USER`S MANUAL

V 5.1

October 2020

ABAKUS d.o.o. & ELSYST/GM Arhitektura d.o.o.

Slovenia

Program **ELIN** helps designers of electrical installations to calculate and optimize electrical network quickly according to IEC standards.

As the authors of program **ELIN** we wanted to make a program with all needed calculations for project but on a simple way, with possibility to calculate the whole network easily and not just one part of the circuit. Program **ELIN** uses IEC standards and independent products so it is suitable for different users.

This Manual is written for the complete version of a program, the difference to **DEMO** is only in limited number (35) of electrical elements and non saving a project.

Program **ELIN outputs** can be connected to **AutoCAD environment** for making drawings and to **EXCEL** for spreadsheets.

This manual describes only program **ELIN 5.1** as standalone version, because it is a base for electrical computer aided design (ECAD) in different environments. In the new **Upgrade** there are procedures for Install/Uninstall updated. There are more additional tools in database and outprints available. Using command **EI2EIP** conversion of projects from older versions is possible.

Program **ELIN 5.1** offers graphical presentation of cut off protection device characteristcs.

In the Manual for **ELIN 5.1** there are a lot of pictures of previous versions of **ELIN**, because they are unchanged.

ELIN is registered name by company ABAKUS d.o.o., Vernek 3, 1281 KRESNICE, SLOVENIA. Company ELSYST/GM Arhitektura d.o.o., Na jasi 16, 1241 KAMNIK, SLOVENIA is distributor and system provider for program ELIN.

Contents

1. ABOUT PROGRAM ELIN

1.1 Installing program ELIN

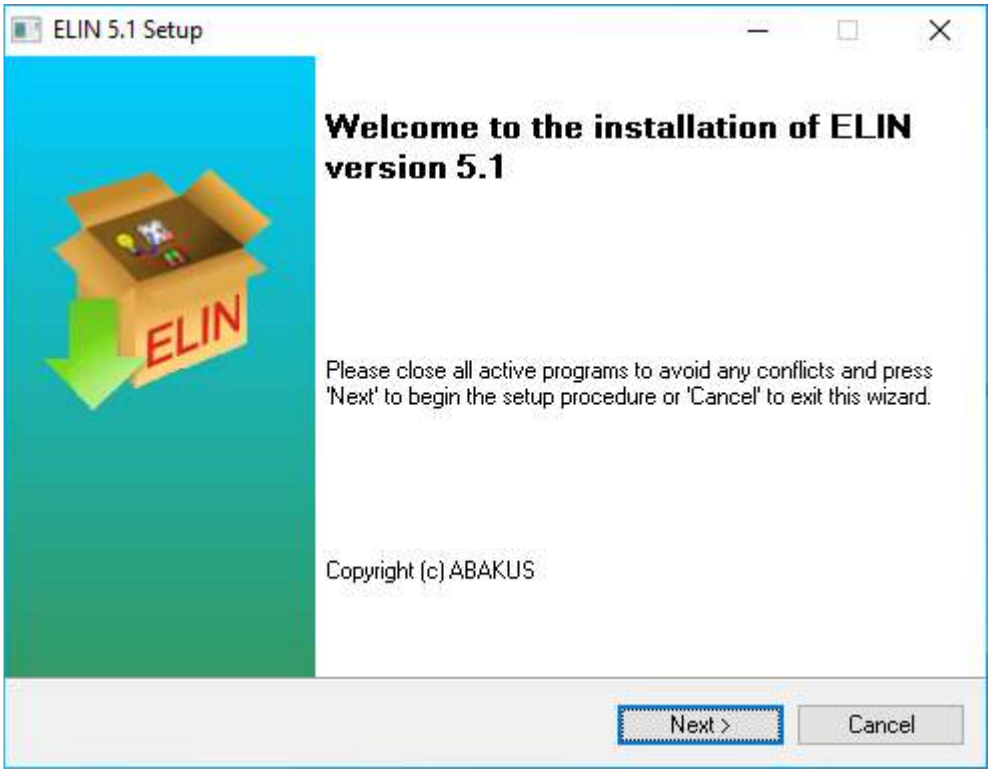
Installation is done through program **ELIN-Setup** on CD or when downloaded from **ABAKUS** or **ELSYST** site:

http://www.abakus-lj.si/ABAKUS-ELIN.htm

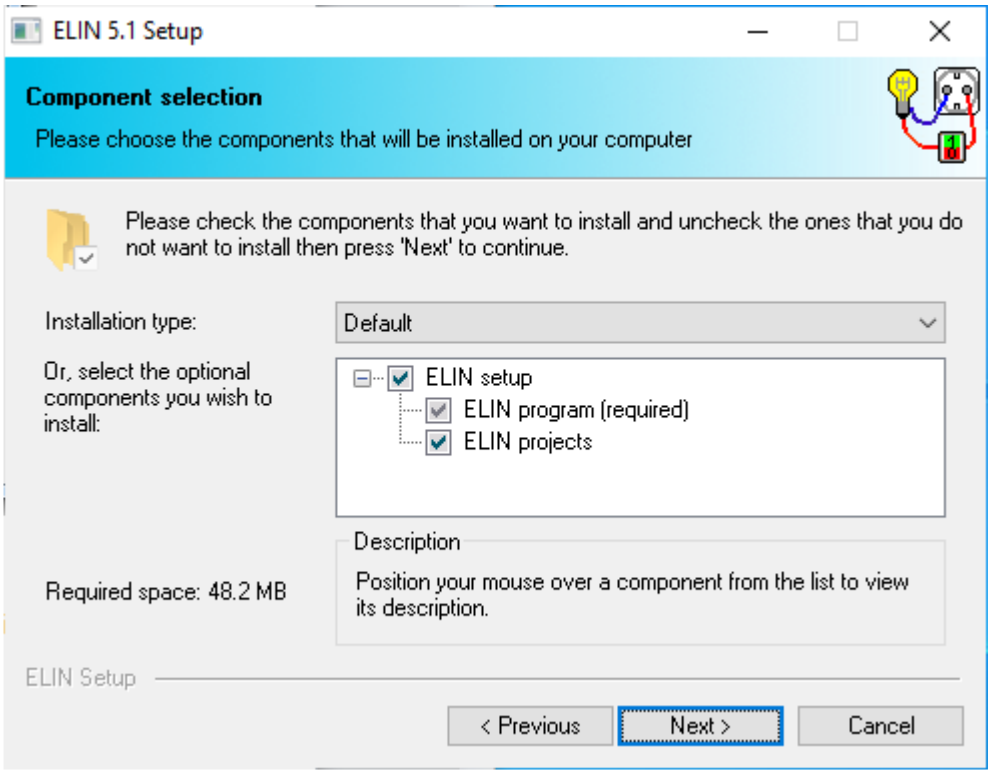
There are two possibillities: **DEMO** and full version with protection key.

http://www.elsyst.si/Programi.asp

There it can be downloaded **DEMO** version.



Installation and opening new projects is similiar for all **WINDOWS XP/Vista/WIN7/WIN10** only some commands are differently shaped but generally the same ones.



After program **ELIN** is installed there is a line in **Start** menu prepared, and there are two icons on the desktop. One is identified as

program **ELIN**

and

folder for projects

Tree (folders) structure of **ELIN** is following:

..\ABAKUS\ELIN	main folder
..\ABAKUS\ELIN\Image	folder for graph.elements
..\ABAKUS\ELIN\Sim	folder for graph. symbols
..\Documents\ELIN proj	folder for project data

There are four files in main folder (Predloga_xx_iz.xls), where headers for sheets in spreadsheets are defined (files *.XLS).

Program **ELIN** can be run by doubleclick on three places:

- at a line **ELIN** in Start menu
- at icon **ELIN** on desktop
- at icon or at a line with the name of project in browser

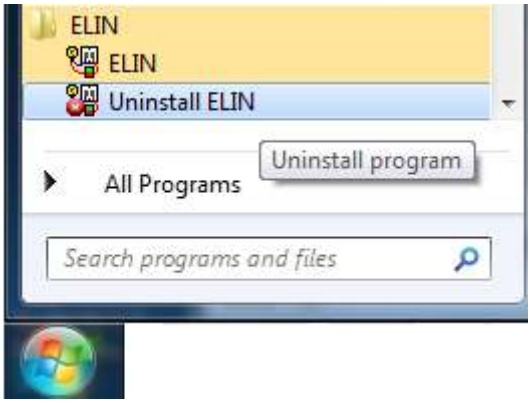
Project folder is as default set:

..\Documents\ELIN proj,

but it can be changed for every project by defining using »**Save as..**« . Project default is Anonymus but there are free names and folders.

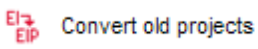
1.2 Uninstalling of program ELIN

Using command Uninstall in »Control panel/Add/Remove SW« it is possible to remove program **ELIN**.

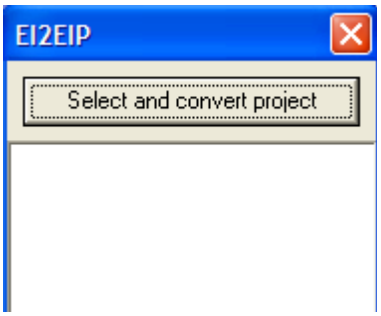


1.3 Converting projects done with older versions

Using command Project/Extra/Convert from old versions



The following program changes the old poject form from *.ei to *.eip. For versions older than 4.x only structure of tree can be done.

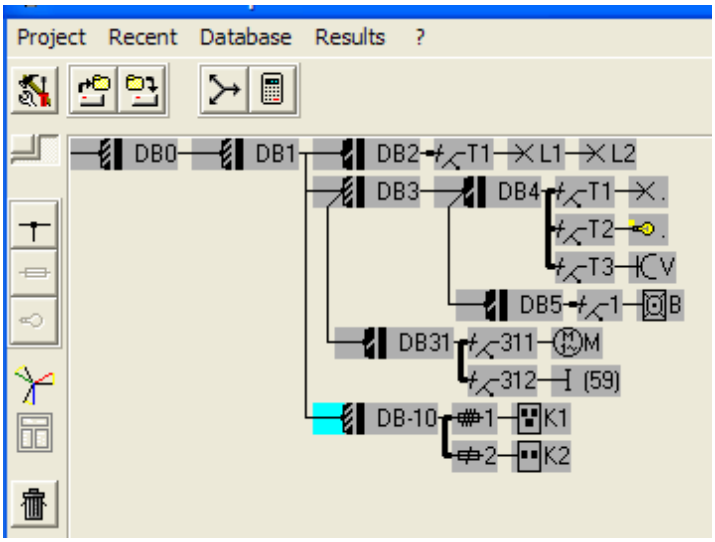


After selecting project (xxx.ei) the new version of project (xxx.eip) is placed in the same folder. Using X you can leave this program.

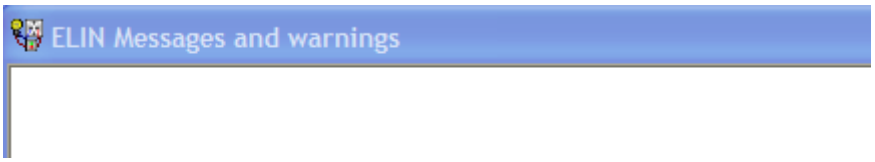
2. STRUCTURE OF PROGRAM ELIN

Program **ELIN** is composed of more windows screens:

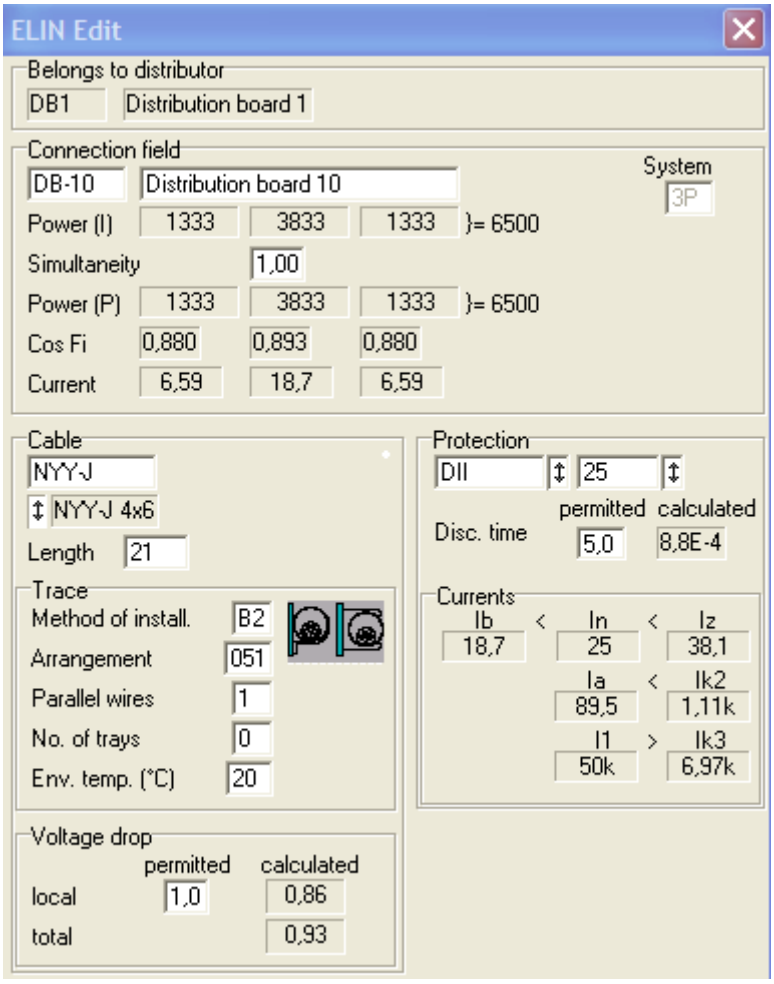
- main screen with download menu
- edit screen with wiring menu
- message screen
- setting screen
- power diagram screen
- graphical menu for methods of installation
- data base screen



