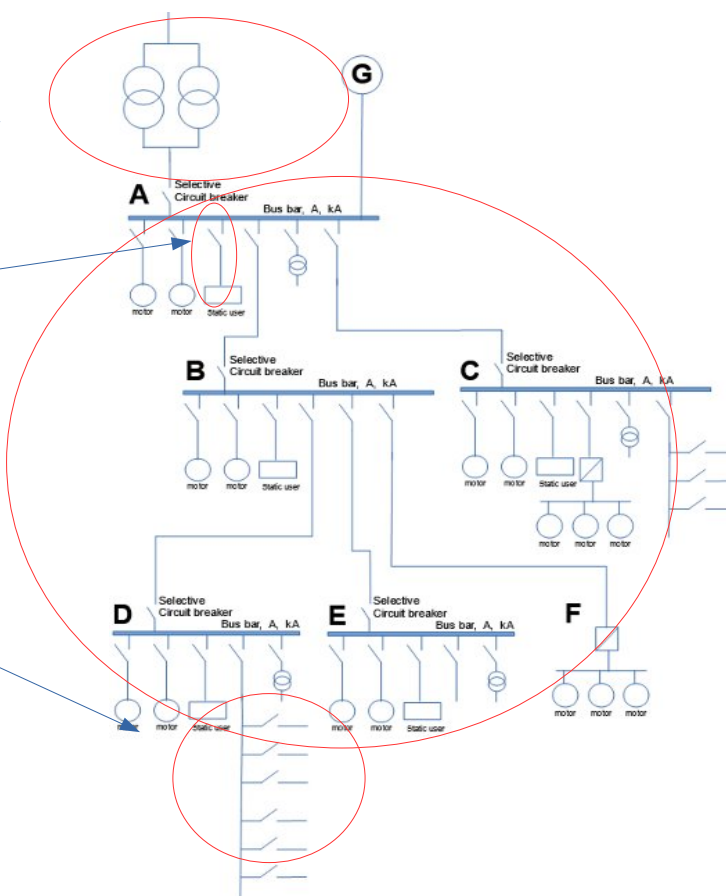
See also § 7

Network module:

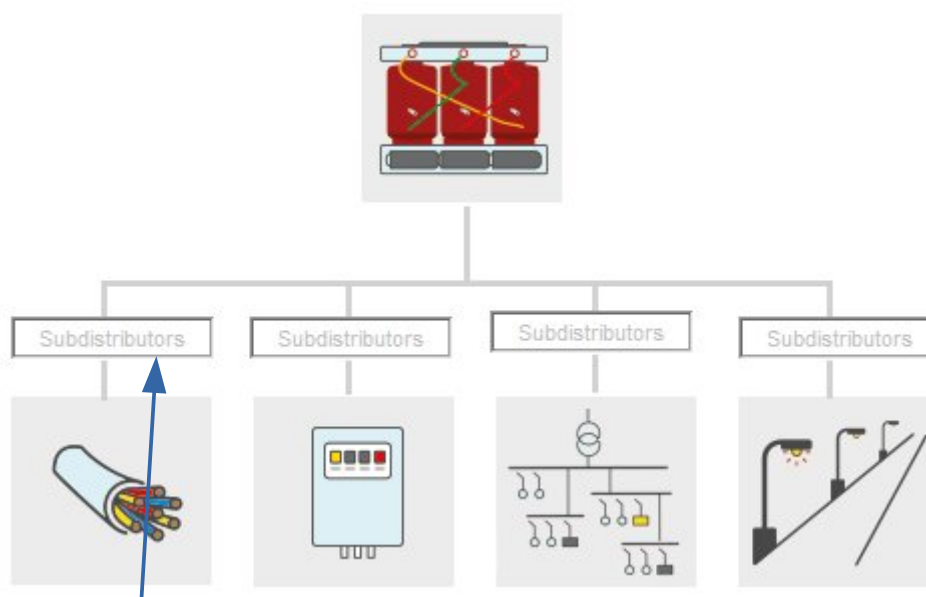
See also § 13

trunk cable module:

See also § 12



### 6.2 From main menu



Note that an existing cable between the transformer module and main or sub-distributor can be inserted between the transformer module and the other modules. This for the damping of a short circuit current.

## 7 MODULE: CABLE CALCULATION

### 7.1 directions for first use

The first time you use the program, follow the blue directions, or follow the directions in the orange panel.

The [Advanced] button (bottom right) takes you to more extensive settings and data and greyscale.

### 7.2 Usage

- Red:  
Setting the short-circuit power at the supply point of the cable. Here is also a setting of the type of power supply type is, for example if the power supply consists of a current-controlled power supply. (Delta power supply for example).
- Olive green:  
Choose the type of load and then the design flow or power.  
If the load is an engine, choose the shaft power.
- Yellow:  
Choose the type of security.  
Make a distinction between standardized characteristics or factory types.
- Blue:  
Choose the type of cable, usually XLPE, and select the location of the cable.  
You also set the maximum permissible voltage drop and cable length.
- Calculate:  
Finally, click on the calculate button and in the yellow area the selected protection is displayed in purple and above the calculation button the calculated cable cross section in purple in the Advanced version/dark grey in the Light version

### 7.3 Several remarks

- By means of coloured panels a convenient interface is erected to the benefit for the user.
- With the bar-graph right below KABEL++ shows whether the cable is optimal in use.
- Attention to the distinction between cables that are “parallel” and “side by side”.
- With the button [advanced] the software arises more adjustments and values.
- Standard wise the software calculates for cables sizes to 240 mm<sup>2</sup> cross section, and when this is not enough it switches to cables in parallel. Noted here that you can check for larger cross-section sus-

tained so the software end up to 2500 mm<sup>2</sup> before it runs for parallel cables.

- The checkbox for the solar panel dictates the program not to do the short short circuits. You can use this als when a regulated power supply is used (e.g. Delta DC supply unit).
- At the combobox for the current system type (TN, TT, IT) you also chose or safety safe of the installation (if not safe then in a TN system the short circuit is allowed to maintain for 5 sec).
- When printing, also a schematic presentation is given. When a transformer is connected (see with the short circuit next) The schematic presentation will be enhanced with a schematic presentation of the transformer installation.
- In the cable calculation the impedances L and parasitic C in relation with the frequency is also put into the calculations.
- Wenn you choose for a frequency convertor or for cable laid in the ground, then KABEL++ chooses for an armoured cable, unless the cable type is of a non-armoured type.
- When you choose for a cable type that yields the code for non-armoured, then the adjustments for ar-mouring disappears.
- In the short short circuit the voltage drop at feeding point is default set at 20%. When long feeding cables are the case the voltage drop will be more and can be set. When the short circuit is connected then the voltage drop is not adjustable but is calculated, and also you can set a known short circuit strength.

## 7.4 Cable type

By default, an extensive list of cable types is available.

From the 9th type in the list are generally accepted type indicated. Subsequently, cable types are available, sorted by:

- general most used,
- general divers,
- general high voltage,
- coding VDE,
- coding Cenelec,
- per application,
- country of origin,
- manufacturer.

If the cable has to be fire resistant, this can be set by selecting the right cable type from the list, but you can also tick the blue part on the right.

The first 8 types can be chosen if the module + K has been ordered. With this module you can set the con-

struction of the cable yourself. This is particularly important in order to be able to set the section and material of the screen. This is not standardized in contrast to the core material and material of the insulation. Differences in the net cross section of the shield determine the resistance and thus the short-circuit length.

Whether the cable is shielded can also be set in the blue panel, but can also be set by coding.

Favourite cables:

In the cable type settings form, there is a star in the lower left corner. Clicking this (circled in red in the example on the right) makes this cable favourite. On the main form, a yellow star is now added next to the cable type selection.

The screenshot shows a 'Cable type settings' dialog box with the following fields:

- Fixed size: --choose--
- Shielded: choose
- With core: --choose--
- Shield: --choose--
- Single core: --choose--
- Conductors per phase: 1
- Armoured: --choose--
- Max. core temperature: Standard (50°C) °C
- Functional presentation: --choose--
- High voltage cable: --choose--
- Triplastic: --choose--
- Star icon: ☒ (circled in red)
- Maximum operating hours at max. operating temperature: 20000 hour
- Cable must comply with IEC 60295: choose
- Cable name:
- Cable description:

Buttons at the bottom: OK, Cancel, Default settings, No previous.

## 7.5 Cable route

Here you set how you apply the cable guide. In most cases, the route concerns a cable duct, whether or not covered, are free in the air on a ladder track, or in the ground.

After this choice, you determine how many cables are lying next to each other in the route and if the cable is in the ground, the heat conduction of the ground.

Note: The resistance of the copper gives rise to heat development in the cable. The possibility of the cable to give up its heat determines the maximum continuous current through a cable. This is why you have to give up how the cable is laid.

Two cable route types:

Since a cable often traverses multiple routes before it is connected to the end user, you have to take the route where the heat output is least possible, for example in a closed gutter. An example is a switch box in a building where an outgoing field provides a pump with power outside in a well. The cable runs both in a gutter in the crawl space of the building and in the ground outside the building.

To activate a second route, tick the right side in the blue/grey area indicating that there is a second route type. The program now calculates the route that the thickest cable needs.

## 7.6 Parallel and 'bunched'

The program automatically chooses an additional cable if the current value is too large for, for example,  $240 \text{ mm}^2$ . Since the heat output of two cables is better than one thicker cable,  $240 \text{ mm}^2$  will by the way often be calculated as two cables of  $95 \text{ mm}^2$ .

However, when calculating in parallel, Kabel++ automatically increases the number of cables bunched, depending on what you have set for the [bunched parallel automatic] button. The [Accumulation] field then temporarily takes on the color of a result field.

## 7.7 Coupling with Extracable (Advanced version)

When your installation has extra feeding cables between the feeding point of your out-going cable and the main MCC or low-voltage distribution board then you may click on [Substations]. When appending an extra cable in the feeding line the attenuation of the short circuit current is taken into account, and thus influ-

ences the short circuit length, the discrimination and the motor startup current.

With the same reason one opens de short circuit, adjust to the correct transformer and strikes the button [Connect].

## 7.8 Optimal cable cross-section

To achieve the optimal cable cross section in the cable price including mounting, versus the annual energy loss in the cable you may use the ECO button. Kabel++ then runs form 0 to 5% for the voltage loss in the cable and finds the optimum investment versus energy.

For the investment you may adjust a correction factor to comply with the price-index of your cable supplier, and also adjust the number of running hours per year. To adjust Kabel++ automatically opens the 'more-info' module.