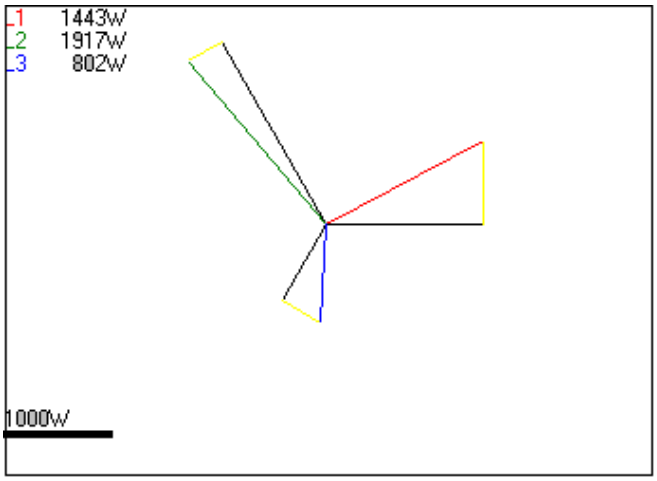
main screen



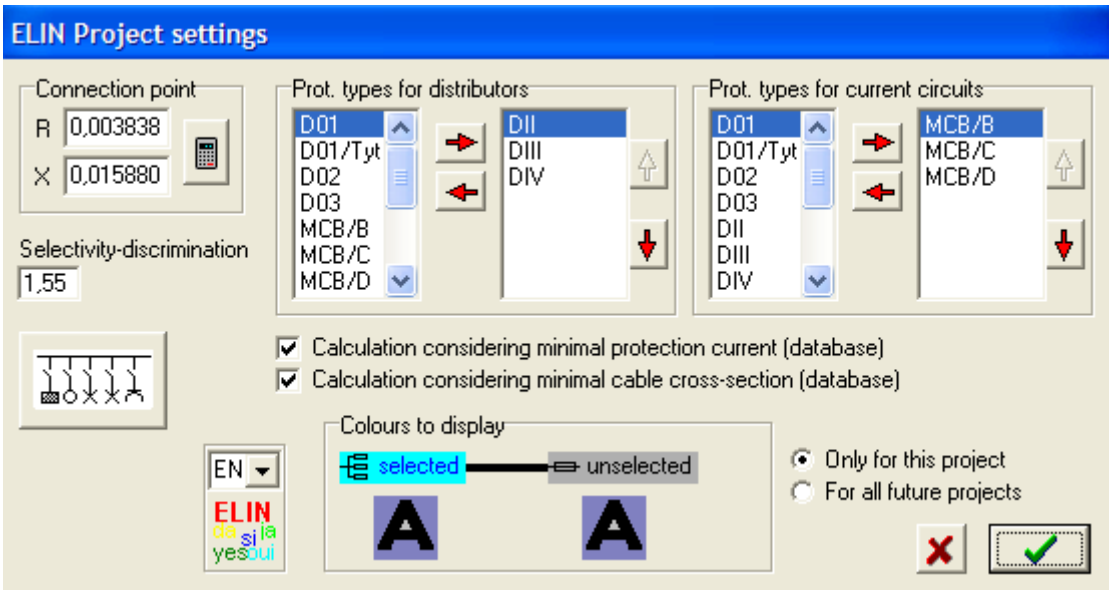
message screen



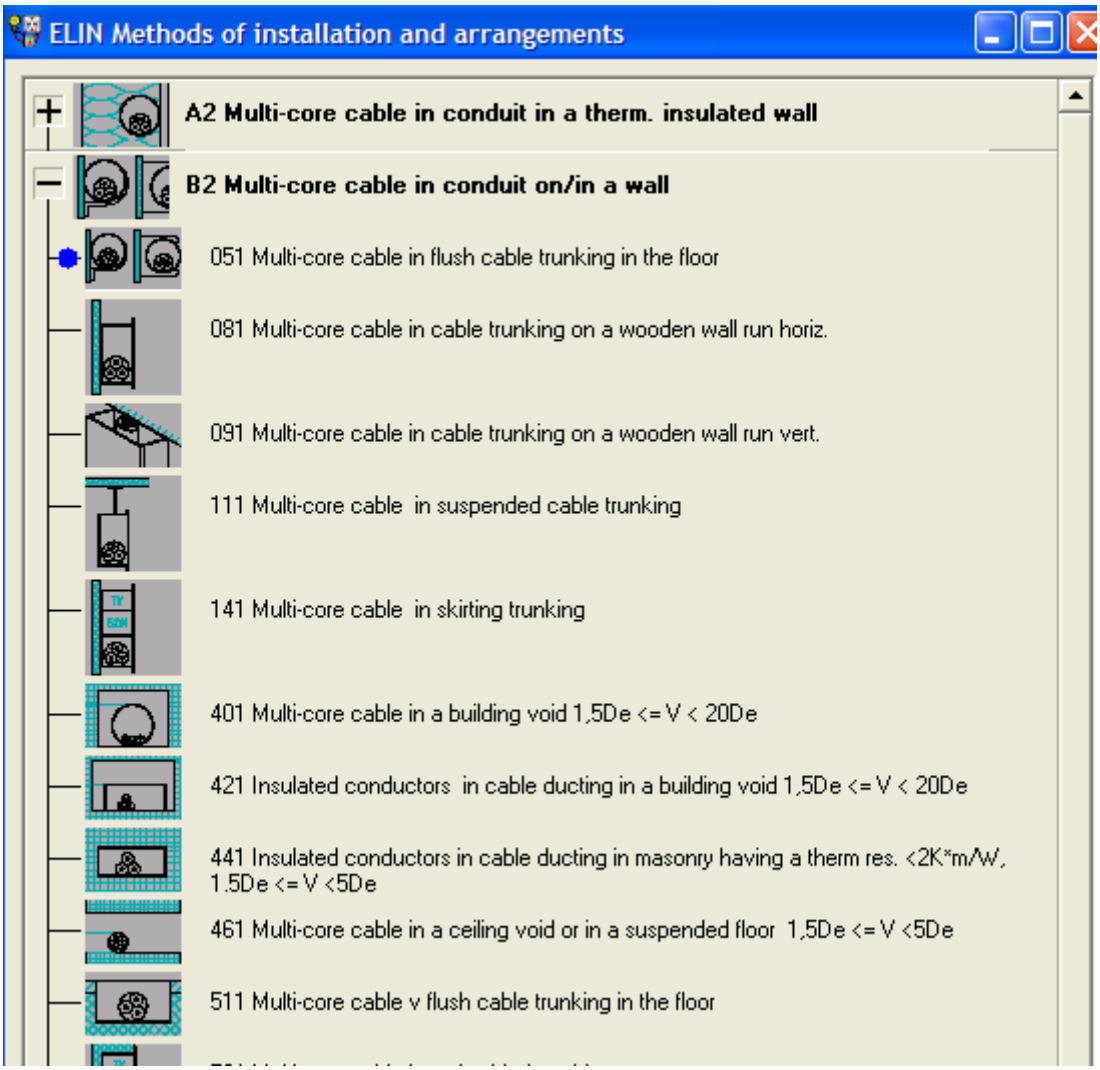
edit screen



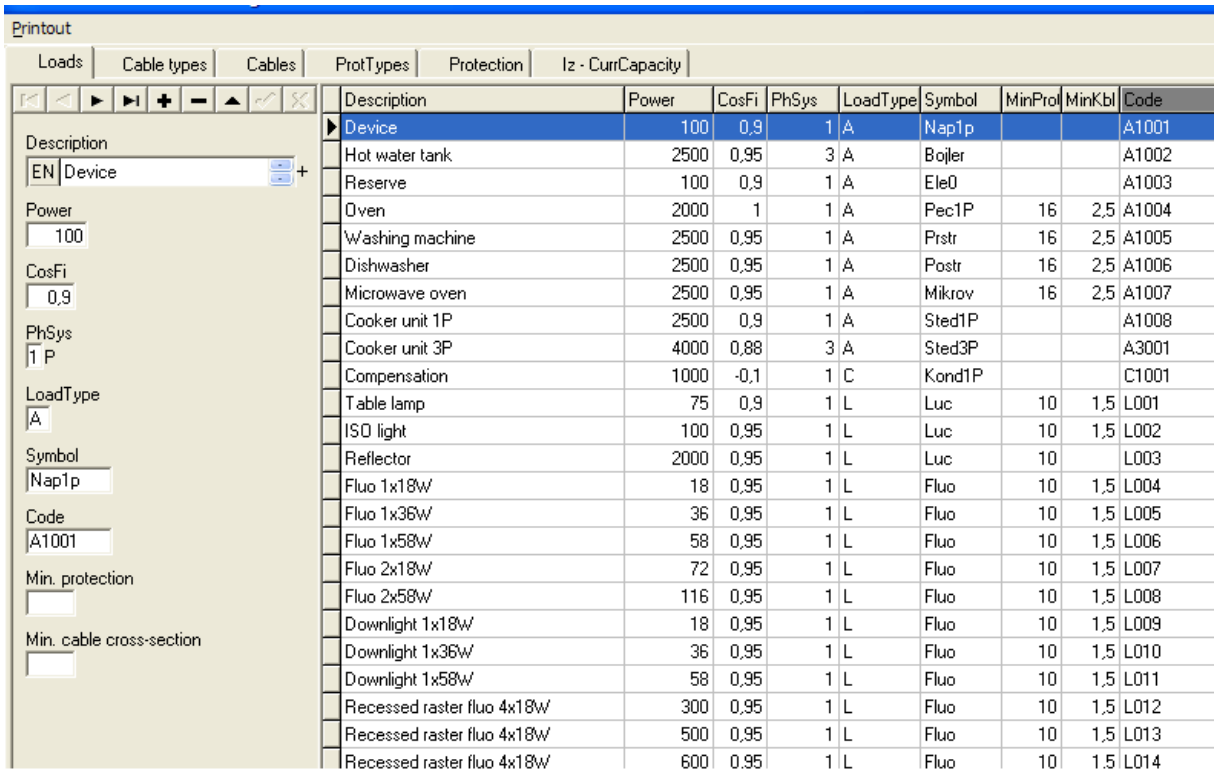
power diagram



setting screen



graphical screen for methods of installation



Description	Power	CosFi	PhSys	LoadType	Symbol	MinProt	MinKbl	Code
Device	100	0,9	1	A	Nap1p			A1001
Hot water tank	2500	0,95	3	A	Bojler			A1002
Reserve	100	0,9	1	A	Ele0			A1003
Oven	2000	1	1	A	Pec1P	16	2,5	A1004
Washing machine	2500	0,95	1	A	Prstr	16	2,5	A1005
Dishwasher	2500	0,95	1	A	Postr	16	2,5	A1006
Microwave oven	2500	0,95	1	A	Mikrov	16	2,5	A1007
Cooker unit 1P	2500	0,9	1	A	Sted1P			A1008
Cooker unit 3P	4000	0,88	3	A	Sted3P			A3001
Compensation	1000	-0,1	1	C	Kond1P			C1001
Table lamp	75	0,9	1	L	Luc	10	1,5	L001
ISO light	100	0,95	1	L	Luc	10	1,5	L002
Reflector	2000	0,95	1	L	Luc	10		L003
Fluo 1x18W	18	0,95	1	L	Fluo	10	1,5	L004
Fluo 1x36W	36	0,95	1	L	Fluo	10	1,5	L005
Fluo 1x58W	58	0,95	1	L	Fluo	10	1,5	L006
Fluo 2x18W	72	0,95	1	L	Fluo	10	1,5	L007
Fluo 2x58W	116	0,95	1	L	Fluo	10	1,5	L008
Downlight 1x18W	18	0,95	1	L	Fluo	10	1,5	L009
Downlight 1x36W	36	0,95	1	L	Fluo	10	1,5	L010
Downlight 1x58W	58	0,95	1	L	Fluo	10	1,5	L011
Recessed raster fluo 4x18W	300	0,95	1	L	Fluo	10	1,5	L012
Recessed raster fluo 4x18W	500	0,95	1	L	Fluo	10	1,5	L013
Recessed raster fluo 4x18W	600	0,95	1	L	Fluo	10	1,5	L014

data base screen

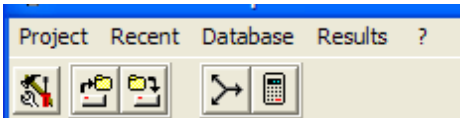
3. Commands

3.1 Screens

3.1.1 Structure (main) screen

After starting **ELIN** this screen with menu is open. In this screen we can make structure of electrical net (structure, tree,..) so we can call it structuring or main screen.

In main screen the following commands are present:

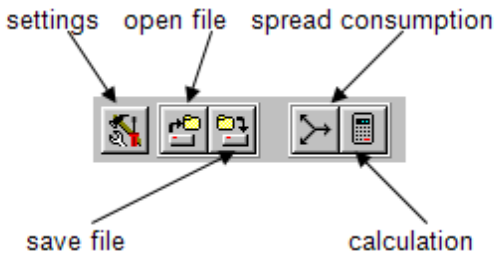


Project has following commands:

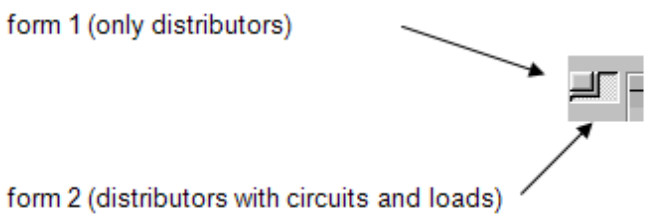
Open	open existing project
Reopen	open already once opened project
New	open a new project (not in demo)
Save	save a project with a temporary name (not in demo)
Save as	saving a project wit a new name (not in demo) From the begining of session the project has no name (Anonymus) till we do not **save as** with new name.
Settings	opening of setting screen
Extra	converting older projects
Refresh load	if there are changes in database during opened project it refreshes data
Close	closing of project

Recent	the last project will be opened
Database	to edit database
Results	there are two types of results:
Print	2 printout formats of project data
Plot	generating onepole schemes
?	about authors and help text

Icon buttons represent:

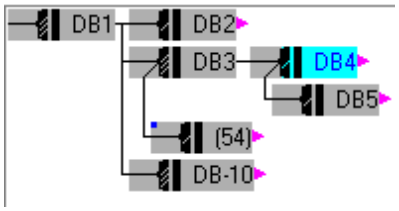


There are 2 forms of presenting project data:

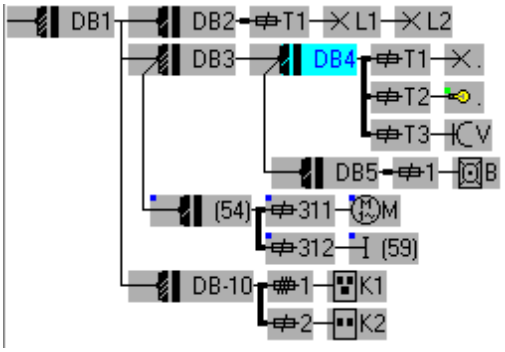


as you can see:

form 1

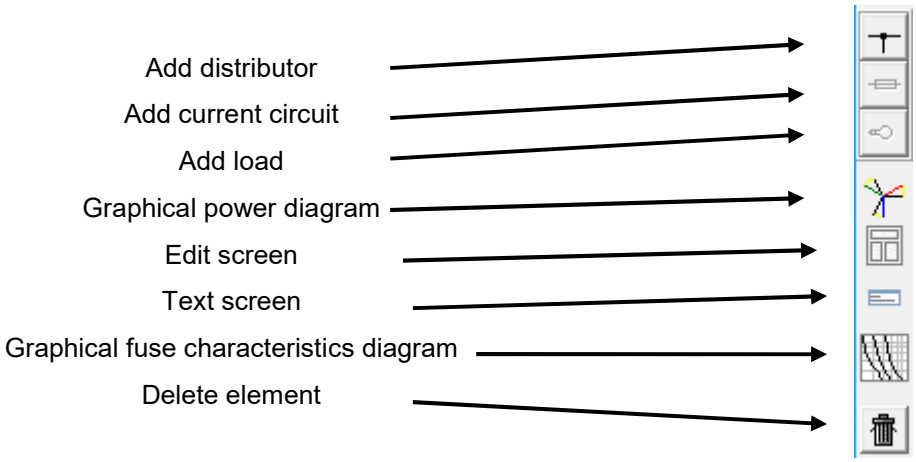


form 2



Depending on these forms also printouts are different.

There are also following buttons:

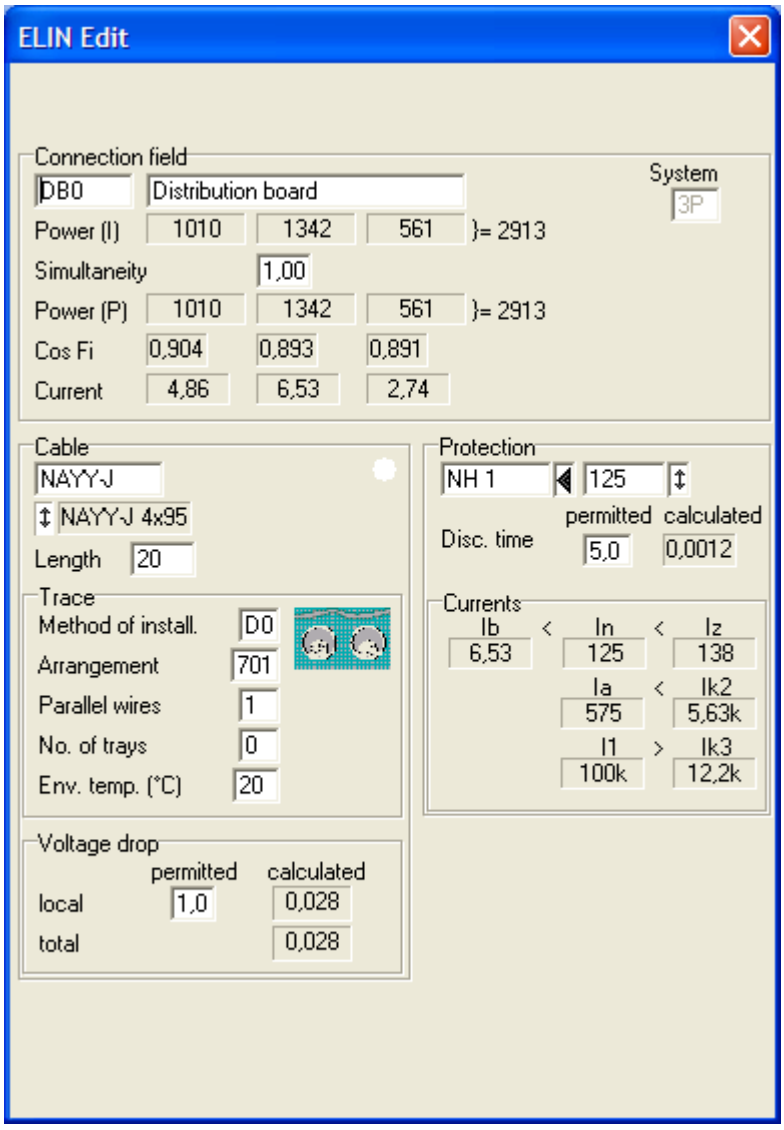


In the main screen we create tree structure of electrical net, which begins at left side with connection point. This point we do »not see«, it is virtual, the data (R and X) are inserted in settings screen. The first element we »see« is a distributor, which is connected via main cable (type of cable, length, typ of installation).

Distributor is divided into two parts (left part is distribution/connection field with cable terminals, and the right part as bus terminals for circuit cables). Using buttons (Add distributor/circuit/load) we can create project in right direction. Each of this element has its own edit screen on the right side.

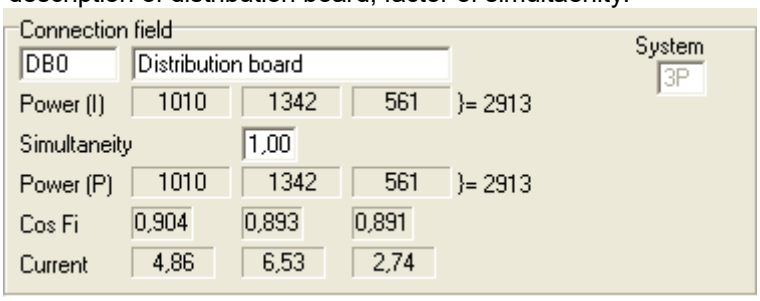
3.1.2 Edit screen

3.1.2.1 Distribution field



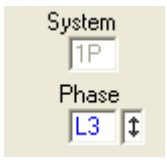
Edit screen is divided into 6 parts:

Distribution (connection) field / distribution of power (installed and peak), currents and cos Fi
To enter: Label and description of distribution board, factor of simultaenity.



Calculation takes max value of phase currents as distributor current (in our case 6,53A).

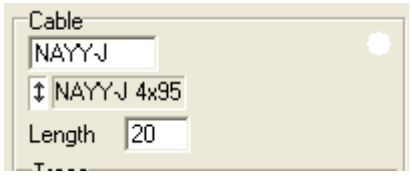
If there is an 1-phase distributor, then selected phase is shown in a right corner.



free selection of phase

fixed selection of phase

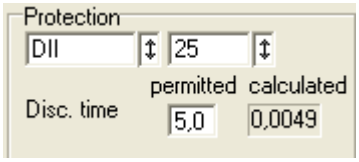
Conductor/ typ of conductor, cable, length



To enter: type of cable, length [m]

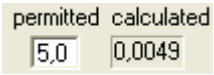
Number of wires is selected automatically (for 1-phase circuit 3 wires and for 3-phase 5 wires). In the upper right corner there is a schematic crosssection shown.

Protection/ type of protection

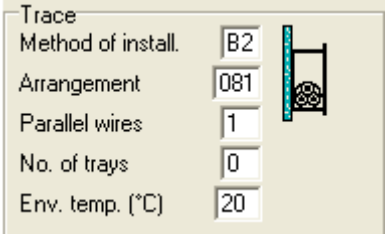


To enter: permitted disconnection time [s]

ELIN selects the type of protection depending on Settings, value is calculated according to formulas. **Disconnection time** is entered by user, **ELIN** calculates if it is suitable and shows the real calculated time [s] (for times smaller than 1/10000 transcription is E-x, where E=10).



Type of trace /data about method of installation and arrangement (according to IEC 60364-5-52)

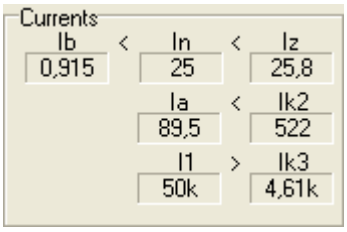


To enter all data; if the field is red than perhaps the trace is not found or data are incorrect.

For inserting method of installation and arrangement for cable or conductors there is an graphical screen when clicking on blank square or icon. This menu is compound on the base of International Standard IEC 60364-5-52, Annex A. The letters (2 digit) and item numbers (3 digits) are identical to the standard except C, F and G where they are divided in C1 and C2, F1 and F2 and G1 and G2.

Currents/ data after finished calculation

Here data can not be entered, here are just results.



I_b <= I_n <= I_z condition

I_b	designed current
I_n	nominal current
I_z	current-carrying capacity

I_a < I_{k1} disconnection

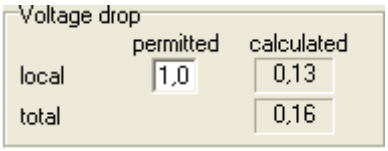
I_a	current ensuring the automatic operation of disconnecting protective device within disconnecting time T_i
$I_{k1} = I_{kmin}$	1-pole short-circuit current (min)

I_1 > I_{k3} breaking capacity

I_1	breaking capacity of protective device
$I_{k3} = I_{kmax}$	3-pole short-circuit current (max.)

If the value of current is greater then 1000 A it is written as 1kA.

- **Voltage drop** /data about permitted and calculated values of local and total voltage drop



To enter data: permitted voltage drop

Voltage drop for 1-phase and for 3-phase system is calculated using formula for 1-phase, so we do not lose data about cos Fi for each phase.

$$U_i = \frac{100 \times P \times 2 \times L_s \times \cos Fi}{\lambda \times U^2 \times A}$$

dU_i	voltage drop in %
P	power in W
L_s	cable length

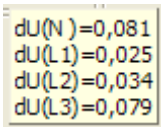
λ	conductor material property in S.m/mm^2
U	line voltage in V
A	cross-section in mm^2
cos Fi	cos Fi of phase voltage

Program **ELIN** summarize voltage drop along phase (L) and neutral (N) conductor and for displaying the maximum calculated value is chosen. To observe also the other values of voltage drops you can use mouse position near voltage drop field:

Example:

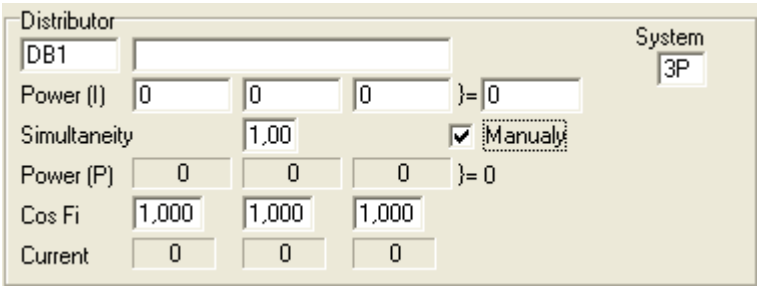
$$dU_{calc} = Max\ (dU(Lx)) + dU(N)$$

$$dU_{calc} = dU(L3)) + dU(N) = 0{,}079 + 0{,}081 = 0{,}16$$



3.1.2.2 Distributor

There is a difference between left (distribution field) and right (distributor) side of a distribution board. In the right side you can input manually data about power consumption without inserting current circuits.



This manual insertion is possible only in the first insertion of distributor. It can be entered separately for each phase or only as a total and program divides among phases. It is possible for 3P and 1P distributors.

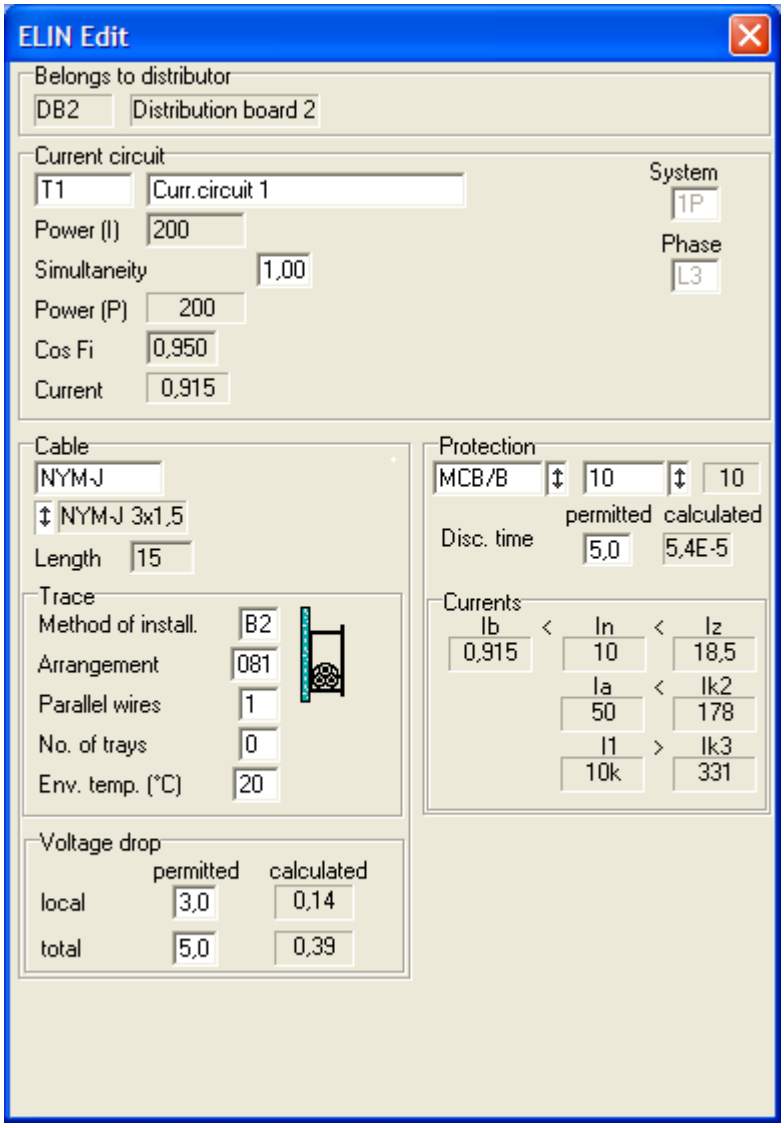
Such a manually inserted distribution board is signed with a yellow point in the right corner. It can be copied too.

3.1.2.3 Current circuit

Each current circuit has following data written in edit screen, which are very similiar with distributor data. So only differencies are written:

In upper left corner there is a label of the distributor to which it belongs.

Factor simultaneity can be used for getting real value of load current. If there are 5 sockets installed in one current circuit and to get a real current value a factor simulaneity **1/n** sockets should be used (5x2000 W=10000 W installed, and (1/5)*10000W= 2000W).

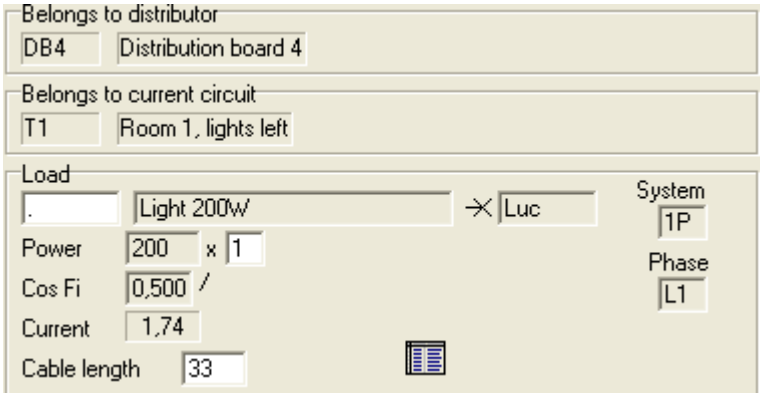


There is a special value in the quite right place in Protection box. In this field a minimum value for the current circuit is read from database.

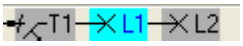
Program **ELIN** calculates two different values of voltage drop: local and total. Local means voltage drop from last distributor to end user and total means from the first point of the net (CP) till end user. In combining these values different options of cable crosssections can be observed.

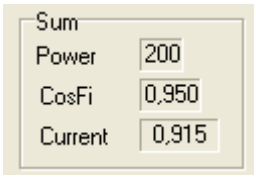
3.1.2.4 Load

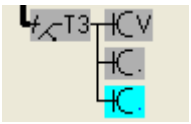
Every load has data of its owner (distributor and current circuit) in upper left corner. Load can have a label (it can be just ».«) or it gets the internal index number. All values are read from database. If we want to change the load the icon  should be used.



If there are more then one load in a current circuit **ELIN** make a sum of power and the cable length is a sum in vector form.







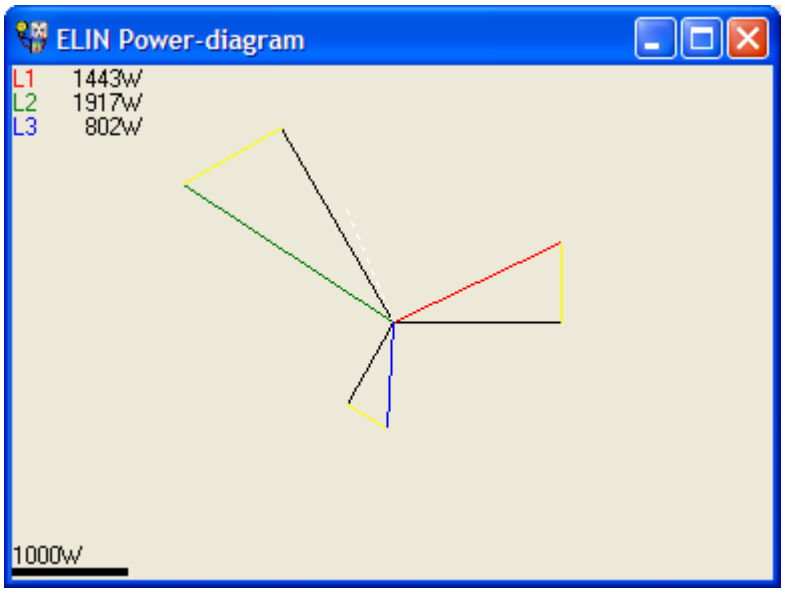
If there is no suitable load in database there are two possibilities:

- general, open the database and insert a new load for all the projects
- especial, manually inserted load only for this project

At manually insertion load with description is inserted and there is a sign  . If graphical symbol is missing in database there is one general symbol like  used. It can be even manually made new symbol but it must be in accordance to other ones.

3.1.3 Power diagram

In every point of electrical net power distribution can be observed in graphical form.

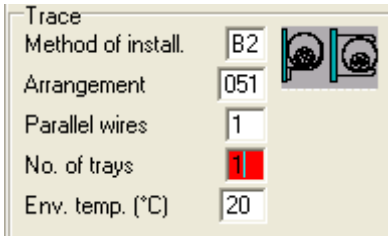


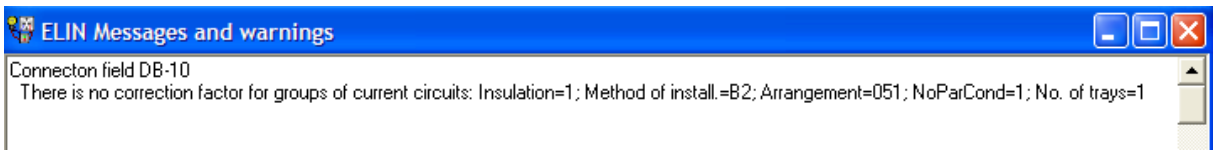
3.1.4 Screen for messages

If program **ELIN** finds some data collision or failure then messages are written in an extra screen so this screen should not be closed.

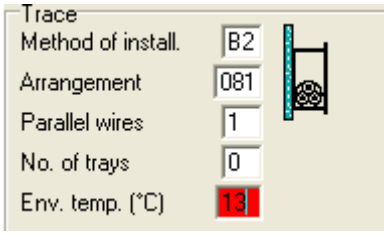
Some kind of messages:

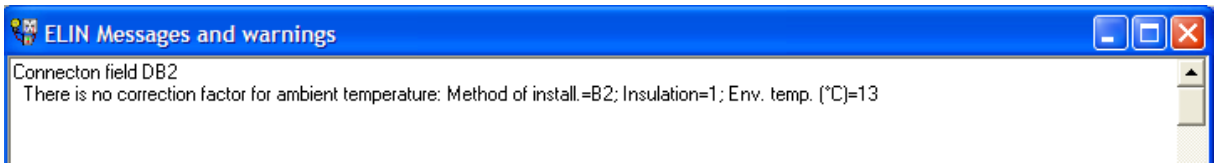
- There is a value »1« for tray for method of installation B2 what is not true.





- Value for temperature can only be in step of 5°C, so for the value 13 there is no correction factor.





Error messages are written only for database inconsistence, other errors or unfullfilling of conditions are shown in red color of field.

3.2 Graphical screen of wiring systems

This is a main feature of a program **ELIN** which offers designer a direct approach to **IEC standard 60364-5-52**, which is the base for calculating of current carrying capacity. Instead of alphabetical codes for methods of installations there are now graphical presentations. The codes are following:

A1	Insulated conductors in conduit in a thermally insulated wall
A2	Multi-core cable in conduit in a thermally insulated wall
B1	Insulated conductors in conduit on a wooden wall
B2	Multi-core cable in conduit on a wooden wall
C	Single-core or multi-core cable in conduit on a wooden wall
D	Multi-core cable in ducts in the ground
E	Multi-core cable in free air
F	Single-core cables, touching in free air
G	Single-core cables, spaced in free air

Every method of installation has also different arrangements – details of laying, depending on correction factor for current carrying capacity. Explanation of **ELIN** code is following:

XX. YYZ

where

XX	method of installation (table A.52-1 from IEC 60364-5-52)
YY	arrangement (item of table 52-3 from IEC 60364-5-52)
Z	serial number because of deviation in arrangement

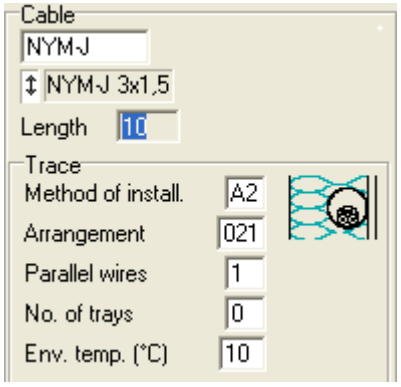
There are three exceptions in **ELIN** labels comparing to IEC. Because of different formations of cable in the same method of installation in **ELIN** there are:

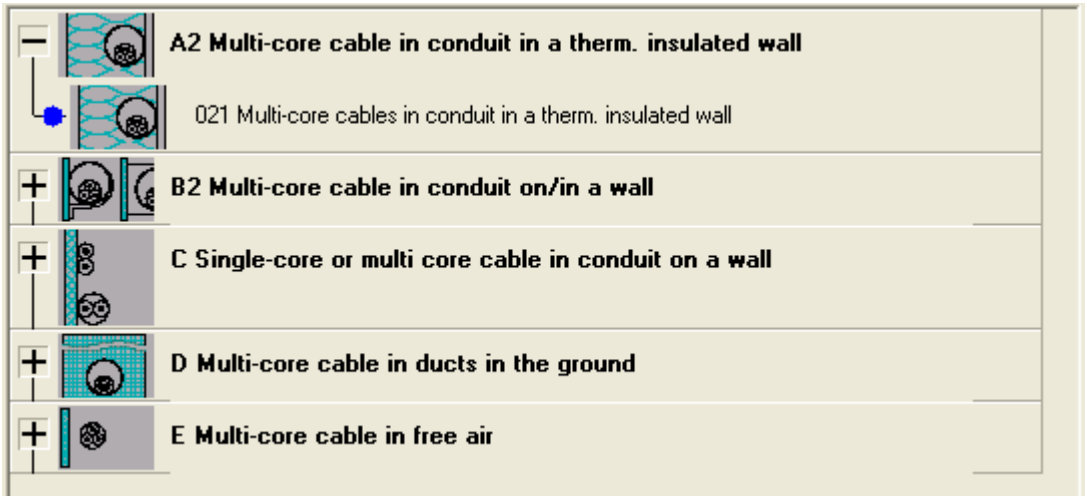
C1	for flat formation of 3 loaded conductors
C2	for trefoil formation of 3 loaded conductors
F1	for flat formation of 3 loaded conductors
F2	for trefoil formation of 3 loaded conductors
G1	for horizontal spaced flat formation of 3 loaded conductors
G2	for vertical spaced flat formation of 3 loaded conductors

In database for cable types for each cable type there are permitted or possible methods of installations written and only these can be seen and inserted in edit screen.