## 7.9 Result calculated cross-section

The calculated cable cross section is presented in a pink field. The presentation depend on the cable construction:

- Multicore cable  
The first number is the number of cores per cable and the second number is the cross-section.
- Two or more multicore cables parallel  
The first number is the number of cables in parallel, the second number is the number of cores per cable and the third number is the cross-section.
- Single core cables  
The first number is the number of cables(cores), the second is the number of neutral- and earthcores and the last number is the cross-section.

By means of a bar graph the load of the cable is presented. For instance when the cable is suitable to yield 60 Amps and the design current is 61A then the bar graph will show a very low loaded cable. You may then consider several parameters in order to calculate a thinner cable that can flow the 60A.

Apart from this in text is shown what was the caused that resulted in the thickness of the cross-section.

## 7.10 Protection device selection

By default, an extensive list of protection types is available.

From the 9th type in the list are generally accepted type indicated. Subsequently, protection types are available, sorted by:

- general fuses,
- general circuit breakers,
- DC,
- manufacturer,
- norms.

The first 8 types can be chosen if the module + K has been ordered. With this module you can set the properties of the protection yourself.

Favourite cables:

In the cable type settings form, there is a star in the lower left corner. Clicking this (circled in red in the example on the right) makes this cable favourite.

On the main form, a yellow star is now added next to the cable type selection.

The screenshot shows a settings window for a protection device. The background is yellow. At the bottom left, there is a star icon circled in red. The form contains the following settings:

- Thermic (overload) setting: Ir, I<sub>r</sub> > yes
- Magnetic (overcurrent) setting: Im, yes, setting: 1.35 x Is ±15 %
- Instantaneous: Ii, no
- Electronic trip: no
- Limiting: no
- Earth det: no
- Time delayed overcurrent (t<sub>sd</sub>): t<sub>sd</sub>, no
- Panel temp: Default °C, Calibration temp: 20 °C
- Release is temp compensated: no
- Max short circuit time allowed: Default sec
- Hatch characteristic in the graph: Extended range (checked)
- Info: Notes for the start-up commissioner: (empty text area)

At the bottom, there are buttons: OK, Cancel, Default settings, and As previous.

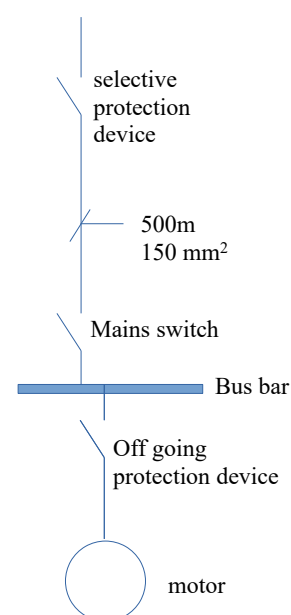
## 7.11 Discrimination

The discrimination is calculated related to the short circuit current, the characteristic of the of the out-going protection device and the characteristic of the upstreams connected protection device.

The selectivity result is presented as the minimum size of the upstreams connected protection device.

You can choose between:

- Full selectivity:  
The upstream protection is fully selective both in the overcurrent short-circuit range (<15 sec.) and in the overload thermal range (> 15 sec.). This means that the upstream protection is not triggered by the short-circuit current of the outgoing cable.
- Thermal (partial selectivity):  
With partial selectivity, only the thermal part of the characteristics is taken into account and the short-circuit current is disregarded.
- Thermally delayed:  
For the thermal part of the characteristic, the selective protection is set so that it responds with a delay in the overload range. This applies to an overload from 10 to 20 seconds. This means, for example, that an over loaded machine does not trigger the main protection.
- Magnetically delayed:  
For the magnetic part of the characteristic curve, the selective protection is set so that it reacts with a delay in the short-circuit range. This applies to an excessive overcurrent of 0.01 to a few seconds.



When you have an extra-cable installed due to long feeding lines then discrimination may be enhanced due to the lower short circuit current.

Adjust 'time-delayed' in order to not check for the short-circuit current in the discrimination calculation.

Discrimination is checked from 0.1 sec and up.

## 7.12 Response time of a protection device

A fuse starts melting through basically from the first millisecond. The arc that then occurs limits (limits) the short-circuit current.

A circuit breaker usually reacts from 0.1 sec. The larger circuit breakers often also have a setting for faster (instantaneous) switching of 5-10 msec. This does not simultaneously imply that the breaker in question is then limiting.

## 7.13 Voltage loss in a cable

A setting in Cable++.

The lower the voltage drop the more favourable the energy loss.

In PV installations, 1 % is often used to prevent inverter shutdown in connection with voltage boosting if all PV installations in the vicinity supply power and thus the voltage rises.

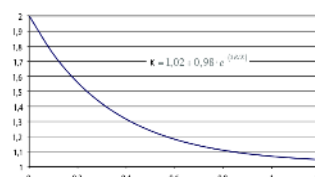
For information that the maximum 5 % mentioned in the standards refers to the whole installation and not to the cable to be calculated. This 5 % together with the 10 % allowed voltage change in the Electricity Law will correspond to the voltage variation included in the product standards of devices.

### 7.14 Short-circuit power

For proper calculation of the short-circuit length, the short-circuit power of the feed point of the cable is required. The short circuit power is specified in kA and together with the R/X ratio Kabel++ converts the kA value to a resistance  $R_{grid}$  and reactance  $X_{grid}$ .

#### *R/X ratio*

If you leave a value of 0 for the R/X the program itself takes a value appropriate to the situation. Upstream, the value usually decreases and reactance X starts to play a larger role.



### 7.15 Short circuit strength circuit breakers

Or the minimum strength the protection-device must be able to withstand. The presented value is calculated as the short circuit power of the feeding point of the out-going cable. It is only calculated when the transformer is connected in the short circuit.

A two phase short short circuit often here leads to a higher value than a three phase short circuit, mainly due to the contact resistant of connections. This is also the reason that the value here is lower than the value presented at the busbar system in de transformer window.

### 7.16 High-voltage

#### *Regarding cable*

In Kabel++, you can also calculate the cross-sectional area of high-voltage cables. In particular, the thermal load is a point of interest here. The standard applied here is the HD 620 (EU Harmonized Document). This standard is intended for cables up to 30 kV. Manufacturers can deviate from this in their specifications, which you should check when ordering a cable.

You can also use Kabel++ for voltages higher than 30 kV. In principle, this means that the maximum current

$I_z$  will be slightly lower, but it is necessary to take into account the manufacturer's specification for this voltage. By 'playing' with the voltage drop, for example, you can then 'set' the cross-sectional area suggested by the manufacturer.

#### *Regarding the protection device*

Fuse: Special fuses are made for high voltage. These have a higher trip value in the overload range. After all it is too great an impact if the installation is switched off. Additional monitoring is then applied.

Circuit breaker: Examples are the Siprotec, WIC.

See also Chapter 10.

## 7.17 DC voltage

In Kabel++, you can do both AC and DC voltage calculations.

#### *Regarding the cable*

Since there is no frequency, the inductive reactance of the cable and devices is zero, and the capacitive reactance is infinite. Kabel++ assumes that the ripple on the direct current is zero.

Thus, there is also no parasitic current flowing in the cable.

Regardless of the influence of reactance, the thermal load is the same for direct current as for alternating current, since the heating is determined by the effective value of the current and it is the same for alternating current ( $\sqrt{2}$ ) and direct current.

#### *Regarding the protection device*

With a fuse there is no difference between alternating or direct current, since the effective value determines the melting through.

With a circuit breaker it is different. There, the characteristic curve does shift. In Kabel++, you can set whether a circuit breaker is calibrated for direct current.

## 7.18 Skin effect.

Electrons are negatively charged and repel each other, but also generate a magnetic field. These fields become stronger as the frequency increases. This results in current displacement occurring in the conductors in a cable at higher frequencies.

At 50 Hz, this only comes into play at conductor cross sections from 300 mm<sup>2</sup>.

Kabel++ takes the skin effect into account.

## 7.19 Harmonics

Devices with electronics do not produce a neat sine wave, but introduce sinuses with higher frequencies, the so-called higher harmonics.

Kabel++ distinguishes between:

With zero:

The higher harmonics cause heating in the neutral conductor if present. The standards include a table for

this purpose. However, Kabel++ does not do it incrementally.

Without zero

Heating in the neutral is now not possible, however, because the higher harmonics have to do with the skin effect, the total energy transfer will be lower, or the current will be higher. This is what Kabel++ charges. The standards do not specify this.

## 7.20 Optimal cable cross section

There are two possibilities, namely:

- **Eco:**  
To achieve the optimum cable cross-section in comparison of cable price and installation hours versus annual energy costs, use the ECO button. Kabel++ now runs through the voltage loss from 0 to 5% and then displays the optimum between investment and energy loss. For the investment you can set a correction factor for your rebate with your supplier or the annual price increase and for the energy loss you can set the number of operating hours per year and the kWh price. To do this, the setting sheet for this opens automatically.
- **Optimum:**  
Determines the optimum voltage loss for a cable with varying loads.  
Suppose the cable is used to deliver energy from a wind turbine to the grid. The load varies quite a bit over the year. Wind force 0 is not common but neither is 10. Where should the cable now be interpreted in terms of voltage drop, at the average power or at the maximum power. In the table, enter for 12 loads what the time of occurrence of that power is in hours per year. The depreciation period in years can be adjusted in the automatically opening sheet.  
While searching for the optimum, the program runs through all cross sections from 1 mm<sup>2</sup> to 240 mm<sup>2</sup> (depending on the general setting).

## 7.21 Cable price and mounting

Kabel++ includes a calculation of the price of a cable. This price is made as a best estimate based on the copper or aluminum price and the price of plastics.

Through the button , settings can be made.

This price calculation does not take into account any discounts from suppliers.

## 8 EXTRACABLE OR SUBSTATION (ADVANCED VERSION)

### 8.1 General

This module doesn't calculate.

It's a module that can be called from all other modules.

Actual this module consists of three modules; one for the single cable calculation, one for the trunk cable and one for the network module.

### 8.2 Purpose of this module

The purpose of this module is that a long power feeding cable gives an attenuation to the short circuit current as well as to the voltage loss during motor starting for instance. As a consequence this must be transferred to the calculation of the out-going cables.

Remark: When due to a too thin cable, the voltage loss is too large and thus the short circuit current is too less for the out-going protection-device to switch-off then it is not possible to calculate a cross-section result. To prevent an endless loop Kabel++ sets the cable length of the extra-cable to zero.

## 9 MODUL: OWN CHARACTERISTIC OF PROTECTION DEVICES AND CABLE CONSTRUCTIONS (OPTIE K)

### 9.1 Own cable construction

Besides from a list of cables, one can also construct one's own. To do this, select in the field for the choice to choose a cable, from the top first 8. (somewhat hidden, scroll up). Application is particularly because of the fact that the net cross-sectional area of the shield varies from manufacturer to manufacturer.