Example:

For cable **NYM-J** only these methods (A2, B2, C, D, E) of installations can be seen and inserted:





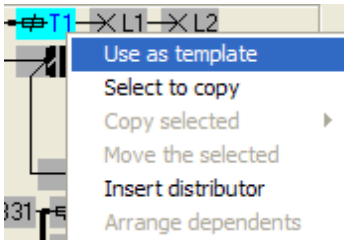
All methods of installations and their arrangements can be seen only when inserting new cable type in database. With doubleclick on the right side of a list, it is selected and jumps to the left side.

3.3 Download menu

Some special functions in main screen open when the right button of the mouse is used.

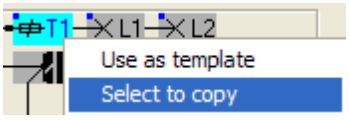
3.3.1 Use as template

First select an icon of distributor or current-circuit. With a right button on the mouse the popdown menu opens. Use command **Use as template** and next time at inserting a new circuit all data from the selected icon are copied.



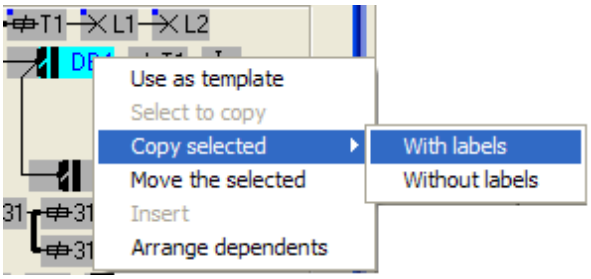
3.3.2 Select to copy

First select an icon of distributor or current-circuit. With a right button on the mouse the popdown menu opens. Use command **Select to copy**. In the left corner of the icon a blue point appears and remains till next selection. Next step is to point to distributor and to open popdown menu and choosing **Copy selected.**

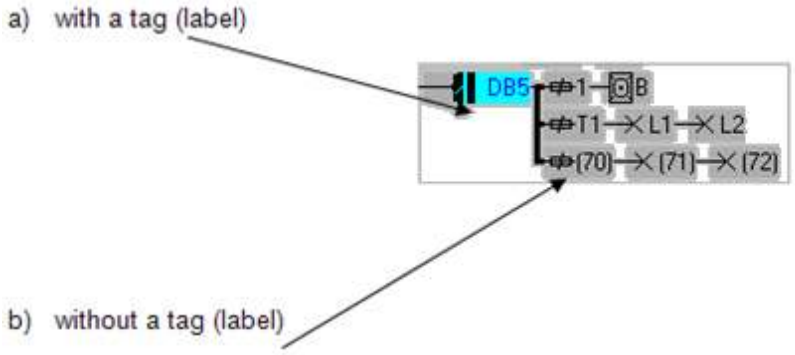


3.3.3 Copy selected

Using this command two possibilities appear:

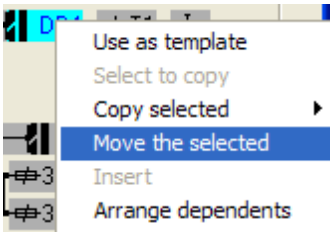


First option is to copy also the tag (label) of selected icon, and the other without the name.



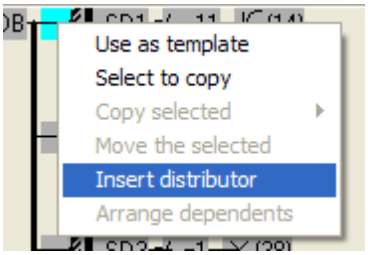
3.3.4 Move selected

The selected distributor/circuit can also be **moved** from one to another distributor with following command.

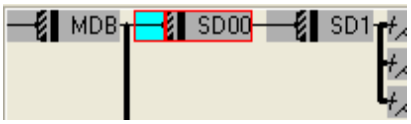


3.3.5 Insert distributor

A new distributor can be inserted between two distributors. Select the left side of distributor, open popdown menu and select command **Insert distributor**. A new distributor is inserted and data must be entered.

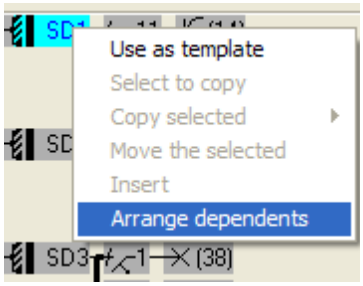


In following case selecting distributor SD1 and function **Insert distributor** results in a new distributor with label SD00.

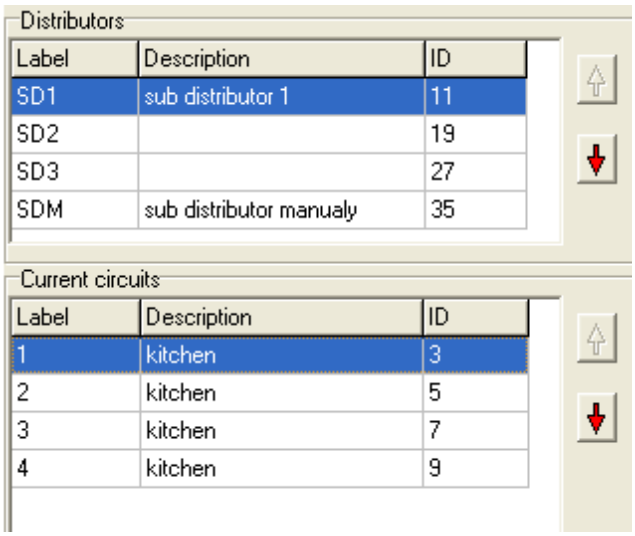


3.3.6 Arrange dependents

Using this command it is possible to change the order of subdistributors or current-circuits.

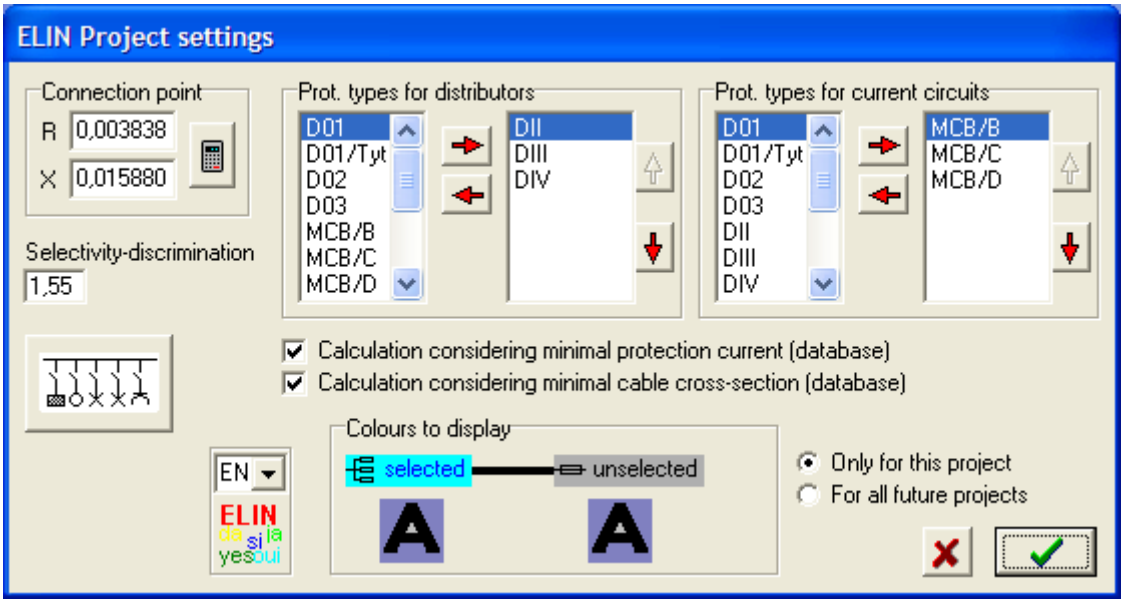


Using this command a list of subdistributors and current circuits is visible and with commands up and down the order can be changed. This command is useful when a new current circuit should be inserted but not everywhere but where other similiar group (lights) already exist, so you can arrange groups of circuits. If there are subdistributors and current circuits then two lists are presented.



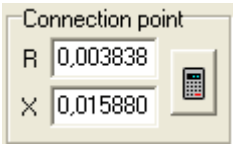
3.4 Project settings

At opening new project or by using icon  the following screen opens (here with some data inserted already):



- impedance of connection point (CP)

input ohmic and reactance value of impedance of CP

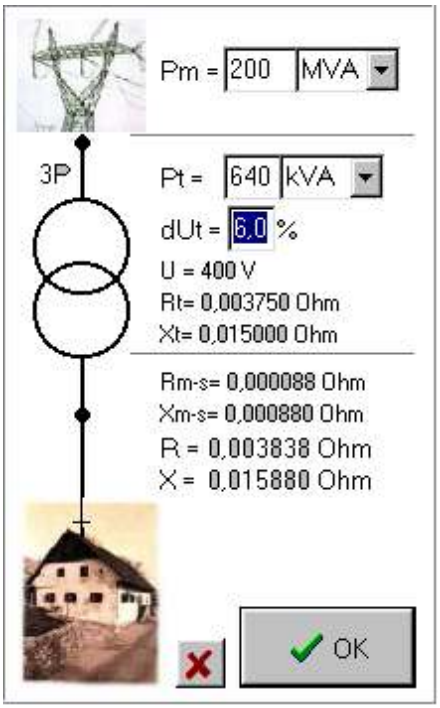


if only impedance Z_m is presented, values for R and X can be approximately calculated :

$$X_m = Z_m$$

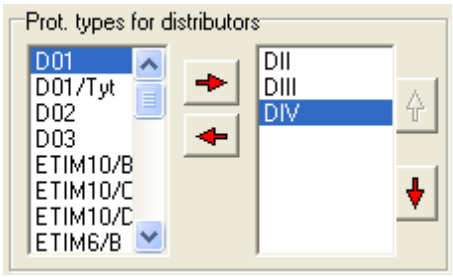
$$R_m = 0{,}1X_m$$

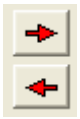
if total power P_m and data about transformer are presented then R and X can be calculated by using small »calculator« icon on the right side.



- **selecting and ordering of protection devices for distributors**

  program inserts protection devices according to this right list untill dimensioning is satisfied



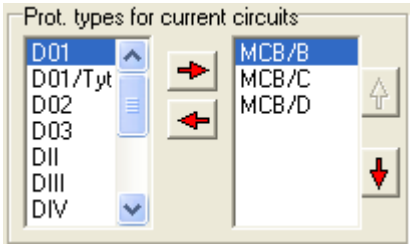


selecting or deselecting of item

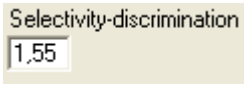
ordering of selected item up or down

- **selecting and ordering of protection devices for current circuits**

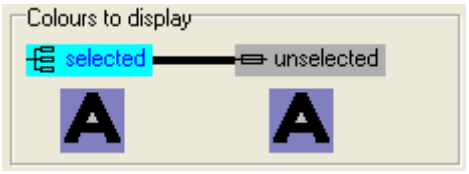
  program inserts protection device according to this list untill dimensioning is satisfied (first MCB/B, then MCB/C,…)



- **factor of selectivity – discrimination of protection devices** (default 1,55)
  for discrimination of fuses there is a factor between two nominal currents which should be used



- **selecting of colors** for text and back



- **selecting of language** for text and database

SI	slovenian
EN	english
HR	croatian
DE	german

The change of language is mainly used for texts in program screens but also the language in database changes as well (look 3.6.1).

- **calculation considering minimal protection current (database)**

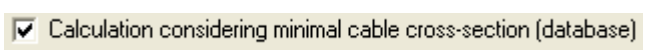
In database of loads there is data of min. protection current.
If the value is entered **ELIN** will use it for calculating load current when

is entered in Settings.

This feature is used if load current is less than 2A, but Regulations order 10A for minimal value.

- **calculation considering minimal cable crosssection (database)**

In database of loads there is data of min. crosssection of conductor. If the value is entered **ELIN** will use it for calculating crosssectional area when

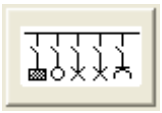


is entered in Settings.

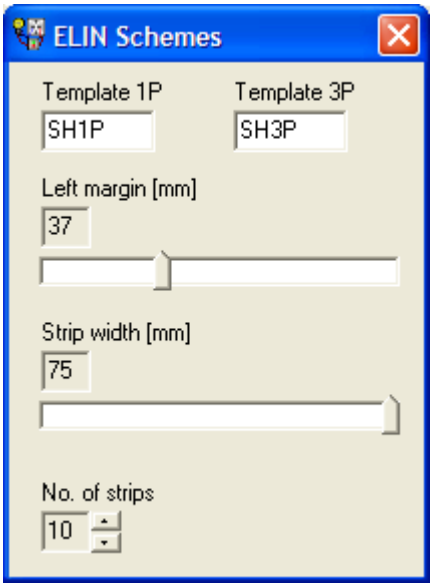
This feature is used if load current for a socket (2000W) is 10A and crosssection 1,5mm2, but Regulations order 16A and 2,5mm2 for socket.

- graphical forming of one pole schemes

Using icon



we can change parameters for creating one pole shemes in CAD environment:



In the first row there are names of template files for 1-phase (SH1P.dwg) and 3-phase system (SH3P.dwg). These drawings can include logo of the user – company and other project data and should be placed in project folder. So we recommend to copy this files from folder \SIM and edit the data. Using these margins and strip width onepole schemes can be generated at your needs.

These selections can be saved for a project or as general for all projects by confirming this button:

3.5 Description of electrical network elements

In program **ELIN** construction of electrical network is as simple as it is in real world. From the beginning (connection point CP) to the last load we are going in right and down direction. The first point CP is not seen on the screen, data for CP are entered in setting screen.

We start with main distributor and with main power supply cable data (type, length, laying). Cables to distributors are from the left side and written in distributor icon. The same data for cables from distributor to loads are written in load icons.

Every element in network can have its own name or just index number which is written in brackets. A name can be of 8 characters long.

Example: distributor with index number (2)

3.5.1 Distributor

Electricaly distributor is divided in to 2 parts:

Input field	- here main input cable is connected or connection cable to next distributor input field is done – paralel connection - input cable length and type are inserted - protection type is to be inserted, if not in setting screen
Output field	- represent busbar where output current circuits are connected - only factor of simultanesity (demand factor) is inserted - manually insert of power consumption

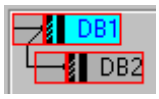
Graphical icon of distributor is also divided in 2 parts:

When inserting data for distributor the input cable data have always to be inserted. On the output side of distributor we can manually insert the power consumption by phases if we have no data for each current circuit.

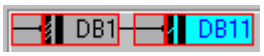
When connecting other distributors in network there are following options:

throu input field	paralel connecting
throu output field	serial connection – as subdistributor

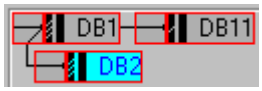
When DB2 is connected paralel to DB1, only protection for both distributors is calculated and positioned in CP, but written in input fields of DB1 and DB2.



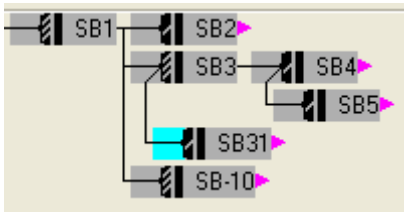
When connecting DB11 as subdistributor it is like a current circuit of DB1



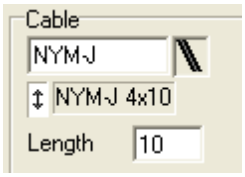
Here is an example of both connections:



Explanation of calculating parallel connection of distributors SB3 and SB31:

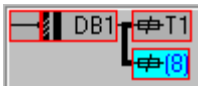


After calculating summarized load of both distributors **ELIN** writes cable crosssection and protection for both ones. But using different icons  and  in distributor SB31, the cable crosssection using second icon can be changed.



3.5.2 Current circuit

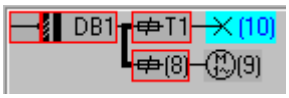
Current circuit is physicaly connected to busbar, which is presented in output field of distributor as a wide black line. Each current circuit is represented by its icon, with its own label and data. A label can have 8 characters, for description 30 characters are left.



After defining protection also the icon changes accordingly.

3.5.3 Load

Depending on type of circuit (1P or 3P) the suitable part of database is opened.



As database is opened every sort of loads can be inserted, and multiply factor can be used. If there are more loads in one current circuit the power is multiplied by factor, but the length is divided by factor.

Viewing database is done by typing icon  .

If there is no suitable load in database then we can do following:

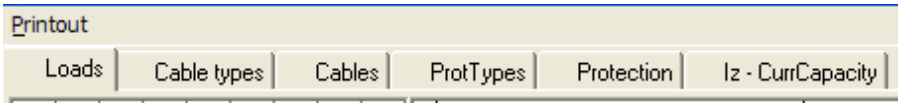
- make a new load manualy as temporary one for this project only
- open database, insert a new load, save it, and select it

Aftter inserting and saving new data for a load in database the following command in Settings should be used:

Project/ Refresh loads

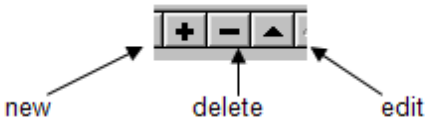
3.6 Database

In database all needed data for calculation are written. All of them you can change.



Using command **Printout** the selected part of database can be printed out.

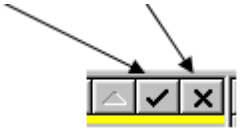
In database there are some functions identical for all data.



When pointing to »**+**» a new line is open. With icon »edit» the data can be edit.

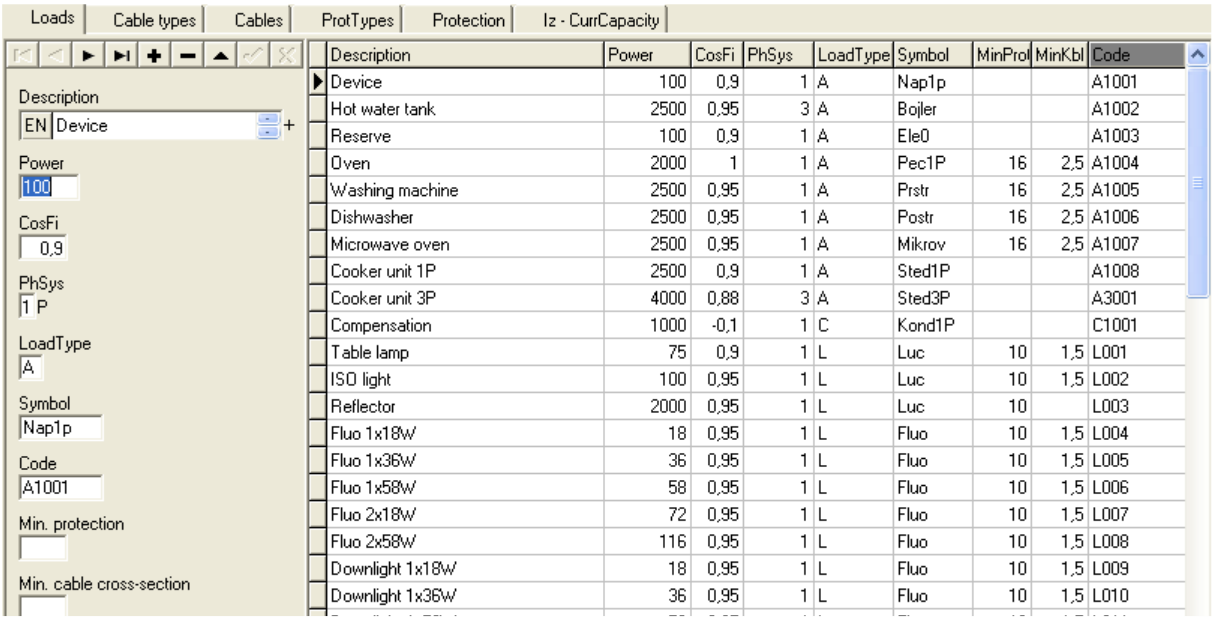
When **editing** a yellow underline appears.

After inserting or editing it can be saved or cancelled:



3.6.1 Loads

Data for load can be entered or edited.

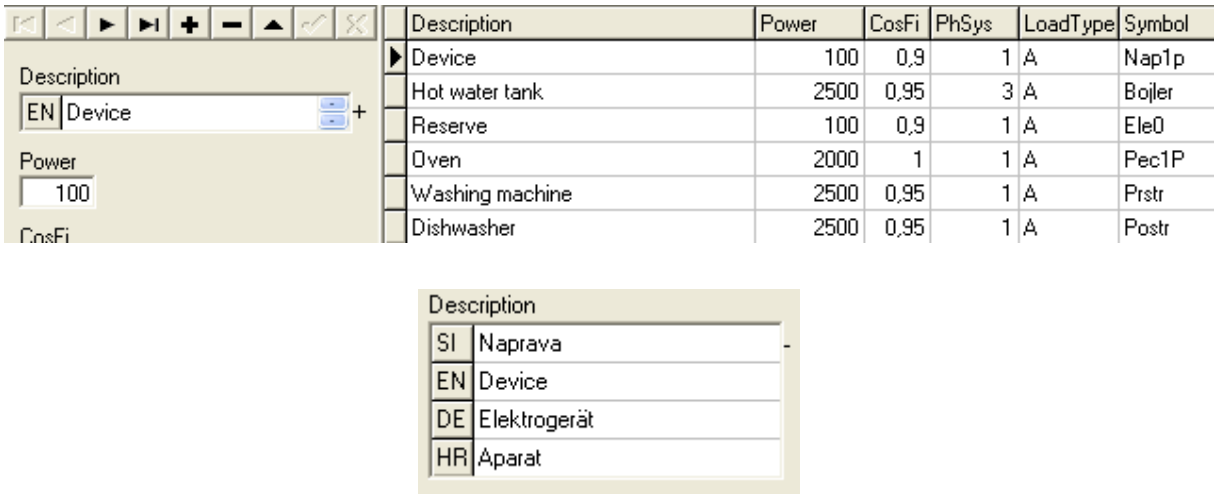


Description	Power	CosFi	PhSys	LoadType	Symbol	MinProt	MinKbl	Code
Device	100	0,9	1	A	Nap1p			A1001
Hot water tank	2500	0,95	3	A	Bojler			A1002
Reserve	100	0,9	1	A	Ele0			A1003
Oven	2000	1	1	A	Pec1P	16	2,5	A1004
Washing machine	2500	0,95	1	A	Prstr	16	2,5	A1005
Dishwasher	2500	0,95	1	A	Postr	16	2,5	A1006
Microwave oven	2500	0,95	1	A	Mikrov	16	2,5	A1007
Cooker unit 1P	2500	0,9	1	A	Sted1P			A1008
Cooker unit 3P	4000	0,88	3	A	Sted3P			A3001
Compensation	1000	-0,1	1	C	Kond1P			C1001
Table lamp	75	0,9	1	L	Luc	10	1,5	L001
ISO light	100	0,95	1	L	Luc	10	1,5	L002
Reflector	2000	0,95	1	L	Luc	10		L003
Fluo 1x18W	18	0,95	1	L	Fluo	10	1,5	L004
Fluo 1x36W	36	0,95	1	L	Fluo	10	1,5	L005
Fluo 1x58W	58	0,95	1	L	Fluo	10	1,5	L006
Fluo 2x18W	72	0,95	1	L	Fluo	10	1,5	L007
Fluo 2x58W	116	0,95	1	L	Fluo	10	1,5	L008
Downlight 1x18W	18	0,95	1	L	Fluo	10	1,5	L009
Downlight 1x36W	36	0,95	1	L	Fluo	10	1,5	L010

In the left part there is a description of a row written in the right side of database. Selecting coloumn in the right part data can be sorted upward or downward.
Here are descriptions for data:

Description	description in different languages
Nominal power	nominal power, which using cosFi create $\mathbf{P_{act}}$
	$\mathbf{P_{act} = U \times I_b \times \cos Fi}$
Cos Fi	cosinus Fi of a load (if positive inductive if negative capacitive character)
Phase system	load can be 1-phase or 3-phase
Load type	there are different load types: A general load L light M motor O outlet, socket C capacitor
Symbol	name of graphical symbol for graphical editor (..\ELIN\IMAGE*.bmp)
Min. protection	minimal protection value
Min. cable	minimal crosssection of cable
Code	each load has its own unique code which can be a link to other programs like bill of materials

For different languages also descriptions are presented. Using sign + all translations for one load can be seen.

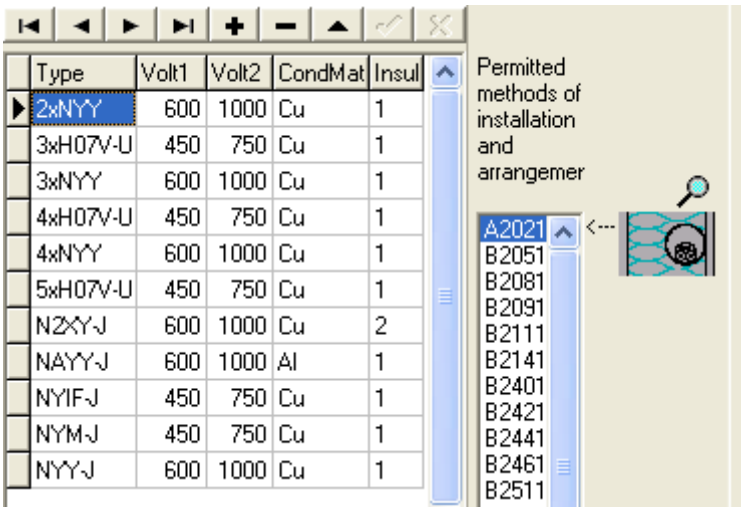


3.6.2 Cables

Each cable or conductor is defined twice. First as a cable type and a second one as a data about cable. In cable type general data are entered and in cable specific data for each crosssection are presented.

3.6.2.1 Cable types

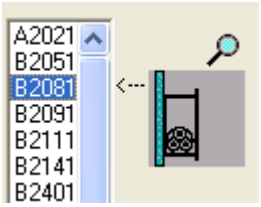
In the left part of screen are electrical properties of cables. In the middle there is a coloumn of permitted methods of installation and arrangements.



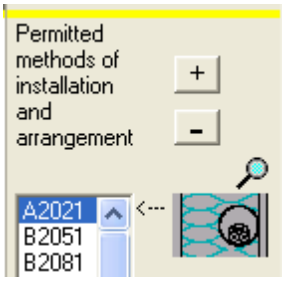
Explanation of coloumns:

Type	type of cable
Volt1	Line voltage
Volt2	Nominal test voltage
CondMat	material of conductor
	Cu
	Al
Insul	Type of insulation
	1 – PVC
	2 – XPLE
	3 – mineral 70°C
	4 – mineral 105°C

Pressing on  it is possible to zoom in the method of installation, so the label **B2081** (**B2** as method of installation **8** as arrangement and **1** as version) is more clear.



Editing of data is possible using  . In that moment also the middle coloumn of permitted types of trace is seen and using **+** and **–** sign data can be added or deleted.

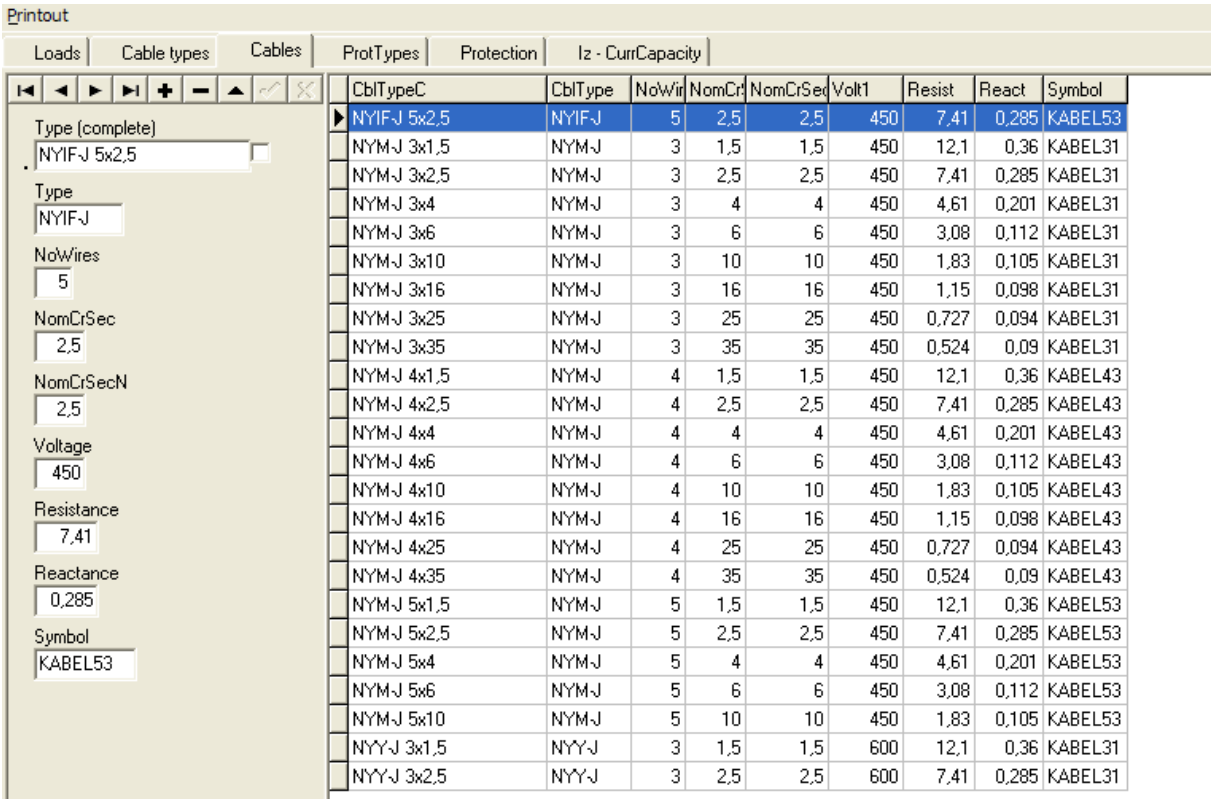


At adding (**+**), graphical menu with all of methods of installation according to IEC 60364-5-52 (look 3.2) opens and using doubleclick the line is copied on the left side.

Using **–** sign the line is deleted.

3.6.2.2 Cables

This screen has properties of cable for every crosssection and for every number of wires.



CblTypeC	CblType	NoWir	NomCrS	NomCrSec	Volt1	Resist	React	Symbol
NYIFJ 5x2,5	NYIFJ	5	2,5	2,5	450	7,41	0,285	KABEL53
NYM-J 3x1,5	NYM-J	3	1,5	1,5	450	12,1	0,36	KABEL31
NYM-J 3x2,5	NYM-J	3	2,5	2,5	450	7,41	0,285	KABEL31
NYM-J 3x4	NYM-J	3	4	4	450	4,61	0,201	KABEL31
NYM-J 3x6	NYM-J	3	6	6	450	3,08	0,112	KABEL31
NYM-J 3x10	NYM-J	3	10	10	450	1,83	0,105	KABEL31
NYM-J 3x16	NYM-J	3	16	16	450	1,15	0,098	KABEL31
NYM-J 3x25	NYM-J	3	25	25	450	0,727	0,094	KABEL31
NYM-J 3x35	NYM-J	3	35	35	450	0,524	0,09	KABEL31
NYM-J 4x1,5	NYM-J	4	1,5	1,5	450	12,1	0,36	KABEL43
NYM-J 4x2,5	NYM-J	4	2,5	2,5	450	7,41	0,285	KABEL43
NYM-J 4x4	NYM-J	4	4	4	450	4,61	0,201	KABEL43
NYM-J 4x6	NYM-J	4	6	6	450	3,08	0,112	KABEL43
NYM-J 4x10	NYM-J	4	10	10	450	1,83	0,105	KABEL43
NYM-J 4x16	NYM-J	4	16	16	450	1,15	0,098	KABEL43
NYM-J 4x25	NYM-J	4	25	25	450	0,727	0,094	KABEL43
NYM-J 4x35	NYM-J	4	35	35	450	0,524	0,09	KABEL43
NYM-J 5x1,5	NYM-J	5	1,5	1,5	450	12,1	0,36	KABEL53
NYM-J 5x2,5	NYM-J	5	2,5	2,5	450	7,41	0,285	KABEL53
NYM-J 5x4	NYM-J	5	4	4	450	4,61	0,201	KABEL53
NYM-J 5x6	NYM-J	5	6	6	450	3,08	0,112	KABEL53
NYM-J 5x10	NYM-J	5	10	10	450	1,83	0,105	KABEL53
NYY-J 3x1,5	NYY-J	3	1,5	1,5	600	12,1	0,36	KABEL31
NYY-J 3x2,5	NYY-J	3	2,5	2,5	600	7,41	0,285	KABEL31

Explanation of coloumns:

CblTypeC	Type of cable in complete form (type, number of wires and crosssection) which is created from single data. If there is something special to write in this name it is signed on the right side in the field.
CblType	Type of cable already entered in Cable Type file
NoWir	Number of wires
NomCrSec	Nominal crosssection of line and neutral
Volt1	Line voltage
Resist	Resistance [Ohm] at 20°C
React	Reactance [Ohm]
Symbol	name of graphical symbol for graphical editor and the same for 1-pole scheme (example: KABEL31 – 3wires cable, KABEL43 – 4wires cable, KABEL53 – 5wires cable)

Calculating short circuit circumstances **ELIN** uses resistance value of cable at 80°C:

$$R_{80}=R_{20}(1+\alpha(80-20))$$

Where α temperature coeficient of electrical resistance for Cu (0,0039 K^{-1}) and Al (0,0040 K^{-1}).

Extra: multiplying crosssections of wires

When multiplying crosssections mostly for supplying (main) cables we get a situation where the products are mathematicaly equal, but electrically unequal so we should separate such products by renaming.

As an example for such products:

2x120=**240**=1x240 2x150=**300**=1x300

4x120=**480**=2x240 4x150=**600**=2x300

or description of cables looks like:

NYY 4x240 is not equal 2xNYY 4x120

To distinguish among these products we have changed or renamed the value for »+**1**« for all virtual multiplyed crosssections, so we have now:

2x120=**241** 2x150=**301**

4x120=**481** 4x150=**601**

This changed value is seen only in tables and not in specifications of cable.