Description: definable 1

| Material | mm² core | mm² earth | mm² neutrahmm² shield | Outer diameter [mm] | Weight [kg/m] | Price [prijs/m] |
|----------|----------|-----------|-----------------------|---------------------|---------------|-----------------|
| Cu       | 0.25     | 0.25      | 0.25                  | 0.0                 | 0.0           | 0.0             |
| Cu       | 0.34     | 0.34      | 0.34                  | 0.0                 | 0.0           | 0.0             |
| Cu       | 0.50     | 0.50      | 0.50                  | 0.0                 | 0.0           | 0.0             |
| Cu       | 0.75     | 0.75      | 0.75                  | 0.0                 | 0.0           | 0.0             |
| Cu       | 1.00     | 1.00      | 1.00                  | 0.0                 | 0.0           | 0.0             |
| Cu       | 1.5      | 1.5       | 1.5                   | 0.0                 | 0.0           | 0.0             |
| Cu       | 2.5      | 2.5       | 2.5                   | 0.0                 | 0.0           | 0.0             |
| Cu       | 4.0      | 4.0       | 4.0                   | 0.0                 | 0.0           | 0.0             |
| Cu       | 6.0      | 6.0       | 6.0                   | 0.0                 | 0.0           | 0.0             |
| Cu       | 10.0     | 10.0      | 10.0                  | 0.0                 | 0.0           | 0.0             |
| Cu       | 16.0     | 16.0      | 16.0                  | 0.0                 | 0.0           | 0.0             |
| Cu       | 25       | 25        | 25                    | 0.0                 | 0.0           | 0.0             |
| Cu       | 35       | 35        | 35                    | 0.0                 | 0.0           | 0.0             |
| Cu       | 50       | 50        | 50                    | 0.0                 | 0.0           | 0.0             |
| Cu       | 70       | 70        | 70                    | 0.0                 | 0.0           | 0.0             |
| Cu       | 95       | 95        | 95                    | 0.0                 | 0.0           | 0.0             |
| Cu       | 120      | 120       | 120                   | 0.0                 | 0.0           | 0.0             |
| Cu       | 150      | 150       | 150                   | 0.0                 | 0.0           | 0.0             |
| Cu       | 185      | 185       | 185                   | 0.0                 | 0.0           | 0.0             |
| Cu       | 240      | 240       | 240                   | 0.0                 | 0.0           | 0.0             |
| Cu       | 300      | 300       | 300                   | 0.0                 | 0.0           | 0.0             |
| Cu       | 400      | 400       | 400                   | 0.0                 | 0.0           | 0.0             |
| Cu       | 500      | 500       | 500                   | 0.0                 | 0.0           | 0.0             |
| Cu       | 630      | 630       | 630                   | 0.0                 | 0.0           | 0.0             |
| Cu       | 800      | 800       | 800                   | 0.0                 | 0.0           | 0.0             |
| Cu       | 1000     | 1000      | 1000                  | 0.0                 | 0.0           | 0.0             |
| Cu       | 1200     | 1200      | 1200                  | 0.0                 | 0.0           | 0.0             |
| Cu       | 1400     | 1400      | 1400                  | 0.0                 | 0.0           | 0.0             |
| Cu       | 1600     | 1600      | 1600                  | 0.0                 | 0.0           | 0.0             |
| Cu       | 2000     | 2000      | 2000                  | 0.0                 | 0.0           | 0.0             |
| Cu       | 2500     | 2500      | 2500                  | 0.0                 | 0.0           | 0.0             |

Set material or value selection  
☒ choose type isolation material  
☐ Enter the thermal conductivity coefficient

XLPE Material core insulation

yes Provided with an earth core  
 yes Provided with a neutral  
 yes Provided with shield?  
 no Provided with armour?  
 no Single core?  
 class 1 or 2, notflexible flexible  
 PVC Material sheath  
 no Functional preservation?  
 no Provided with extra insulation layer (mostly >3kV)  
 °C 60 Max. core temperature (for 200,000 h)  
 °C 250 Max. short circuit temperature  
 Ωm²/m 0.018 Specific electrical resistance phase  
 - 0.0039 versus temperature  
 Ωm²/m 0.018 Specific electrical resistance screen  
 - 0.0039 versus temperature  
 0.040 Tan δ of the isolation

Export  
Import

Data can be exported and read into another calculation.  
 A custom library of cable types can be created with this.

### 9.2 Own characteristic protection device

Besides from the list of protection devices, one can also construct one's own construction.

Name of the protection device: Sicherung gG

Leftsite of characteristic

| Time [sec] | Current [A] |
|------------|-------------|
| 1.0E+5     | 1.20        |
| 1.0E+4     | 1.26        |
| 1000       | 1.44        |
| 1000       | 1.44        |
| 100        | 1.94        |
| 100        | 1.94        |
| 10.0       | 2.84        |
| 1.00       | 4.0         |
| 0.10       | 6.5         |
| 0.010      | 12.2        |

Right site of characteristic

| Time [sec] | Current [A] |
|------------|-------------|
| 1.0E+5     | 1.46        |
| 1.0E+4     | 1.54        |
| 1000       | 1.76        |
| 1000       | 1.76        |
| 100        | 2.38        |
| 100        | 2.38        |
| 10.0       | 3.47        |
| 1.00       | 4.8         |
| 0.10       | 7.9         |
| 0.010      | 14.9        |

Refresh graphic >>

☐ Hatches the characteristic in the graph  
☐ Characteristic is of a fuse  
☐ This circuit breaker has an instantaneous setting  
☐ This circuit breaker limits the short circuit current  
☐ Program determines the value for limiting

100,000  
10,000  
1,000  
100  
10  
1  
0.1  
0.01

1 10

left  
right

Import Export

Remark: the data entered here, will be stored in the project file .KE

Data can be exported and read into another calculation.

An own library can be created with this.

## 10 MODULE: TRANSFORMER (ADVANCED VERSION, OPTIE T)

### 10.1 Blue directives

The first time you use the program you may follow the blue info texts.

At startup of this module only the transformer fields are visible.

The generator fields will only get visible when you activate it with the button [activate generator/PV/UPS].

The middle voltage cable-fields will get visible when the button 'activate middle voltage' is clicked.

### 10.2 This module comprises the calculation of:

- Transformer power and transformer cable, circuit breaker and discrimination,
- Generator cable, circuit breaker and discrimination,
- Middle voltage cable, circuit breaker and discrimination, in a ring main unit (RMU),
- Middle voltage ring cable

and:

- a coupling to the other modules to give through the short-circuit power. This is switched on/off by means of the button [connect].

You can (must) call this module from all other modules!

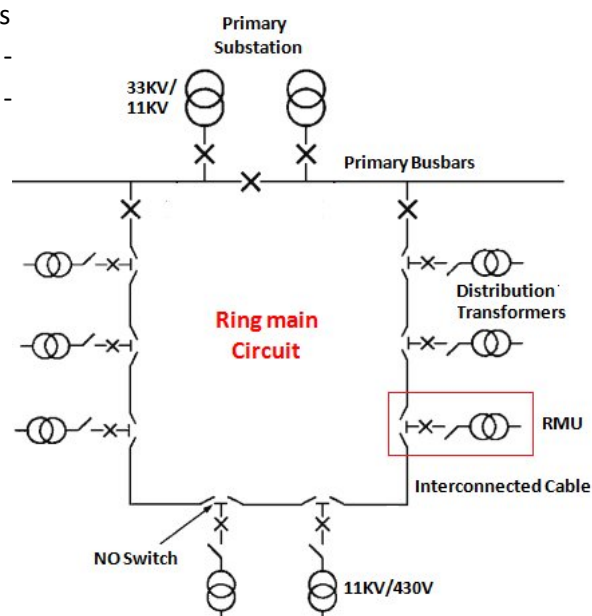
### 10.3 Parameters of cable laying, protection etc.

To do this, select the [Changes parameter ...] buttons.

For parameters of a cable you can also click on the symbol of that cable, idem for protection devices and the symbol of the transformer.

### 10.4 High voltage cable versus Ring

In many cases, the primary supply cable from the transformer will be connected to a high voltage ring main (10 kV and above). The connection is then performed by means of a high voltage distributor consisting of two switchable incoming fields and one switchable outgoing field with a protection device (circuit breaker WIC relays or fuses).



## 10.5 Transformer capacity

Enter in the middle left the maximum simultaneous power, upon which the program calculates the required transformer power and selects a transformer. The program takes into account various losses. After you specify the way of laying of the transformer cable, the program calculates the transformer cable and data of the busbar system in the connected low-voltage distribution.

## 10.6 Transformer

The no-load and short-circuit losses the program assumes to be a standard transformer. However, you can modify these data by clicking on the transformer symbol or via the [Show Transformer Data] button.

You can set the desired derating by adjusting the:

- amount of harmonics present,
- ambient temperature,
- and a residual derating.

The derating for the harmonics is corrected for the K factor.

|                           |            |           |   |
|---------------------------|------------|-----------|---|
| Transformergrootte        | 630        | [kVA]     | 0 |
| Transformer type          | cast resin |           |   |
| Shortage U loss           | 4.0        | [%]       |   |
| Trafo zero burden         | 1200       | [W]       |   |
| Shortcircuit voltage loss | 6100       | [W]       |   |
| Inrush current (0.30 sec) | 10.0       | Ia / Inom |   |
| Derating                  | 0          | %         |   |
| K factor                  | 1.00       |           |   |
| R                         | 14770      | [mOhm]    |   |
| X                         | 59201      | [mOhm]    |   |

## 10.7 Generator

The generator power is not calculated in this module. You have to enter the size on with which the software calculates the short circuit current to the installation. When there is a stepup transformer you check as such. After changing the size the impedances of the generator, which are given default, can be adjusted. By means of a button you can change for the generators are connected to low or to the middle voltage bus-bar system.

For your attention:

- a generator delivers a comparatively small short-circuit current, especially the single-phase short-circuit current. This means that the short-circuit length becomes short. The solution is to choose a circuit breaker with magnetic setting and then set it to about 3x,
- A generator set often has its own control box. This monitors, among other things, the speed and perhaps also overload and overcurrent. In this case, it can be set so that a short-circuit calculation is not necessary.

## 10.8 High-voltage cable

Based on the current carrying capacity tables in the HD 620, the  $I_z$  of the cable is calculated. See also in § 7.16.

For the cable type, select a high-voltage cable, and also select in the cable construction parameters that the cable has additional insulation.