CblTypeC	CblType	NoWir	NomCr	NomCrSec	Volt1	Resist	React	Symbol
2xNYY 4x95	2xNYY	4	190	190	450	0,097	0,041	KABEL43
2xNYY 4x120	2xNYY	4	241	241	450	0,076	0,041	KABEL43
2xNYY 4x150	2xNYY	4	301	301	450	0,062	0,041	KABEL43
2xNYY 4x185	2xNYY	4	370	370	450	0,049	0,041	KABEL43
2xNYY 4x240	2xNYY	4	480	480	450	0,038	0,041	KABEL43
2xNYY 4x300	2xNYY	4	600	600	450	0,03	0,041	KABEL43

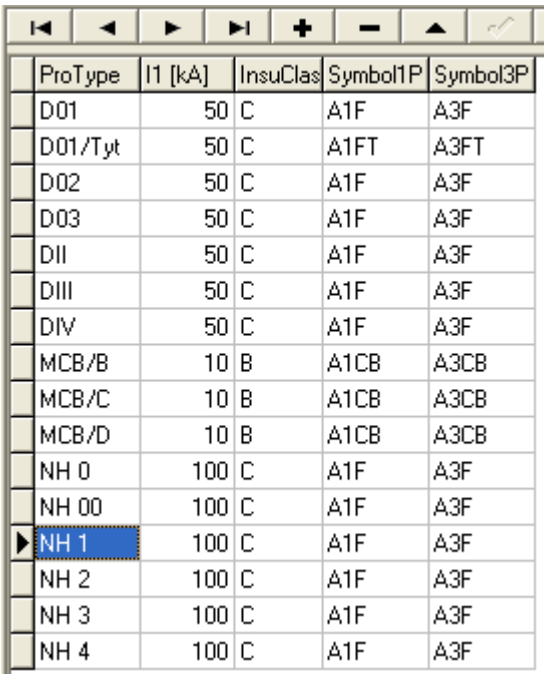
For such artifical (virtual) crossections also current-carying capacity (look 3.6.4) should be observed.

3.6.3 Protection elements

Like cables also protection is defined twice. First as a type of protection and a second one as a data about protection elements.

3.6.3.1 Type of protection

Here are some general data of protection elements.



ProType	I1 [kA]	InsuClas	Symbol1P	Symbol3P
D01	50	C	A1F	A3F
D01/Tyt	50	C	A1FT	A3FT
D02	50	C	A1F	A3F
D03	50	C	A1F	A3F
DII	50	C	A1F	A3F
DIII	50	C	A1F	A3F
DIV	50	C	A1F	A3F
MCB/B	10	B	A1CB	A3CB
MCB/C	10	B	A1CB	A3CB
MCB/D	10	B	A1CB	A3CB
NH 0	100	C	A1F	A3F
NH 00	100	C	A1F	A3F
NH 1	100	C	A1F	A3F
NH 2	100	C	A1F	A3F
NH 3	100	C	A1F	A3F
NH 4	100	C	A1F	A3F

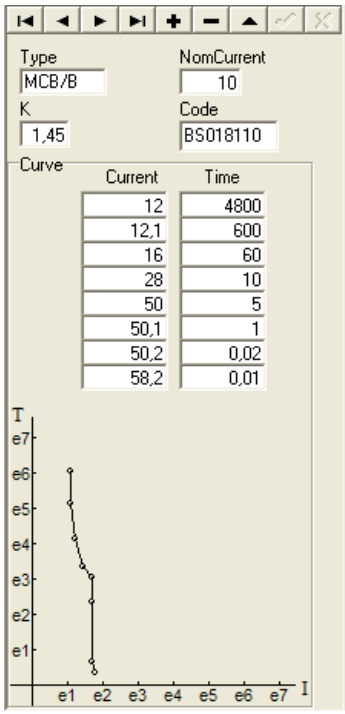
Explanation of coloumns:

ProType	Type of protection
I1 [kA]	Short circuit capacity I_1 [kA]
InsuClas	Class of insulation (B, C)
Symbol1P	name of graphical symbol for graphical editor and the same for 1-pole scheme for 1-phase current circuits
Symbol3P	name of graphical symbol for graphical editor and the same for 1-pole scheme for 3-phase current circuits

3.6.3.2 Protection

For calculating disconnecting circumstances **ELIN** uses the function **I/t** which is defined for each type and nominal value of protection. To get this characteristic curve for every element there is a table of 8 points (I_n/t_n), which mostly satisfy.

In the left bottom of this screen a fuse characteristic can be seen, which is used also in common graph of fuse protections in selected current circuit (look 4.6).



ProType	NomCu	I1	T1	I7	T7	I8	T8	KFactor	ProtCode
DII	20	32,3	1000	800	0,001	1000	0,0005	1,6	
DII	25	40,3	1000	1000	0,001	1200	0,0008	1,6	
DIII	35	60,3	1000	1600	0,001	2000	0,0002	1,6	
DIII	50	81,3	1000	2300	0,001	3000	0,0002	1,6	
DIII	63	100	1000	2700	0,001	3000	0,0002	1,6	
DIV	80	130	1000	3300	0,001	4000	0,0002	1,6	
DIV	100	170	1000	4800	0,001	5200	0,0002	1,6	
MCB/B	6	7,2	4800	30,2	0,02	36	0,01	1,45	BS018106
MCB/B	10	12	4800	50,2	0,02	58,2	0,01	1,45	BS018110
MCB/B	13	15,6	4800	65,2	0,02	71,2	0,01	1,45	BS018113
MCB/B	16	19,2	4800	80,2	0,02	96,2	0,01	1,45	BS018116
MCB/B	20	24	4800	100	0,02	120	0,01	1,45	BS018120
MCB/B	25	30	4800	125	0,02	150	0,01	1,45	BS018125
MCB/B	32	38,4	4800	160	0,02	193	0,01	1,45	BS018132
MCB/B	40	48	4800	200	0,02	240	0,01	1,45	BS018140
MCB/B	50	60	4800	250	0,02	300	0,01	1,45	BS018150
MCB/C	2	2,4	4800	20	0,02	22	0,01	1,45	BS017102
MCB/C	4	4,8	4800	40	0,02	44	0,01	1,45	BS017104
MCB/C	6	7,2	4800	60	0,02	66	0,01	1,45	BS017106
MCB/C	10	12	4800	100	0,02	110	0,01	1,45	BS017110
MCB/C	16	19,2	4800	160	0,02	176	0,01	1,45	BS017116
MCB/C	20	24	4800	200	0,02	220	0,01	1,45	BS017120
MCB/C	25	30	4800	250	0,02	275	0,01	1,45	BS017125

Explanation of coloumns:

ProType	Type of protection (Type)
NomCu	Nominal current (NomCurrent)
I_1/T_1	Point n; e1 …. e 8 ; current/time
ProtCode	Each protection element has its own unique code which can be a link to other programs like bill of materials
KFactor	Factor K

It is possible to edit the data for curve, but program can control only the type od enetered data but not the value. All points of the function must be upwards oriented.

3.6.4 IEC Tables

3.6.4.1 Iz – Current carrying capacity

Our table of current carrying capacity is almost copy of IEC standard 60364-5-52, Table A.52-1 till -13.

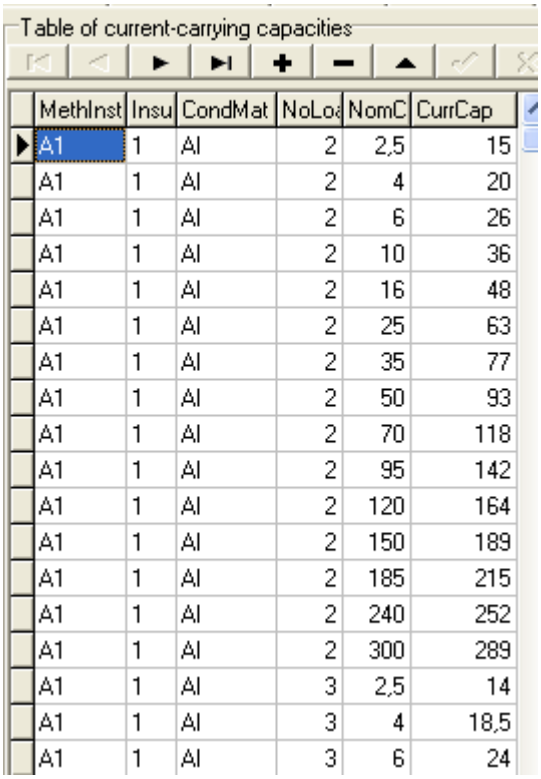


Table of current-carrying capacities

MethInst	Insu	CondMat	NoLoa	NomC	CurrCap
A1	1	Al	2	2,5	15
A1	1	Al	2	4	20
A1	1	Al	2	6	26
A1	1	Al	2	10	36
A1	1	Al	2	16	48
A1	1	Al	2	25	63
A1	1	Al	2	35	77
A1	1	Al	2	50	93
A1	1	Al	2	70	118
A1	1	Al	2	95	142
A1	1	Al	2	120	164
A1	1	Al	2	150	189
A1	1	Al	2	185	215
A1	1	Al	2	240	252
A1	1	Al	2	300	289
A1	1	Al	3	2,5	14
A1	1	Al	3	4	18,5
A1	1	Al	3	6	24

Explanation of coloumns:

	MethInst	Method of installation
	A1	Insulated conductors in conduit in a thermally insulated wall
	A2	Multi-core cable in conduit in a thermally insulated wall
	B1	Insulated conductors in conduit on a wooden wall
	B2	Multi-core cable in conduit on a wooden wall
	C	Single-core or multi-core cable in conduit on a wooden wall
	D	Multi-core cable in ducts in the ground
	E	Multi-core cable in free air
	F	Single-core cables, touching in free air
	G	Single-core cables, spaced in free air
Insu		Type of insulation
		1 – PVC
		2 – XPLE/EPR
		3 – mineral 70°C
		4 – mineral 105°C
CondMat		Material of conductor
		Cu
		Al
NoLoad		Number of loaded wires
		2 – onephase circuits

	3 – threephase circuits
NomC	Nominal crosssection
CurrCap	Current carrying capacity

Indeed IEC standard offers a lot of values for current there is sometimes a need to add new values especially greater ones (more then 1000A). **Program ELIN allows these entering of new data but with some precautions, because program can only control the type of data but not the value alone.**

By entering multiplying crosssections care should be taken for the value of current which could not be a simple multiplyer. At the same time the method of installation for such a multiplyer must be observed.

Explanation of multiplyers:

Cable 3x NYY 4x120 presents 3x paralel laid multicore cables, which already has data in table.

1) Current carrying capacity for cable **NYY 4x120** laid on a tray (method of installation **E**) with following characteristics: insulation material **1=PVC**, material of conductor **Cu**, number of loaded wires **3,** and at crosssection **120 mm^2,** value for current is

$$\mathbf{I_{z0} = 276\ A.}$$

E0	1	Cu	3	120	276
E0	1	Cu	3	150	319
E0	1	Cu	3	185	364
E0	1	Cu	3	190	476
E0	1	Cu	3	240	430
E0	1	Cu	3	285	585
E0	1	Cu	3	300	497

Original IEC table 60364-5-52

2) For cable **3xNYY 4x120** laid on a tray there is no value for **3x120=360 mm^2,** in basic table. So for I_z at crossection **360** we enter this value**:**

$$\mathbf{I_{z0} = 3 \times I_{z0}(120mm^2) \times KF = 3 \times 276A \times 0{,}82 = 679A,}$$

where KF=0,82 is a factor of parallel laid wires (3) on a tray, table **A.52-20**.

E0	1	Cu	3	240	430
E0	1	Cu	3	241	485
E0	1	Cu	3	285	585
E0	1	Cu	3	300	497
E0	1	Cu	3	301	561
E0	1	Cu	3	360	679
E0	1	Cu	3	370	633
E0	1	Cu	3	380	761
E0	1	Cu	3	450	785
E0	1	Cu	3	480	883
E0	1	Cu	3	481	872

ELIN table for **I_z** (60364-5-52)

3) When multiplying crosssections there are special precautions by identical values which are for currents not identical (look 3.6.2.2). For instance

2x150mm^2 <>1x300mm^2

because of parallel laid wires.

3.6.4.2 Correction factors

The other two tables are also according to IEC standard 60364-5-52. This tables are showing correction factors for groups of current circuits and ambient temperature (60364-5-52, Table A.52-14 till -21).

Correction factor for groups of current circuits

MethInst	Insul	Arrangem	ParallWir	NoTray	CorrFactor
A1	1	011	1	0	1
A1	1	011	2	0	0,8
A1	1	011	3	0	0,7
A1	1	011	4	0	0,65
A1	1	011	5	0	0,6
A1	1	011	6	0	0,57
A1	1	011	7	0	0,54
A1	1	011	8	0	0,52
A1	1	011	9	0	0,5
A1	1	011	12	0	0,45
A1	1	011	16	0	0,41
A1	1	011	20	0	0,38
A1	1	031	1	0	1
A1	1	031	2	0	0,8
A1	1	031	3	0	0,7
A1	1	031	4	0	0,65
A1	1	031	5	0	0,6
A1	1	031	6	0	0,57
A1	1	031	7	0	0,54

Correction factor for ambient temperature

MethIns	Insul	EnvTemp	CorrFactor
A1	1	10	1,22
A1	1	15	1,17
A1	1	20	1,12
A1	1	25	1,06
A1	1	30	1
A1	1	35	0,94
A1	1	40	0,87
A1	1	45	0,79
A1	1	50	0,71
A1	1	55	0,61
A1	1	60	0,5
A1	2	10	1,15
A1	2	15	1,12
A1	2	20	1,08
A1	2	25	1,04
A1	2	30	1
A1	2	35	0,96
A1	2	40	0,91
A1	2	45	0,87

Explanation of coloumns:

MethInst	Meth. of inst. (A1,…,G)	MethInst	Meth. of inst. (A1,…,G)
Insul	Type of insulation	Insul	Type of insulation
Arragem	Arrangement of in. (011,…,735)	EnvTemp	Environment temp.
ParallWir	Number of par.wires	CorrFactor	Correction factor
NoTray	Number of trays		
CorrFactor	Correction factor		

4. CALCULATIONS

After the entire network or some part has been constructed, calculations can follow. Program **ELIN** calculates (dimensions) cables and protection of the whole network in one step.

Calculation is made in two directions, from the last load to the connection point (CP) and vice versa. Determination of cross-sectional area and of protective device is reached after "**Seven steps**" (Author W.Rudolph: Einfuehrung in DIN 57100/VDE 0100, Berlin 1983) according to **IEC 364-4-43** and **IEC 364-4-473** (now IEC standards 60364-4-43 and 60364-4-473):

1) Calculation of the design current $\mathbf{I_B}$
2) Selection of protective device regarding its nominal current $\mathbf{I_n}$
3) Selection or calculation of cross-sectional area of conductors of a circuit, **S**
4) Calculation of the max. short-circuit current $\mathbf{I_{kmax}}$ and verification of the conditions for short-circuit protection – against $\mathbf{I_1}$ breaking capacity
5) In **TN system** calculation of the short-circuit current $\mathbf{I_{kmin}}$ and verification of length of the circuit, fault loop impedance $\mathbf{Z_s}$ and $\mathbf{I_a}$
6) Verification of proper discrimination of protective devices in series
7) Verification of voltage drop **dU**

Explanation:

1) Design current

For calculation of $\mathbf{I_B}$ the peak power is needed. It depends on demand factor “g”, which can be also called simultaenity and all installed power in current-circuit.

$\mathbf{P_{max} = P_i \times g}$

P_i	installed power
g	demand factor g
P_{max}	peak power

$\mathbf{I_B}$	designed current

$\mathbf{I_B = P_{max} / (U \times \cos Fi)}$ for 1P system
$\mathbf{I_B = Max (IL1, IL2, IL3)}$ for 3P system

Design current $\mathbf{I_B}$ is also for 3P loads calculated as 3x 1P-current with 3x cosFi, so we can get for every phase its own $\mathbf{I_B}$ and **cosFi** and power diagram. The maximum of three $\mathbf{I_B}$ is used in further formulas. On this way we can even calculate compensation if needed.

2) and 3) Selecting fuse and cable

Continuous current-carrying capacity of cable or conductor $\mathbf{I_z}$ is a product of basic current $\mathbf{I_{zo}}$ and environment factors (temperature, number of parallel cables, method of installation) according to IEC 60364-5-52.

$$I_z = I_{zo} \times KF_{group} \times KF_{temp}$$

I_z	current-carrying capacity
I_{zo}	current-carrying capacity from tables A.52-2..-13
KF_{group}	correction factor for cable arrangings from tables A.52-17..-21
KF_{temp}	correction factor for ambient temperature from tables A.52-14,-15

For calculation according to IEC 60364-4-43 and 60364-4-473 two conditions are observed:

1.condition /nominal current rule

$I_B <= I_n <= I_z$ calculation

I_B	current for which the current is designed
I_n	nominal current of protective device
I_z	continuous current-carrying capacity of cable or conductor

2.condition /tripping current rule

$I_2 <= 1{,}45 I_z$ calculation

I_2	tripping current ensuring effective operation of protective device
$I_2 = \mathbf{k}\ I_n$	values for **k** are different but all of them are aproaching value 1,45

so we can write the second condition as:

$1{,}45\ I_n <= 1{,}45 I_z$

$I_n <= I_z$

but this is already included in the first condition, so if the 1. condition is fullfilled also the 2. one is fulfilled.

4) Short circuit protection

In the next step the (short-circuit) breaking capacity of protective device **I_1** (IEC 60364-4-41) is compared to maximum prospective short-current **I_{k3}**

$I_1 > I_{k3}$	**calculation**
$I_{k3} = I_{kmax}$	3-pole short-circuit current (max.)
I_1	breaking capacity of protective device

$$I_{k3} = \frac{c \times U}{1.73 \times Z}$$

where:

c	voltage factor **0,95** considering voltage drop at terminals, fuses,..
Z	total impedance from source up to the point of short current (Zmin, without cable)
U	voltage between phase conductors

5) Prospective short circuit current

For calculation of proper work of protective device we have to calculate:

$I_a < I_{k1}$ **calculation**

where

I_a current ensuring the automatic operation of disconnecting protective device within disconnecting time T_i

$I_{k1} = I_{kmin}$ 1-pole short-circuit current (min)

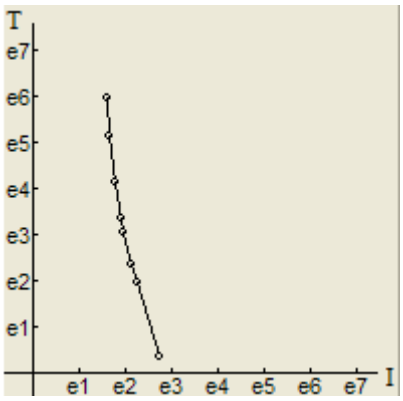
$$I_{k1} = \frac{c \times U}{2 \times Z}$$

c voltage factor **0,95** considering voltage drop at terminals, fuses,..

Z total impedance from source up to the point of short current (Zmax, with cable)

U voltage between phase conductor and neutral

Current I_a is gathered from time/current characteristic (**I/t**), which is inserted for each protective device in database. In the case of knowing I_a we can calculate the real disconnecting time.



Curves for I/t characteristics can be put additionaly if there is a need. There are already some curves in database which consist of 8 points (I and t). For inserting new ones program **ELIN** expects that the points are all different and that they are ascending.

6) Discrimination (selectivity) of overcurrent protection

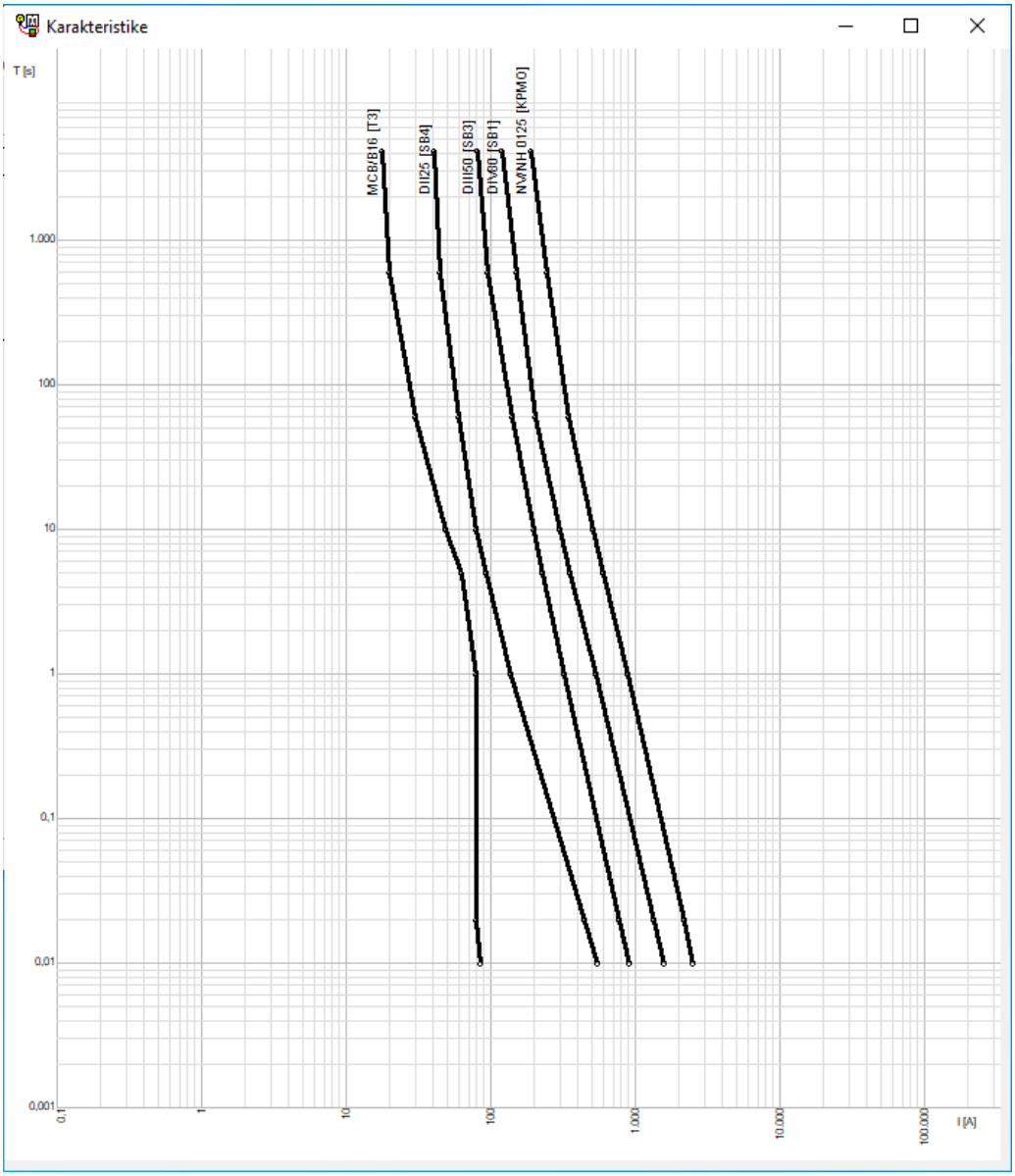
To avoid unnecessary interruption of supplies, the characteristics and settings of protective devices for overcurrent protection shall be such that proper discrimination in their operation is ensured.

For overload protection discrimination of the protective devices is assured if the devices in series have decreasing values of nominal current.

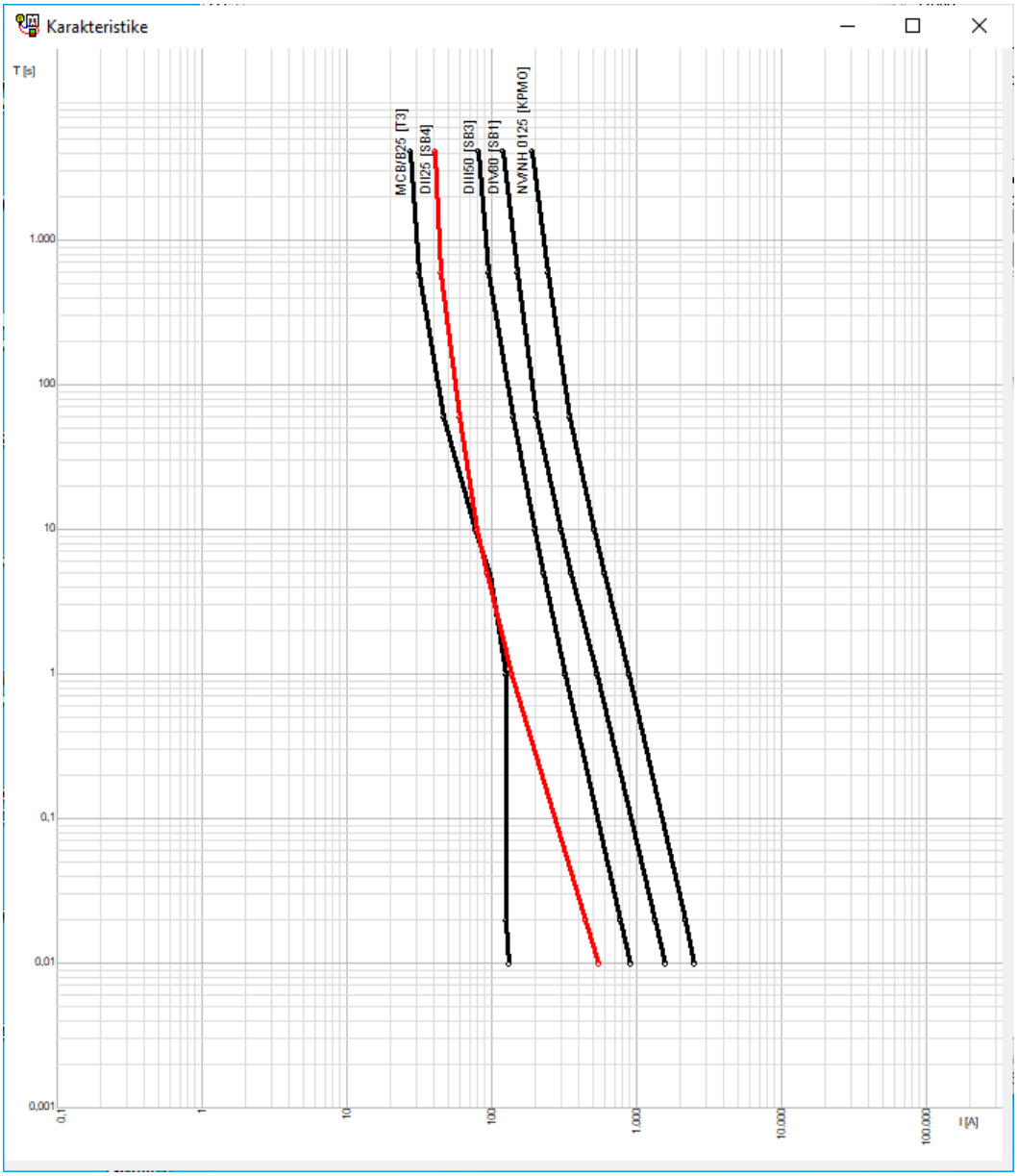
For short-circuit protection discrimination of the protective devices needs more investigation because there are at short-circuit currents many times greater as normal ones.

Generally discrimination between two fuses is achieved when this factor is at least 1,6. Program **ELIN** calculates only relation between two nominal currents (default value in setting screen is 1,55).

For better overview of protection devices in **ELIN 5.1** a graph of current-cut functions can be displayed.



If there is a colisition between curves the color of curve change into red.



7) Calculating voltage drop

Program **ELIN** calculates voltage drop in 2 parts:

- from the load to the protection device – local part
- from the load over the protection device till connection point (CP) – complete part

The complete voltage drop must not exceed the value (3-5%) .

$$U_i = \frac{100 \times P \times 2 \times L_s \times \cos Fi}{\lambda \times U^2 \times A}$$ for 1-phase system

where

U_i	voltage drop in %
P	power consumption in W
L_s	conductor length in m
λ	conductor material property in S.m/mm^2
U	line voltage in V
A	conductor cross-sectional area in mm^2
cos Fi	cos Fi

In our calculations this formula is used also for 3-phase system, because we calculate the whole network as 3 one-phase systems.

5. RESULTS

5.1 Printout tables

Two different printouts (5.1.1 and 5.1.2) are prepared in the screen form. At the same time a file **Project_iz.xls** is generated in folder project (5.1.3). The outputs depend on selected form (look 3.1.1).

5.1.1 Output of dimensioning current-circuits (Printout 1)

DIMENSIONING OF CURRENT-CIRCUITS

SYSTEM OF EARTHING TN-C-S

L E G E N D

Owner	Source of supply
Name	Label (name) of distributor or current-circuit
Description	Description of distributor/circuit name
Phase	Phase (L1, L2, L3) for 1P circuit, otherwise 3P for 3P circuit
P_i	Installed power
g	Demand factor g (simultan.)
P_{max}	Peak power $P_{max} = P_i \times g$
CosFi	CosFi at I_B
I_B	Designed current $I_B = P_i / (U \times \cos F)$ for 1P system $I_B = Max (IL1, IL2, IL3)$ for 3P system
I_n	Nominal current of protective device
MethInsta	Method of installation (A1 ... G)
Arrangem.	Arrangement of installation (001 ... 072)
I_n	Nominal current of protection
CblIEf	Efficency of cable
I_z	Current carrying capacity
Cable	Cable components n x S

Project: Example1

Owner	Name	Description	Phas	Power (I)	Simult.	Power (P)	Cos Fi (Ib Max)	Ib (Max)	MethInst	Arrangem.	In	CabEff	Iz	Cable
	-DB0		3P	2913	1	2913	0,893	6,53	B2	401	125	1,12	130	NAYY-J 4x70
-DB0	DB0		3P	2913	1	2913	0,893	6,53	B2	401	125	1,12	130	NAYY-J 4x70
DB0	-DB1	Distribution board 1	3P	8323	0,35	2913	0,893	6,53	D0	723	80	1	86	NYY-J 3x25+16
-DB1	DB1		3P	8323	0,5	4161	0,893	9,33	D0	723	80	1	86	NYY-J 3x25+16
DB1	-DB2	Distribution board 2	L3	200	1	200	0,95	0,915	B2	081	25	1,12	25,8	NYIF-J 4x2,5
DB1	-DB3	Distribution board 3	3P	2704	0,6	1623	0,923	7,31	D0	724	50	1	63	NYM-J 4x10
DB1	-DB-10	Distribution board 10	3P	6500	1	6500	0,893	18,7	B2	051	25	1,12	38,1	NYY-J 4x6
-DB2	DB2		L3	200	1	200	0,95	0,915	B2	081	25	1,12	25,8	NYIF-J 4x2,5
DB2	T1	Curr.circuit 1	L3	200	1	200	0,95	0,915	B2	081	10	1,12	18,5	NYY-J 3x1,5
-DB3	DB3		3P	2586	1	2586	0,923	12,2	D0	724	50	1	63	NYM-J 4x10
-DB3	-DB31	Distribution board 3.1	L3	118	1	118	0,908	0,565	B2	051	50	1	63	NYM-J 4x10
DB3	-DB4	Distribution board 4	L1	3233	0,8	2586	0,923	12,2	E0	312	25	1,12	57,1	NYY-J 4x6
-DB4	DB4		L1	2533	1	2533	0,915	12	E0	312	25	1,12	57,1	NYY-J 4x6
-DB4	-DB5	Distribution board 5	L1	1750	0,4	700	0,95	3,2	A2	021	25	1,12	57,1	NYY-J 4x6
DB4	T1	Room 1, lights left	L1	200	1	200	0,5	1,74	A2	021	10	1,22	17,1	NYIF-J 3x1,5
DB4	T2	Room 1, lights right	L1	333	1	333	0,95	1,52	B2	081	6	1,22	20,1	NYM-J 3x1,5
DB4	T3	Room 1, sockets	L1	2000	1	2000	0,95	9,15	B2	111	16	1,22	28,1	NYIF-J 3x2,5
-DB5	DB5		L1	1750	0,4	700	0,95	3,2	A2	021	25	1,12	57,1	NYY-J 4x6
DB5	1	Kitchen, dishwasher	L1	2500	0,7	1750	0,95	8,01	B2	081	16	1,22	28,1	NYM-J 3x2,5
-DB31	DB31		L3	118	1	118	0,908	0,565	B2	051	50	1	63	NYM-J 4x10
DB31	311	Curr.cicuit 311	L3	100	1	100	0,9	0,483	B2	051	6	1,22	20,1	NYM-J 3x1,5
DB31	312	Curr.cicuit 312	L3	18	1	18	0,95	0,082	B2	111	10	1,22	20,1	NYM-J 3x1,5
-DB-10	DB-10		3P	6500	1	6500	0,893	18,7	B2	051	25	1,12	38,1	NYY-J 4x6
DB-10	1	Kitchen, cooker 3P	3P	4000	1	4000	0,88	6,59	B2	051	10	0,87	13,1	NYM-J 5x1,5
DB-10	2	Kitchen, cooker 2P	L2	2500	1	2500	0,9	12,1	B2	081	16	1,22	46,4	NYM-J 5x6

5.1.2 Output of voltage drop, fault currents and impedances of current circuits (Printout 2)

VERIFICATION OF VOLTAGE DROPS AND IMPEDANCES

SYSTEM OF EARTHING TN-C-S

L E G E N D

Name	Label (name) of distributor or current-circuit
Description	Description of distributor or current-circuit
T_a	Disconnecting time of protective device (IEC 60364-4-41)
	T_a = 5,0s for distribution circuits and final circuits for stationary equipment only
	T_a = 0,4s for 1P circuits with outlet (for portable equipment)
	T_a = 0,2s for 3P circuits with outlet (for portable equipment)
	T_a = 0,1s for places with danger of explosion
I_B	Designed current
	$I_B = P_i / (U \times \cos F)$ for 1P system
	I_B = Max (IL1, IL2, IL3) for 3P system
FuType	Type of protective device
I_n	Nominal current of protective device
Cable	Cable components n x S
L[m]	Average length of cable
dU_{per}	Permitted voltage drop
dU_{cal}	Calculated voltage drop
I_a	Operating current in the disconnecting time
$I_{k1}=I_{min}$	Minimum shortcut current of fault loop
Z_{k1}	Impedance of fault loop at current I_{k1}
$I_{k3}=I_{max}$	Maximum shortcut current of fault loop
Z_{k3}	Impedance of fault loop at current I_{k3}