### Main ring

Based on the power in MW to be specified, the high voltage cable in the ring is calculated.

### *Primary to the transformer*

Based on the power required by the transformer at rated load, the high-voltage cable is calculated.

## **10.9 High-voltage protection**

The list of protections includes a summary of protection devices for high voltage. Examples are high-voltage fuses and e.g. the WIC or Sepam relay's.

## **10.10 Button Connect**

A transformer can yield a maximum short-circuit current, the short-circuit power. This available short-circuit power affects the cable calculation in the other modules (descending cable, the cable along the light poles and the distribution network). To transfer the short-circuit power to the other modules, use the [connect] button.

## **10.11 Discrimination**

The discrimination of the middle voltage cable onto the transformer protection release en onto to the protection releases in other modules must be selective. You can suppress the discrimination with the checkbox. Because of the discrimination the transformer protection-device release can thus be larger in size than obviously seems necessary in relation with the transformer current, due to currents and safeties on other modules.

Discrimination is checked at 0,1 and 5 sec for as well as the characteristics as the short circuit current.

## 11 MODULE: GROUP BOX (ADVANCED VERSION, OPTION GK)

### 11.1 8.1. Blue directions

The first time you use the program, follow the blue directions.

### 11.2 Application

A group box (meter box) with up to 55 branches.

Note that when expanding an existing meter cabinet with, for example, charging stations:

- Whoever last makes a change to a distributor is responsible for the cabinet according to IEC 61439. This means that the complete installation must be re-calculated.
- As the current increases, the heat output in the cabinet increases by the square, since the energy loss in the copper is  $I^2 \cdot R$ . It is therefore definitely necessary to reassess the heat management in the cabinet.
- While many cabinets can handle a reasonable design current  $I_{th}$  or  $I_b$ , in the past they have been calculated for a simultaneity factor that is currently far exceeded with the increase in electric cooktops, EV, PV, heat pump, electric oven, clothes dryer, dishwasher, air-frier, or also jacuzzie, infra red sauna, etc.

## 12 MODULE: TRUNK CABLE (ADVANCED VERSION, OPTION S)

### 12.1 Blue directives

The first time you use the program you may follow the blue info texts.

### 12.2 Quick Selection

On the left is a button to start a wizard for the type of trunk cable.

Then choose the edit button to set the various parameters via a separate settings sheet. On the left side of this sheet you will find the settings for the trunk cable, and on the right side you will find the settings for the branches. Close that sheet again.

Now fill in the cable lengths and the type and the amount of load on the branches.

### 12.3 Directive:

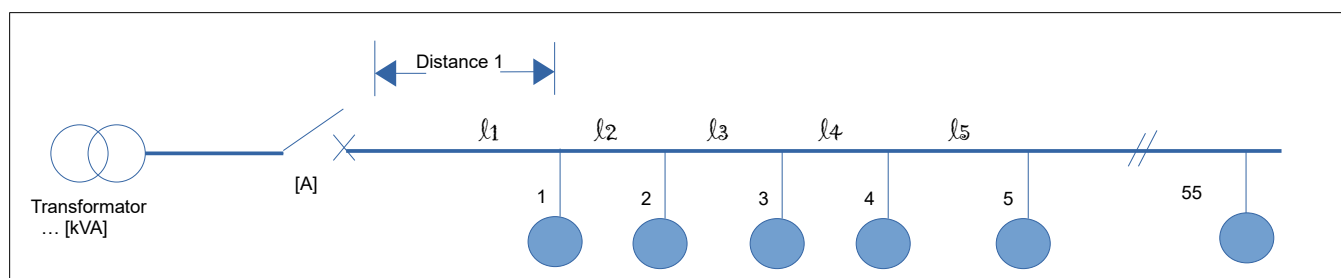
Long trunk cable with up to 55 branches, possibilities are:

- Single phase-cable and single phase branches,
- Three phase-cable and single phase branches,
- Three phase-cables and Three phase branches.

To use for:

- Lighting posts never the motorway,
- Pump fields in a drinking water area,
- Generators connected to a large trunk cable,
- while not meant for: A busbar system with out-going starters.

Basis scheme



### 12.4 Explanatory notes

The background of this module is that the software calculates each segment on thermic load and voltage loss. This leads to the first segment to be the thickest.

The voltage loss is distributed proportionally across all segments, i.e. the more cable length or greater current passing through that segment, the higher the permitted voltage loss of that segment. In other words, the maximum voltage loss per segment is determined as, proportion of current x length of that segment, in relation to the total current x length of all segments.

The voltage loss is for these type of cable calculation mostly the decisive factor (or the short circuit length but this is also backward related to the voltage loss calculation which to minimize). By means of a checkbox you can check that the voltage loss is divided unequally and thus to achieve that the whole cable is more equal in diameter per segment.

The short circuit length is controlled not to exceed and when the cable is too thin to achieve the short circuit length, Kabel++ internally lowers the sustained voltage loss until the correct short circuit length is achieved.

Note that in a TT system with touch safe will be difficult to calculate for a long cable due to the short circuit length.

## 12.5 Ring

If desired, a trunked cable can be chosen to be powered on one side or both sides. For the latter, the program assumes (due to emergency situations) that a single-sided power supply on any side of the cable must be taken into account. As a result, the cable is now not thicker on one side, but on both ends

## 12.6 3 Phase versus 1 phase

On a 3-phase cable, 3 phase consumers are connected such as 3-phase motors.

However, on a 3-phase cable also 1-phase consumers can be connected. Connect 3 lighting poles one after the other to the trunk cable: In the first pole the lamp will be connected to L1 and the zero, in the second pole to L2 and the zero and in the third pole to L3 and the zero. Another possibility is to connect 400V lamps between two phases. For example two 400V lamps per mast connected to L1-L2 and on the next post L2-L3 respectively.

You may also choose via the wizard for the trunk cable to be one phase and the branches also one phase.

## 12.7 Branch

Protection device:

Every branch has a protection device. In many situations this will not apply because the tool or lamp is connected almost directly to the master cable and this protection can be ignored.

Together for all branches, you set whether the branch has protection. This is processed in the calculation as follows:

- No protection in the branch:
  - . The short-circuit length is calculated on the basis of the protection device of the trunk cable,
  - . The cable is thermally calculated on the nominal current.
- Protection in the branch:
  - . The short-circuit length is calculated based on the protection device of the branch.
  - . The cable is thermally calculated based on the strength of the protection device.

Note that the short-circuit current at the supply point of the branch is rather small due to the impedance in the master cable.

Type of load:

You specify the load type per branch.

## 12.8 Buttons

### 12.8.1 *'Divide dU special'*

The voltage loss remaining in one segment is used for another segment in order to obtain the best possible cross-sectional area with a better distribution of the voltage loss across the entire cable. By means of this tick-able choice the program chooses for the first segments a step thinner cable so that the other segments will have a thicker cross-section.

### 12.8.2 *'Earth support'*

Halfway along the cable, a supporting earth electrode is struck to allow the short-circuit current to flow directly to earth. This improves the short-circuit length in some situations.

## 12.9 The trunk cable splits into two trunk cables

If the trunk cable does not run as a single cable along all customers, but has a branch line along the way which is itself a trunk cable, then Kabel++ can handle it up to one level, namely:

### 12.9.1 *A sub-trunk cable is connected to a branch of the main trunk cable:*

Choose the type of load for 'Trunk' and follow the instructions.

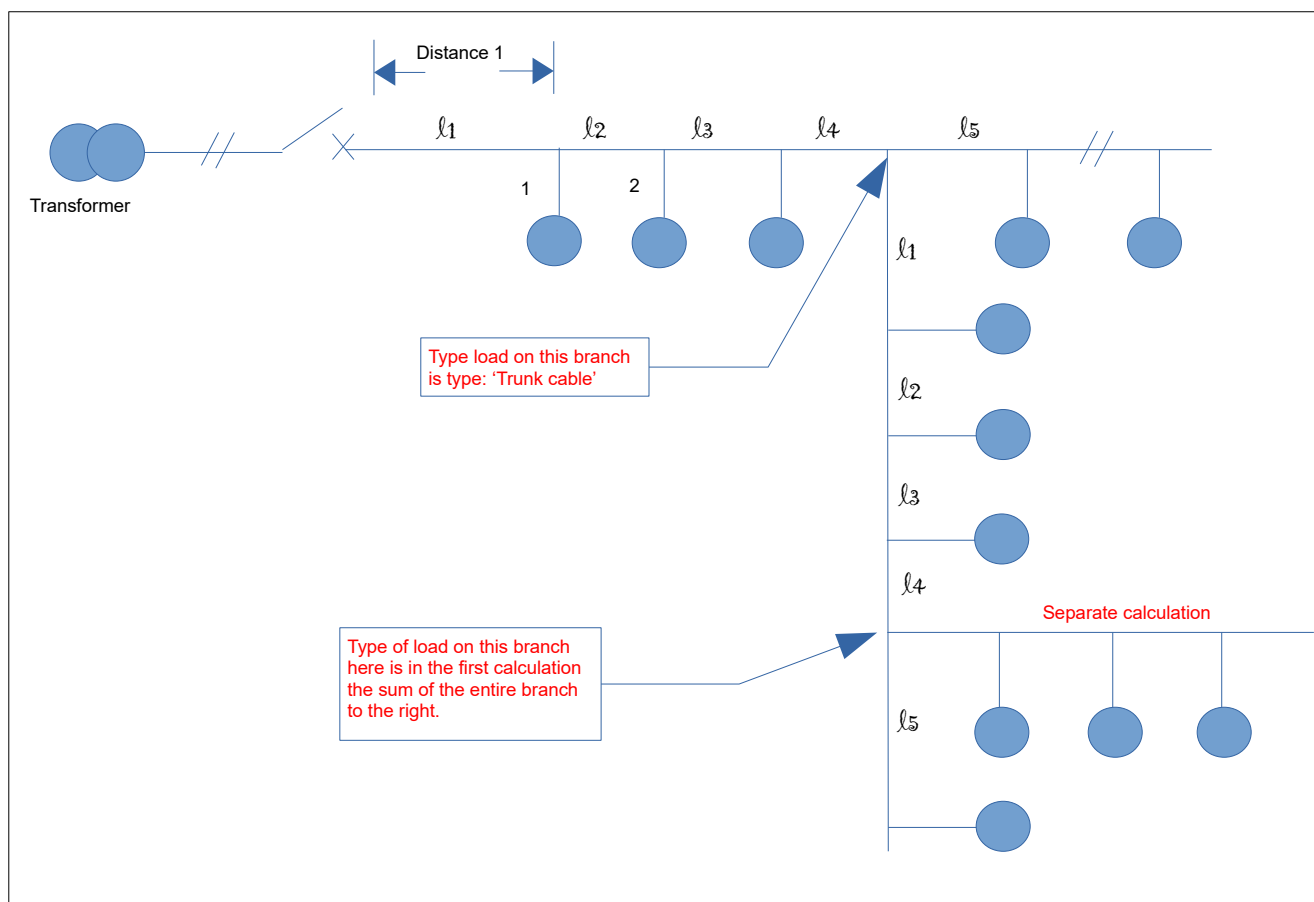
You will be asked successively and activities will be carried out:

- A number of the trunk cable to be connected (1-2000) will be requested first,
- the current trunk cable is first calculated to calculate the short-circuit current strength of the feeding point of the trunk cable to be coupled,
- The current window will be filled with the newly selected trunk cable number and default data. The spreadsheet now has a darker color,
- When you have filled in and calculated this new trunk cable, close the calculation sheet,
- From the main menu, select the trunk cable calculation again and it will be filled with the main trunk cable data.

When printing the main trunk cable, the connected trunk cables are also printed.

### 12.9.2 *However, there are trunk cables connected to branches and there is a branch on them again:*

In the case of trunk cables on branches and trunk cables on branches, separate calculations have to be made. A branch-off on the road is now assumed as a single point on the main log cable with the power equal to the total power of that branch-off.



## 12.10 Result

The result is shown in the pink fields.

The criterium with which the size was conducted is shown on the upper left.

## 12.11 Some scheme's

Diagram 3 phase cable with 2 lamps connected between the phases.  
Each mast has 2 lamps.

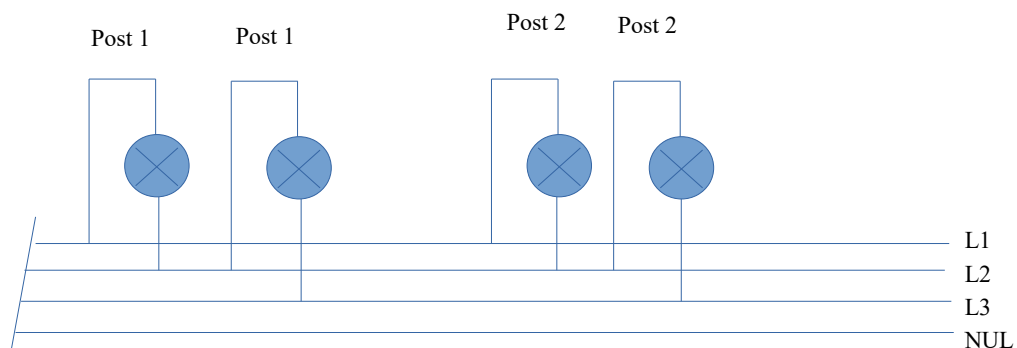


Diagram 3 phase cable with 3 phase load.  
Each mast has 1 load, Example Windmills on one power cable.

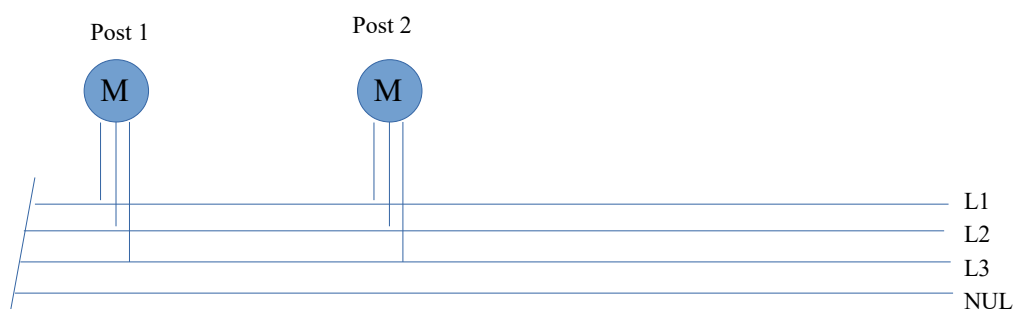
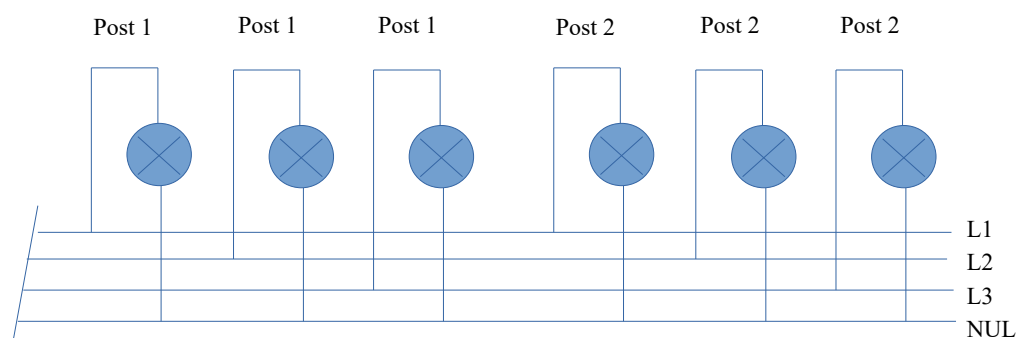


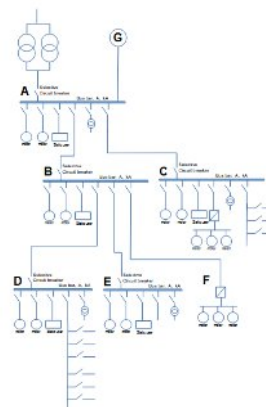
Diagram 3 phase cable with 3 lamps connected to one phase and a neutral.  
Each mast has 3 lamps.



## 13 MODULE NETWORK (ADVANCED VERSION, OPTION LK)

This chapter holds amongst other the following paragraphs.

- § 13.1 General
- § 13.2 Handling
- § 13.3 Entering data
- § 13.5 Execution
- § 13.6 Options



### 13.1 General

The network module comprises of the following submodules to calculate the distribution system, namely:

- Cable list,
- Energie balance,
- Single-line,
- Front view drawing,
- I/O list,
- specification sheets.

Up to 150 distribution boards are possible, but supposed to a maximum of three levels. Kabel++ detects automatically the number of sub-boards and thus feeders out of the input table.

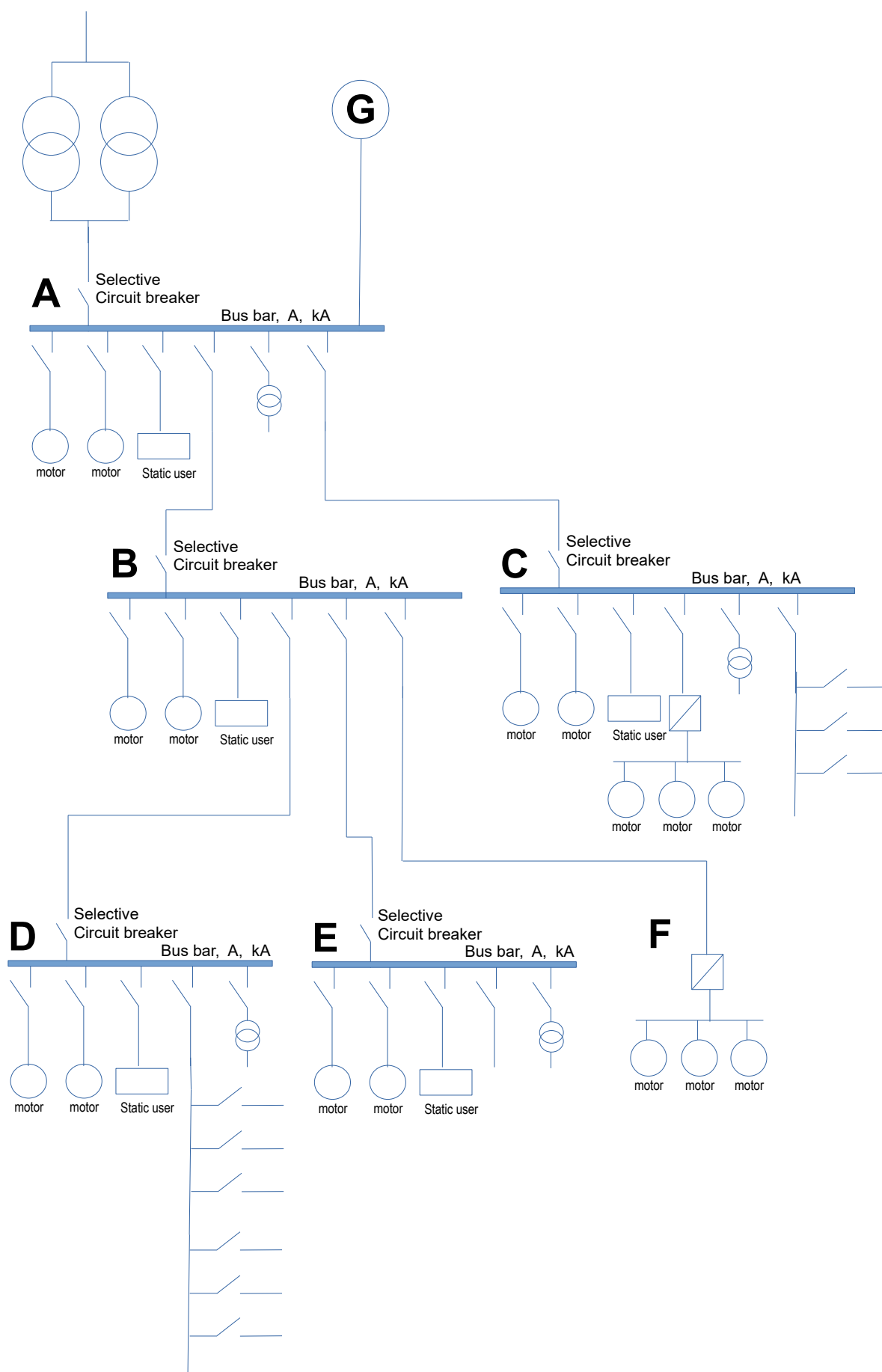
The program thus automatically intercepts from the table the distribution boards and the hierarchy between them.

Up to 2000 lines can be entered in the table.

#### Two important things to realize before you read on:

- Data from a cable are listed both in
  - a line in the table
  - as well as in a parameter set associated with this line.
- Hierarchy between main and subdividers is done via the combination of the cells 'Tagnr' and 'Closet'.

This is explained next.



## 13.2 Handling

### 13.2.1 General

The form gives the following presentations en handling▪

Lower right the table with the consumers,

- Upper left the input buttons to edit lines in the table,
- Middle left the input button the alter the content of cells,
- Lower left the button to execute calculations,
- Upper right a button to alter the mains strength
- Upper middle a button to edit the parameters of the mains cable, if not connected to the transformer module.

### 13.2.2 Buttons edit data input

Upper left holds edit buttons.

These buttons are for copying line and or cells.

When copying a cell with among others columns tagnumber or description, numbers are automatically increased. For instance 'P111' results in 'P112'. A single phase field automatically changes from L1 to L2 etc.

This automatic increase can be switched-off via the options button.

### 13.2.3 Editing Lines

For each consumer a line is held in the table. The consumer may consist of a motor or a static load such as a sub-switchboard, or light installation..

There are some provisions for to enter the consumers-loads in a convenient quick way, namely:

- By means of the button [Insert row] one enters a new line with default values in it,
- With the button [Copy row] one insert a new line, with the values the same as the previous, but numbers in the columns tagnummer, description and L123 are increased. Empty lines are skipped,
- The [copy cell] button allows you to copy by cell. At the same time, the cell underneath becomes the active cell. This button has some automatic operations, namely a blank line is automatically skipped, and in the column tag number, description and L123 and the last characters are a number, then that number is automatically incremented. You can disable this automatic increment by using the options button.
- With the button [Store] the current line is copied in memory according first in, first out.

### 13.2.4 Helpinfo

By clicking with the mouse on a cell, and pressing the F1 key, will show up more info about that cell.

Some data such as type of circuit breaker, motor starter, etc, which is presented in the table by a number, are become user friendly by means of the buttons [edit line] on the left.

## 13.3 Entering data

Data such as cable types, protection-device type of the type of circuitry can be entered by three ways:

- direct in the table,
- via the button [edit line],
- via the button [parameterset].

With this the data is stored in two ways:

- in the table,
- in parameter sets.

### 13.3.1 parameterset

A parameterset holds more detailed information then can be called from lines in the table.

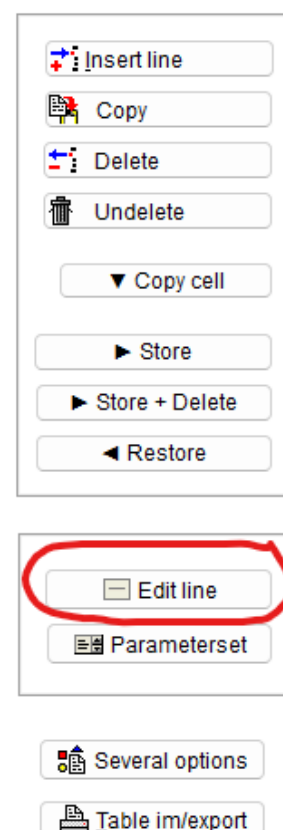
Parametersets are meant to enter in a faster way the properties of your installation. So shall a lighting distributor have the same types of out-going fields. By defining a single parameterset you can quickly define the properties of each out-going fields.

### 13.3.2 Buttons for user friendly editing cells

The content of some cells are based on a reference number rather than on it's name. For instance the column protection-device has only number in stead of for instance a name such as 'C circuit breaker'.

Because number are not understandable, on the left side are present two buttons.

With the button [edit line] one can user easily edit the active cell of the active line.



### Concerning the protection device parameters!

Attention despite the fact that in the table the type of protection can be selected, not all parameters of this can be set. For example, the settings of an electronic trip unit are not found here. These various parameters are included in the parameter set explained below. This means that you have to select the type of protection in the parameter set to get to the desired settings.

### 13.3.3 Button parameterset

Because not all properties fit in the lines in the table, a provision is added to edit these with a separate button. The provided button is [parameterset].

Properties are achievable via numbers. Up to 2000 parametersets are possible. A distributor thus will minimum have at least two parametersets, namely one for the mains, and one for the out-going fields.

The screenshot shows the KABEL++ software interface. On the left, there is a sidebar with various buttons. The 'Parameterset' button is highlighted with a red circle. A red arrow points from this button to the 'Param' column in the table below. The table contains cable parameters for various components, including 'K1', 'K2', 'ONDERVERDELER 1', 'Pomp 1', 'WCD 1', 'ONDERVERDELER 2', 'Pomp 2', and 'WCD 2'. The 'Param' column shows values like '1' and '2'. A red circle highlights the value '2' in the 'Param' column for 'Pomp 1'.

| Tagnummer | Omschrijving    | P&ID | Reser | kW  | L123 | V   | Fasen | Cos  | Kast | Typical | Beveiliging | 2de | Magne | Lengte | Param | A | L |
|-----------|-----------------|------|-------|-----|------|-----|-------|------|------|---------|-------------|-----|-------|--------|-------|---|---|
| K1        |                 |      | -     | 8,5 | -    | 400 | 3     | 0,85 | HVK  | V       | 201         | -   | -     | 60     | 1     | - | - |
| K2        |                 |      | -     | 8,5 | -    | 400 | 3     | 0,85 | HVK  | V       | 201         | -   | -     | 60     | 1     | - | - |
|           | ONDERVERDELER 1 |      |       |     |      |     |       |      |      |         |             |     |       |        |       |   |   |
| Pomp 1    |                 |      | -     | 5   | -    | 400 | 3     | 0,85 | K1   | V       | 201         | -   | -     | 60     | 2     | - | - |
| WCD 1     |                 |      | -     | 5   | -    | 400 | 3     | 0,85 | K1   | V       | 201         | -   | -     | 60     | 2     | - | - |
|           | ONDERVERDELER 2 |      |       |     |      |     |       |      |      |         |             |     |       |        |       |   |   |
| Pomp 2    |                 |      | -     | 5   | -    | 400 | 3     | 0,85 | K2   | V       | 201         | -   | -     | 60     | 2     | - | - |
| WCD 2     |                 |      | -     | 5   | -    | 400 | 3     | 0,85 | K2   | V       | 201         | -   | -     | 60     | 2     | - | - |

### 13.3.4 Storing parametersets

The parametersets you defined are stored in the calculation file. But parametersets can also be exported into a separate file and be imported into other calculations.

### 13.3.5 Consumers versus instruments

Except consumers also instruments can be entered in the table. These are in general useful when generating an I/O list.

### 13.3.6 Im-/export

There are more ways of exporting data:

- im- or export the entered input table,  
The table (or the consumers list) can be exported as CSV (comma separated value) format to Excel or Open Office. Mostly it takes some trials and errors before all columns in Excel or OpenOffice-Calc are correct. Check the use of an apostrophe before and after cells and the separation of the cells with the , of ;
- export the calculated cable list.

After the cable list has been calculated, the list can be exported using CSV from the result sheet.

### Printing

There are more way of printing any kind of data:

- the table, as a consumers list or instruments list
- the calculated cable list.

After the initiation of a print command you get a follow window in which you may adjust some general settings, but also a way to compose a filename which you can use when printing to a pdf.

## 13.4 Columns

Help info

If you press the help key F1 while a cell is active, further information belonging to that column is displayed.

### 13.4.1 Column Tag number

Each tag number shall be unique.

### 13.4.2 P&ID

The program does nothing with this column. You can include a reference to the project's Process and Instrumentation Diagram here.

### 13.4.3 Reserve

The program does nothing with this column, unless you selected that under Options this column is used to include an encoding in the DXF single line diagram.

### 13.4.4 Column kW

The column that holds the power of the consumer must be filled for out-going fields, but not for distributors. For the latter the program itself calculates the power and copies this in the kW-cell.

You cannot enter a Current value in the table. But using the conversion tool (right mouse button) you can possibly convert current from current to kW and then copy it to the active line using the [>] button.

### 13.4.5 L123

Here you can indicate to which phase, in case of a single phase power supply, the power supply is connected.

The program determines the asymmetry.

### 13.4.6 Column voltage

The voltage of out-going fields must be the same as the voltage of the mains, or a factor  $\sqrt{3}$  between the them when is concerns single phase.

There are two exceptions:

- When the type of consumer is a measurement instead of a consumer one can enter a value less than 50 V. The software then still calculates with e.g. 230VAC.
- When the type of consumer is type T. (step-down transformer).

### 13.4.7 Typical

Determines the type of circuit used to power the cable. You can choose from the following types:

- Power supplies, e.g. V, PV. Note Type T4 which has a further hierarchy.
- Motor load, e.g. DOL, FO. Note Type FO4 which has a further hierarchy.
- valves, e.g. A1, A2.
- instrument list, e.g. I2 for an analog two-wire sensor.
- PLC I/O.

The possible typicals are further outlined in more detail in the help. (This help can be accessed by pressing the F1 key when the respective cell is active.).

### 13.4.8 Column Panel

Attention for the hierarchy that is connected to this cell. If your installation includes sub-dividers then this

column will contain the tag number of the sub-dividers.

The program check for some mistakes, such as a zero versus the letter o.

#### *13.4.9 Protection device*

This column indicates the type of security. However, it is indicated by an internal sequence number. Through the button [change rule] you can see which type it really is.

Further setting for the security you do through the parameter set!

#### *13.4.10 Options*

See in paragraph 13.6 on page 58.

## 13.5 Execution

### 13.5.1 hierarchy

Determine the hierarchy of the distribution boards.

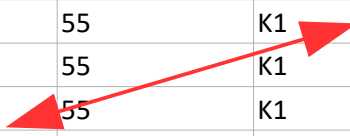
The program automatically determines the number and size of the distribution boards based on the 'Panel' column.

The distinction between main and subdividers is determined by the program using the 'Tag Number' and 'Closet' columns.

Example of the hierarchy in the table:

The hierarchy is automatically established by Kabel++ when entered as follows, where in this example, HK is the main distributor and K1 is a sub-distributor:

| Tagnumber | Load [kW] | Connected on panel |
|-----------|-----------|--------------------|
| Pump 1    | 55        | K1                 |
| Pump 2    | 55        | K1                 |
| Pump 3    | 55        | K1                 |
| K1        | -         | HK                 |
| K2        | -         | HK                 |
| Pump 4    | 55        | K2                 |
| Pump 5    | 55        | K2                 |
| Pump 6    | 55        | HK                 |



Kabel++ intercepts the following different situations:

- One distribution board:  
When you have the same panel code on each line in the column 'panel' there may be two possibilities:
- More distribution boards:  
Up to three levels of sub switchboards will be detected.  
When entering more different panel names, KABEL++ calculates for every panel the mains supply cable (feeding cable to C in the figure), and also when there are more than one chest, calculates the supply cable of A to B. To change parameters of this cable you can use the button 'edit mains power supply cable'.

### 13.5.2 Next two options are available for the connection to mains:

- You have the short circuit connected:

KABEL++ assumes that the out-going cables are direct connected from the main low voltage distributionboard. This distribution board is then assumed the same as the one in the short circuit. Or, from the figure; divider C is considered as A. The feeding supply cable is thus the transformer cable of the short circuit.

| Tagnumber | Description              | P&ID | Reser | kW   | L12, V | Phase | Cos | Panel | Typical | protectio | 2d  | Magne | Length | Param | C | D | Reserve | η corr | Bu |
|-----------|--------------------------|------|-------|------|--------|-------|-----|-------|---------|-----------|-----|-------|--------|-------|---|---|---------|--------|----|
| HV        |                          |      | -     | 23   | -      | 400   | 3   | 0,827 | Main    | V         | 201 | -     | -      | 60    | 1 | - | -       | 0      | 0  |
| SD1       |                          |      | -     | 12,3 | -      | 400   | 3   | 0,85  | Main    | V         | 201 | -     | -      | 60    | 1 | - | -       | 0      | 0  |
| SD2       |                          |      | -     | 12,3 | -      | 400   | 3   | 0,85  | Main    | V         | 201 | -     | -      | 60    | 1 | - | -       | 0      | 0  |
| LD        |                          |      | -     | 16,4 | -      | 400   | 3   | 0,84  | Main    | V         | 201 | -     | -      | 60    | 1 | - | -       | 0      | 0  |
| P101      | main distribution pump 1 | P001 | new   | 5,5  | -      | 400   | 3   | 0,81  | HV      | DOL       | 240 | -     | 13     | 1,00  | 1 | - | 0       | 0      | 0  |
| P102      | main distribution pump 2 | P001 | new   | 5,5  | -      | 400   | 3   | 0,81  | HV      | DOL       | 240 | -     | 13     | 1,00  | 1 | - | 0       | 0      | 0  |
| P103      | main distribution pump 3 | P002 | new   | 5,5  | -      | 400   | 3   | 0,81  | HV      | FO        | 240 | -     | 4      | 1,00  | 1 | - | 0       | 0      | 0  |

- The short circuit is not connected:

KABEL++ calculates the feeding supply cable for the main distribution board. In this situation a button is visible with which you can adjust the parameter settings for this mains supply cable.

| Tagnumber | Description              | P&ID | Reser | kW   | L12, V | Phase | Cos | Panel | Typical | protectio | 2d  | Magne | Length | Param | C | D | Reserve | η corr | Bu |
|-----------|--------------------------|------|-------|------|--------|-------|-----|-------|---------|-----------|-----|-------|--------|-------|---|---|---------|--------|----|
| HV        |                          |      | -     | 23   | -      | 400   | 3   | 0,827 | Main    | V         | 201 | -     | -      | 60    | 1 | - | -       | 0      | 0  |
| SD1       |                          |      | -     | 12,3 | -      | 400   | 3   | 0,85  | Main    | V         | 201 | -     | -      | 60    | 1 | - | -       | 0      | 0  |
| SD2       |                          |      | -     | 12,3 | -      | 400   | 3   | 0,85  | Main    | V         | 201 | -     | -      | 60    | 1 | - | -       | 0      | 0  |
| LD        |                          |      | -     | 16,4 | -      | 400   | 3   | 0,84  | Main    | V         | 201 | -     | -      | 60    | 1 | - | -       | 0      | 0  |
| P101      | main distribution pump 1 | P001 | new   | 5,5  | -      | 400   | 3   | 0,81  | HV      | DOL       | 240 | -     | 13     | 1,00  | 1 | - | 0       | 0      | 0  |
| P102      | main distribution pump 2 | P001 | new   | 5,5  | -      | 400   | 3   | 0,81  | HV      | DOL       | 240 | -     | 13     | 1,00  | 1 | - | 0       | 0      | 0  |
| P103      | main distribution pump 3 | P002 | new   | 5,5  | -      | 400   | 3   | 0,81  | HV      | FO        | 240 | -     | 4      | 1,00  | 1 | - | 0       | 0      | 0  |

### 13.5.3 More than three levels

More than three levels are not possible, however the following possibilities are available:

- 1 If there are even more levels between the transformer and the main distributor A, you can enter additional distributors using the [additional intermediate dividers] button.
- 2 If, for example, there are dividers under the distributor F, it can be done as a new separate calculation. Here you perform the calculated short-circuit power in kA in the calculation from A to F and enter this under "Short-circuit power supply point" in the new calculation.

Adjust short circuit strength mains power

**Short circuit power mains**

Choice shortcircuit power on  Shortcircuit power

Maximum short circuit power at mains  kA

Minimum short circuit power at mains  kA

R/X

**Damping incoming mains**

### 13.5.4 Voltage loss and magnetic setting (sub) main protection-devices:

An error message such as  $IK \gg$  or  $T \ll$  can occur without it being clear where it comes from, eg an overflow can occur in the short-circuit calculation of the power cable between the sub-distributors. The solution may be to lower the magnetic setting of the front feeder or by increasing the transformer cable in the transformer blade, either to bring the switch-off characteristic to a lower tripping current or to increase the short-circuit current. It can also be a solution to reduce the voltage loss of the power cable so the mains cable becomes thicker and thus increasing the short circuit current.

### 13.5.5 Asymmetrical loads

If a sub-distributor has 1 phase groups, unequal loads can occur over the phases, or asymmetrical load. In column L123 you can indicate at which phase the relevant outgoing group must be connected. The program presents the power per phase at the end of the cable list calculation, and shows the asymme-

try as a percentage of the feeding distribution board.

#### 13.5.6 *Higher harmonics*

If you specify a value for the higher harmonic in the parameter sets, then Cable ++ calculates this through to the upper incoming feeds, through.

## 13.6 Options

In this section some options are explained, namely:

- Section 13.6.1, Safety always at least 16 A
- Section 13.6.2, Linking a trunk cable to a branch in the network table
- Section 13.6.3, Increase the value of security
- Section 13.6.4, Increasing the diameter of the cable

These options can be set in two ways:

- By entering a number in the options column. The meaning of that number can be found in the Help. (mouse on the cell in the column options and then press F1).
- With the button [change line].

### 13.6.1 Safety always at least 16 A

For light distributors it is customary to use a value of 16 A for safety releases. By assigning a value of 9 in the column, the safety will always be at least 16 A, even if the capacity is significantly lower. A value of 8 means that the safety is always 6A minimum.

### 13.6.2 Linking a trunk cable to a branch in the network table

You can put a trunk cable on an end group in the network list. You can indicate this using the options. First you choose a number that is not yet in use, with a value from 1 to 2000. Then you will define the trunk cable by opening the trunk cable module. After a trunk cable has been entered in this way, the value in the options column has increased by 10,000 with the sequence number of the trunk cable.

The screenshot shows the KABEL++ software interface with several configuration panels:

- Distributor Panel (Yellow):**
  - Distributor: HK
  - Safety release type: C circuit breaker
  - Size+1: 0
  - Choose way of starting or method of mains: F: supply
- Parameters Panel (Green):**
  - Voltage [V]: 400
  - Number of phases/DC: 3
  - Power [kW]: 10,7
  - Powerfactor: 0,85
  - Real load factor: 0
  - simultaneity: 0
  - Connection trunk cable: noni
- Cable Properties Panel (Blue):**
  - Cable length [m]: 60
  - Screened: no
  - Cable parallel extra: no
  - Cross section Size extra: 0

Red arrows indicate the flow of information from the text in section 13.6.2 to the 'Connection trunk cable' dropdown in the Parameters Panel and the 'Options' column in the network table.

### 13.6.3 Increase the value of security

If you find it necessary for a good reason you can indicate that the value of the safety release has to be increased.

#### 13.6.4 *Increasing the diameter of the cable*

Sometimes it may be necessary to increase the short-circuit current and, for example, to prevent excessive voltage loss during start-up of the motor.

## 13.7 Calculate items

Overview:

1. cable list
2. Energy balance
3. Single line diagram
4. Panel front view
5. I/O list
6. specification sheets

### 13.7.1 Button *[Cable list]*

With the Cable List button, the size of the safety, the selectivity and the cable cross-sections are calculated for all lines in the table.

The cables are calculated against thermal load, voltage loss, short-circuit current and selectivity.

Calculated are both the output cables and the power cables and selectivity between them.

Note: Because the short-circuit current in an off-going cable depends on the cross-section of the mains power cable, the calculation is run through several times.

But because:

- The size of the security device in the power supply to a distributor depends on the size of the security devices in the outgoing groups of the distributor due to selectivity,
- and because the cable in the mains power supply depends on the safety device in the mains,
- and the short-circuit currents in the output groups are determined by the cross-section of the feeding cable to the distributor,

there is an interdependence that sometimes can not work out optimally. You can influence this for instance by adjusting the magnetic release cutoff value of the safety and/or the permissible voltage drop in mains cables.

### 13.7.2 Button *[Energy balance]*

Depending your choice the energy balance is calculated of one or more panels.

The needed power is calculated as well as the expected panel length and the heat dissipation.

### 13.7.3 Button *[Single line]*

A DXF-file will of the single line scheme be generated. This file can be read by Autocad, Open Office etc.

### 13.7.4 Button *[Panel front view]*

A DXF-file will be generated. This file can be read by Autocad, Open Office etc.

### 13.7.5 Button *[I/O list]*

By means of a template per apparatus an I/O list is comprised. The result is in CSV (comma separated values) format which can be read by Excel, LibreOffice etc.

Before the generation is started the user is asked first if he wants to alter the template. The first time the template is copied from the project folder under the name of IO-typicals\_EN.txt.

Notice:

- the difference of consumers and instruments
- the use of an apostrophe before and after cells in the separation of the cells with the , of ;

## 13.8 Examples cable list

Three possible situations:

The program is able to distinguish between one or more levels of subdistribution boards, namely:

- 1 Consumers list, one level, no subdistribution boards
- 2 Consumers list, one level, more subdistribution boards
- 3 Consumers list, two levels, more subdistribution boards

Kabel++ automatically detects the number of levels. In this automatic detecting some remarks apply. These remarks are somehow detailed next.

Remarks: When an error like  $I_k >>$  or  $T <<$  occurs, for instance due to the short circuit calculation of the main supply cable between mainboard and a switchboard then it may not be noticeable where it comes from. The solution is to decrease the magnetic adjustment of the main cable circuit breaker or to increase the cross-section of the transformer cable. Problem is that an error may not be evident from where it comes from.

- When f.i. the cable list is calculated then Kabel++ also calculates the other calculation modules such as the trunk cable. This can lead to an error of that other module and that seems to be in the cable-list-calculation.

On the screen the following presentations and controls are present:

- Right below the table with the out-going consumers;
- Left below the buttons for editing the lines in the table;
- Left upper the buttons for starting out of four calculations
- Right upper a schematic presentation and the belonging buttons:
  - . starting of the short circuit
  - . opening the extra cables module;
  - . changing and activating of an extra main power supply cable;
  - . changing the adjustments of the power supply cables for each sub distributionboard.

Next follows an examples for each situations:

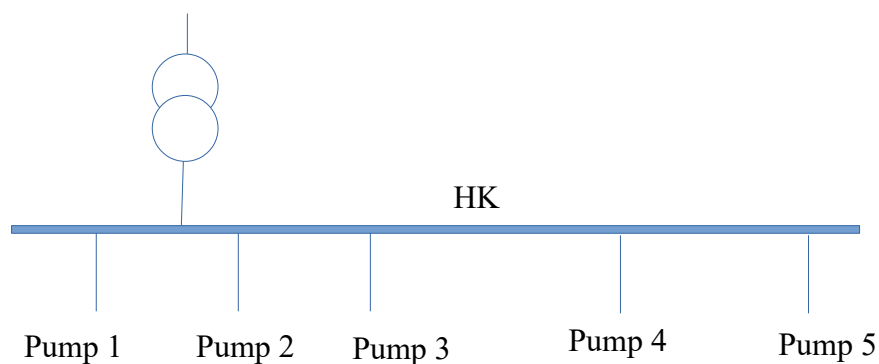
## 13.9 Examples

### 13.9.1 Consumerslist, one level, no subdistributionboards

Suppose the next consumerslist:

| Tagnumber | Power consumption<br>[kW] | Connected on dis-<br>tributor | Circuitry<br>(motorstarter) |
|-----------|---------------------------|-------------------------------|-----------------------------|
| Pump 1    | 55                        | HK                            | DOL                         |
| Pump 2    | 55                        | HK                            | DOL                         |
| Pump 3    | 55                        | HK                            | DOL                         |
| Pump 4    | 55                        | HK                            | DOL                         |
| Pump 5    | 55                        | HK                            | DOL                         |

Or schematic:



Remarks: In the column Tagnumber only consumers are listed.

- When a calculation type is chosen such as the cable list, the program asks for which panel the calculation should be done. In this list the main distribution board HK is taken. In the result the code will not be shown because it concerns the main busbar behind the transformer in the transformer module.

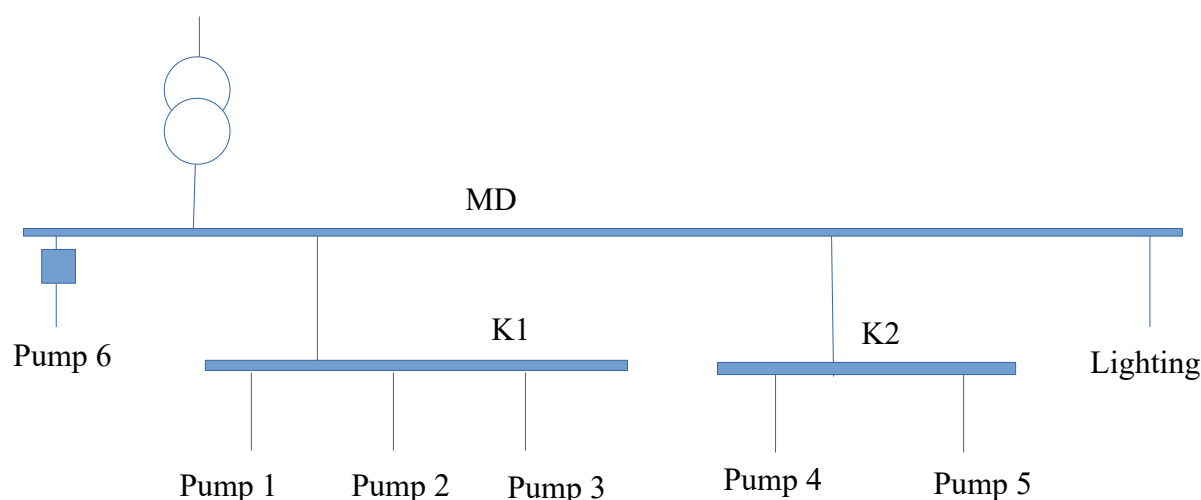
Furthermore you are able to setup a supply cable between the transformer module and the busbar HK. Also you may activate one or more extra cables of which the cross sections are known.

### 13.9.2 Consumerslist, two level, more subdistributionboards

Suppose the next consumerslist:

| Tagnumber | Power consumption [kW] | Connected on distributor | Circuitry (motorstarter) |
|-----------|------------------------|--------------------------|--------------------------|
| K1        | -                      | MD                       | V                        |
| K2        | -                      | MD                       | V                        |
| Pump 1    | 55                     | K1                       | DOL                      |
| Pump 2    | 55                     | K1                       | DOL                      |
| Pump 3    | 55                     | K1                       | DOL                      |
| Pump 4    | 55                     | K2                       | DOL                      |
| Pump 5    | 55                     | K2                       | DOL                      |
| Pump 6    | 1                      | MD                       | VSD                      |
| Lighting  | 1                      | MD                       | V                        |

Or schematic:



Remarks:

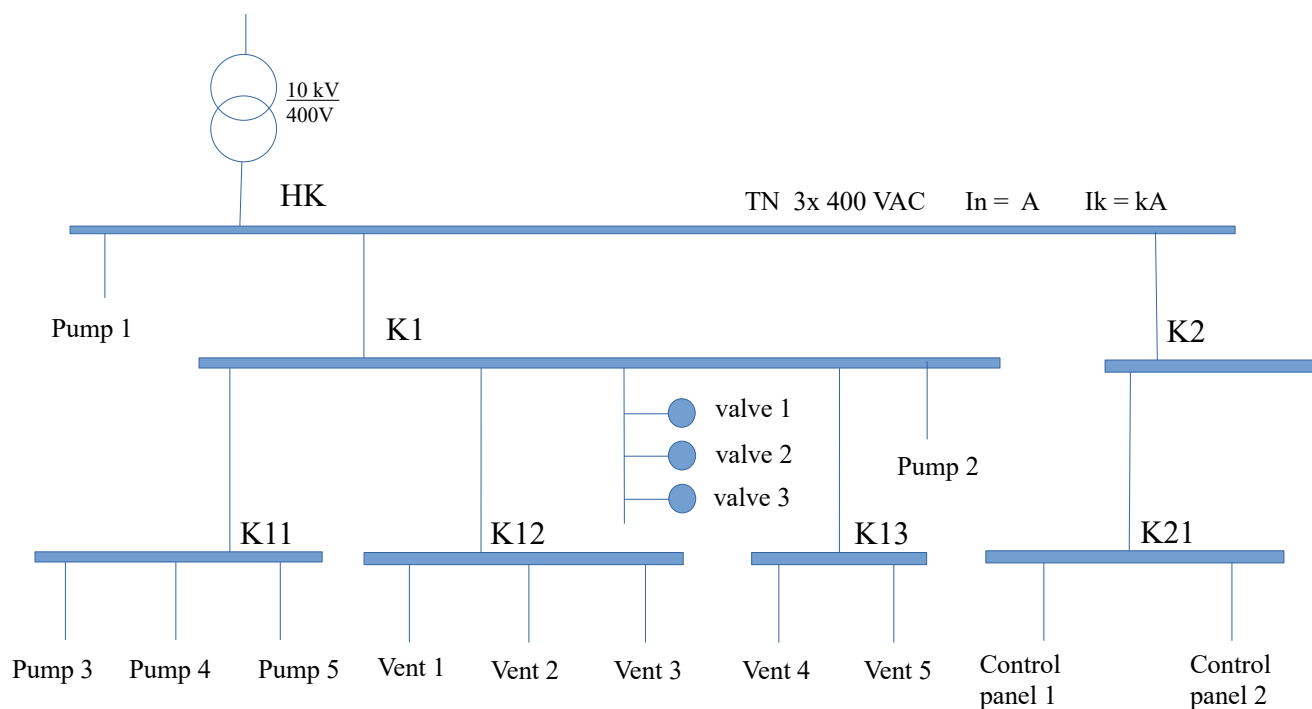
- In the column "Tagnumber" the codes of the panels K1 and K2 are held, connected to the main distributionboard HK. Also notice that on the main distribution board HK a pump (pump 6) directly is connected.
- The program itself detects that there are distribution boards;
- The powers of the distribution boards need not to be filled. Kabel++ does that.
- The panels K1 and K2 are calculated including the corresponding supply cable to HK which also is calculated.
- When a calculation type is activated, such as cable list, the program asks for which panel the calculation should be done. In this list the main distribution board HK cannot be chosen. In the result of the calculation this is also not the case but the main busbar behind the transformer in the transformer module is this HK as such.

### 13.9.3 Consumerslist, three levels, more subdistributionboards

Suppose the next consumerslist:

| Tagnumber | Power consumption<br>[kW] | Connected on dis-<br>tributor | Circuitry<br>(motorstarter) |
|-----------|---------------------------|-------------------------------|-----------------------------|
| K1        | -                         | HK                            | V                           |
| K2        | ---                       | HK                            | V                           |
| K11       | -                         | K1                            | V                           |
| K12       | -                         | K1                            | V                           |
| K21       | -                         | K2                            | V                           |
| Pump 1    | 55                        | K11                           | DOL                         |
| Screen    | 55                        | K11                           | DOL                         |
| Mixer     | 55                        | K11                           | DOL                         |
| Pump 4    | 55                        | K12                           | DOL                         |
| Pump 5    | 55                        | K12                           | DOL                         |
| Valve 1   | 0,5                       | K21                           | REV                         |
| Valve 2   | 0,5                       | K21                           | REV                         |
| Valve 3   | 0,5                       | K21                           | REV                         |
| Control   | 0,2                       | HK                            | V                           |

Or schematical:



Remarks:

- Notice that in the column "Tagnumber" the codes of the panels K1, K2 and K11, K12, K21 are held, respectively connected to the main distribution board HK and K1, K2;
- Also notice that on the main distribution board HK not only the subdistribution boards K1 and K2 are connected, but also a pump (pump 8);
- The program itself detects that there are two levels of sub-distribution boards;
- The powers of the subdistribution boards need not to be filled. Kabel++ does that.
- The panels K1 and K2 are calculated including the corresponding supply cable to HK which also is calculated.
- When a calculation type is started, such as cable list, the program asks for which panel the calculation should be done. In this list the main distribution board HK may not taken. In the result of the calculation this is also not the case but the main busbar behind the transformer in the transformer module is this HK as such.
- A switchboard with a single consumer is not a switchboard.