Project: Example1

Name	Description	Ta	Ib	ProType	In	Cable	L [m]	dUper	dUcal	Ia	Ik1	Zk	Ik3	Zk
-DB0		5	6,53	NH1	125	NAYY-J 4x70	20		0,038	575	5,29k	0,043	12,2k	0,032
DB0		5	6,53	NH1	125	NAYY-J 4x70	20		0,038	575	5,29k	0,043	12,2k	0,032
-DB1	Distribution board 1	5	6,53	DIV	80	NYY-J 3x25+16	10		0,068	334	3,15k	0,073	9,15k	0,043
DB1		5	9,33	DIV	80	NYY-J 3x25+16	10		0,068	334	3,15k	0,073	9,15k	0,043
-DB2	Distribution board 2	5	0,915	DII	25	NYIF-J 4x2,5	22		0,17	89,5	511	0,45	4,03k	0,057
-DB3	Distribution board 3	5	7,31	DII	50	NYM-J 4x10	22		0,31	184	1,54k	0,149	6,97k	0,057
-DB-10	Distribution board 10	5	18,7	DII	25	NYY-J 4x6	21		0,93	89,5	1,11k	0,208	6,97k	0,057
DB2		5	0,915	DII	25	NYIF-J 4x2,5	22		0,17	89,5	511	0,45	4,03k	0,057
T1	Curr.circuit 1	5	0,915	MCB/B	10	NYY-J 3x1,5	15	5	0,32	50	219	1,05	511	0,45
DB3		5	12,2	DII	50	NYM-J 4x10	22		0,31	184	1,54k	0,149	6,97k	0,057
-DB31	Distribution board 3.1	5	0,565	DII	50	NYM-J 4x10	10		0,31	184	1,19k	0,193	1,54k	0,149
-DB4	Distribution board 4	5	12,2	DII	25	NYY-J 4x6	30		1,3	89,5	613	0,375	1,54k	0,149
DB4		5	12	DII	25	NYY-J 4x6	30		1,3	89,5	613	0,375	1,54k	0,149
-DB5	Distribution board 5	5	3,2	DII	25	NYY-J 4x6	10		1,4	89,5	510	0,451	613	0,375
T1	Room 1, lights left	5	1,74	MCB/B	10	NYIF-J 3x1,5	33	5	1,9	50	169	1,36	613	0,375
T2	Room 1, lights right	5	1,52	MCB/B	6	NYM-J 3x1,5	44	5	2	30	136	1,69	613	0,375
T3	Room 1, sockets	0,4	9,15	MCB/B	16	NYIF-J 3x2,5	35	5	3,4	80,1	226	1,02	613	0,375
DB5		5	3,2	DII	25	NYY-J 4x6	10		1,4	89,5	510	0,451	613	0,375
1	Kitchen, dishw asher	5	8,01	MCB/B	16	NYM-J 3x2,5	40	5	4,3	80	194	1,19	510	0,451
DB31		5	0,565	DII	50	NYM-J 4x10	10		0,31	184	1,19k	0,193	1,54k	0,149
311	Curr.cicuit 311	0,4	0,483	MCB/B	6	NYM-J 3x1,5	10	5	0,23	30,1	468	0,491	1,19k	0,193
312	Curr.cicuit 312	5	0,082	MCB/B	10	NYM-J 3x1,5	65	5	0,24	50	107	2,14	1,19k	0,193
DB-10		5	18,7	DII	25	NYY-J 4x6	21		0,93	89,5	1,11k	0,208	6,97k	0,057
1	Kitchen, cooker 3P	5	6,59	DII	10	NYM-J 5x1,5	11	4	1,3	36,9	429	0,536	1,91k	0,208
2	Kitchen, cooker 2P	5	12,1	DII	16	NYM-J 5x6	77	5	3,4	55,1	290	0,794	1,11k	0,208

5.1.3 File »Projekt_iz.xls« including all project data

File **Projekt_iz.xls** is found in the same folder as project, where Projekt is the name of project. There are 8 sheets where the first 5 upper lines are prepared for logo and project data. These 5 lines are copied from the template file:

Predloga_xx_iz.xls, xx=SI, EN, HR, DE/ for 4 different languages

This file is placed in folder **ELIN**.

After the first printout of project, file the Projekt_iz.xls is created in directory of project. It can be edited with logo and project data and saved.

The name of file **Predloga_xx_iz.xls** should not change.
The number and names of sheets in file **Predloga_xx_iz.xls** should not be changed.
The number and names of sheets in file **Projekt_iz.xls** should not be changed.
When making output file **Predloga_xx_iz.xls** should be closed – not in use**.**

5.1.3.1 Cables sorted by distributors Kbl_R

Distributor	Cable	L[m]

Distributor label of supply (distributor, connection point)
Cable type of cable
L[m] length of cable (m)

5.1.3.2 Cables sorted by type Kbl

Cable	L[m]

Cable type of cable
L[m] length of cable (m)

5.1.3.3 Protection elements sorted by distributors Vrv_R

Distributor	ProType	In	PhSys	pcs

Distributor label of supply (distributor, connection point)
ProType type of protection
In nominal current value
PhSys. phase system (1P,3P)
pcs quantity (pcs)

5.1.3.4 Protection sorted by type Vrv

ProType	In	PhSys	pcs

ProType type of protection
In nominal current value

PhSys. phase system (1P,3P)
pcs quantity (pcs)

5.1.3.5 Loads sorted by distributors Por_R

Distributor	Description	PhSys	pcs

Distributor label of supply (distributor, connection point)
Description load description
PhSys. phase system (1P,3P)
pcs quantity (pcs)

5.1.3.6 Loads - general Por

Description	PhSys	pcs

Description load description
PhSys. phase system (1P,3P)
pcs quantity (pcs)

5.1.3.7 Output of dimensioning current-circuits (as Printout 1)

The content of this output is equal to 5.1.1 Output of dimensioning current-circuits
In the **Printout 1** there is an additional coloumn CblEff, for showing the percentage of efficial current according to IEC tables. More are wires together and greater is the ambient temperature smaller is this factor.

5.1.3.8 Output of voltage drop, fault currents and impedances of current circuits (as Printout 2)

The content of this output is equal to 5.1.2 Output of voltage drop, fault currents and impedances of current circuits.
In the **Printout 2** two coloumns are presented to show calculated impedance at Ik1 and Ik3.

5.2 Printout schemes

5.2.1 Plot of one-pole schemes

The schemes are in especial AutoCAD format (*.SCR) which enables working of schemes in whatever version of AutoCAD or AutoCAD-LT.

Schemes are generated with one frame, which can be individual with your logo and from graphical segments. If there are more than 9 circuits or width of segment the next sheet is generated. Details about parameters of sheets are explained in Settings (3.4).

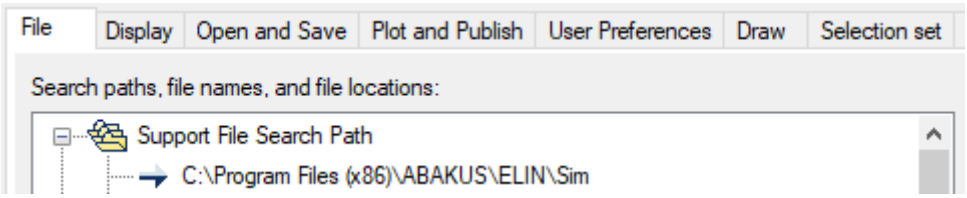
The names of created files in SCR format are:

project.name_distributor.name_serial.number.**SCR**

In AutoCAD these files *.**scr** are inserted with a command **Tools/Run script** and from this point out DWG files with the proposed names are done. The names have following structure:

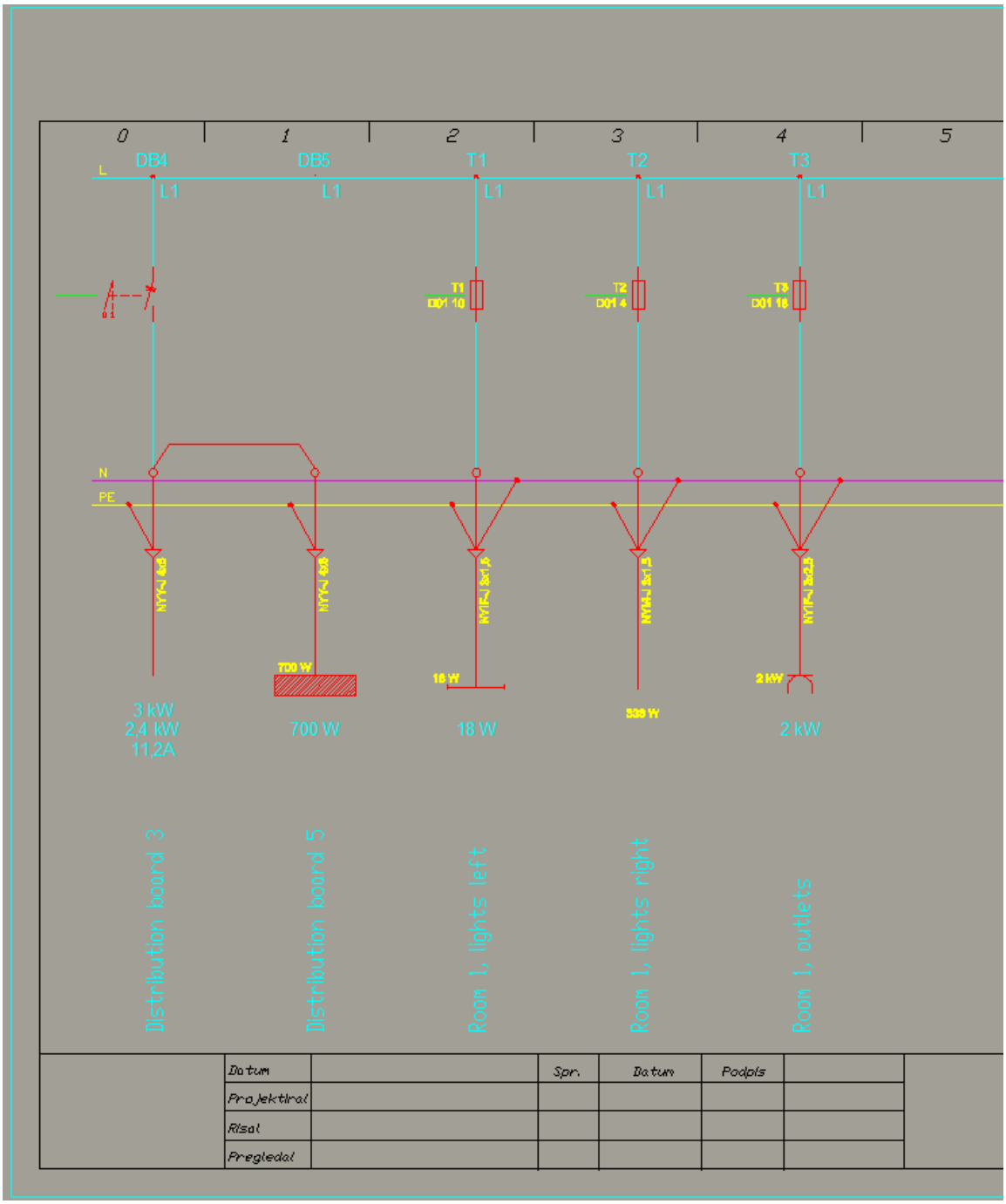
project.name_distributor.name_serial.number.**DWG**

In AutoCAD environment the path to ELIN symbols should be entered like:



To make individual frame for your project the following procedure should be done:

- change file PFORMAPE.dwg
- explode files SH1p, change original PFORMAPE with your own and make again the same file SH1p
- explode files SH3p, change original PFORMAPE with your own and make again the same file SH3p

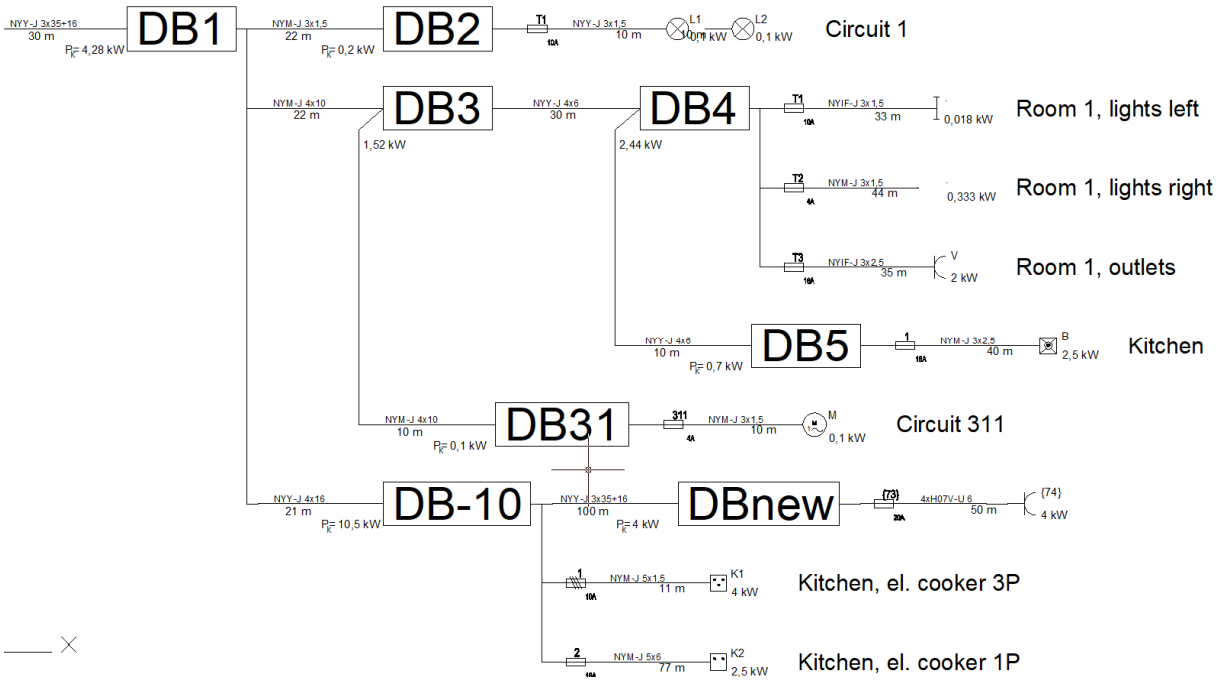


5.2.2 Plot of complete network

Additionaly to one-pole schemes one file

project_grm.scr

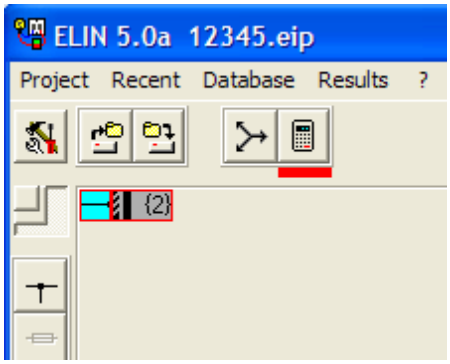
is created which enables us to generate one general scheme of the project. This scheme is without frame.


NYY-J 3x35+16
30 m
DB1
NYM-J 3x1,5
22 m
DB2
T1
NYY-J 3x1,5
10 m
L1
L2
0,1 kW
Circuit 1
NYM-J 4x10
22 m
DB3
NYY-J 4x6
30 m
DB4
NYIF-J 3x1,5
33 m
0,018 kW
Room 1, lights left
NYM-J 3x1,5
44 m
0,333 kW
Room 1, lights right
NYIF-J 3x2,5
35 m
V
2 kW
Room 1, outlets
DB5
NYM-J 3x2,5
40 m
B
2,5 kW
Kitchen
DB31
311
NYM-J 3x1,5
10 m
M
0,1 kW
Circuit 311
DB-10
NYY-J 3x35+16
100 m
DBnew
{73}
4xH07V-U 6
50 m
{74}
4 kW
NYM-J 5x1,5
11 m
K1
4 kW
Kitchen, el. cooker 3P
NYM-J 5x6
77 m
K2
2,5 kW
Kitchen, el. cooker 1P

6. MAKING A PROJECT

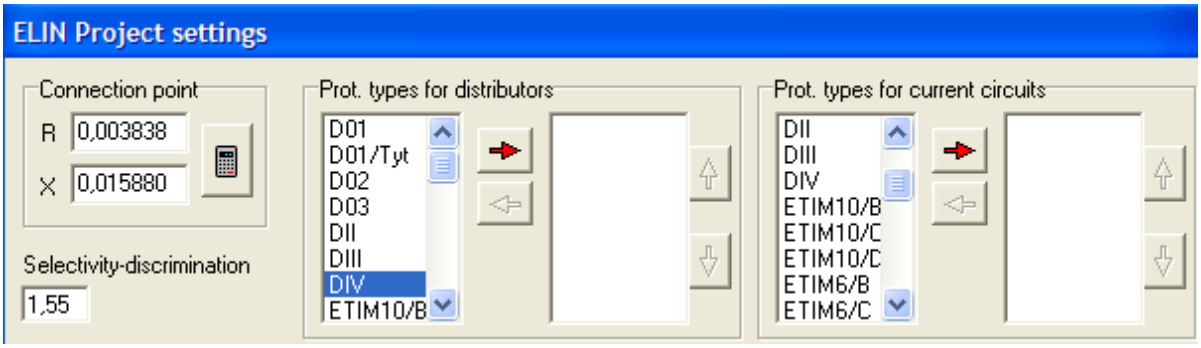
6.1 Saving project as

The name of the project is done via **Save as** command. (There is no saving in DEMO!)

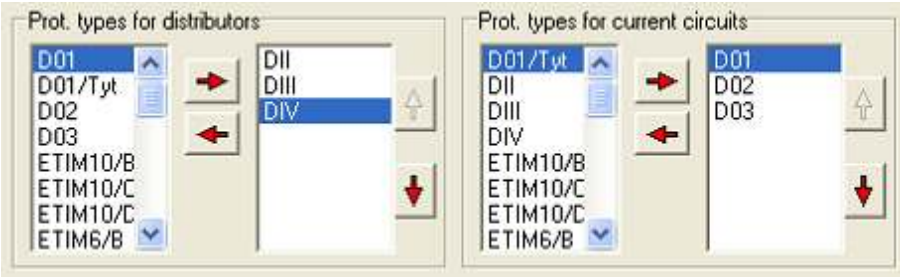


6.2 Project settings

In this settings it is possible to define the order BF selecting protection devices which program ELIN uses at calculations.



Example:



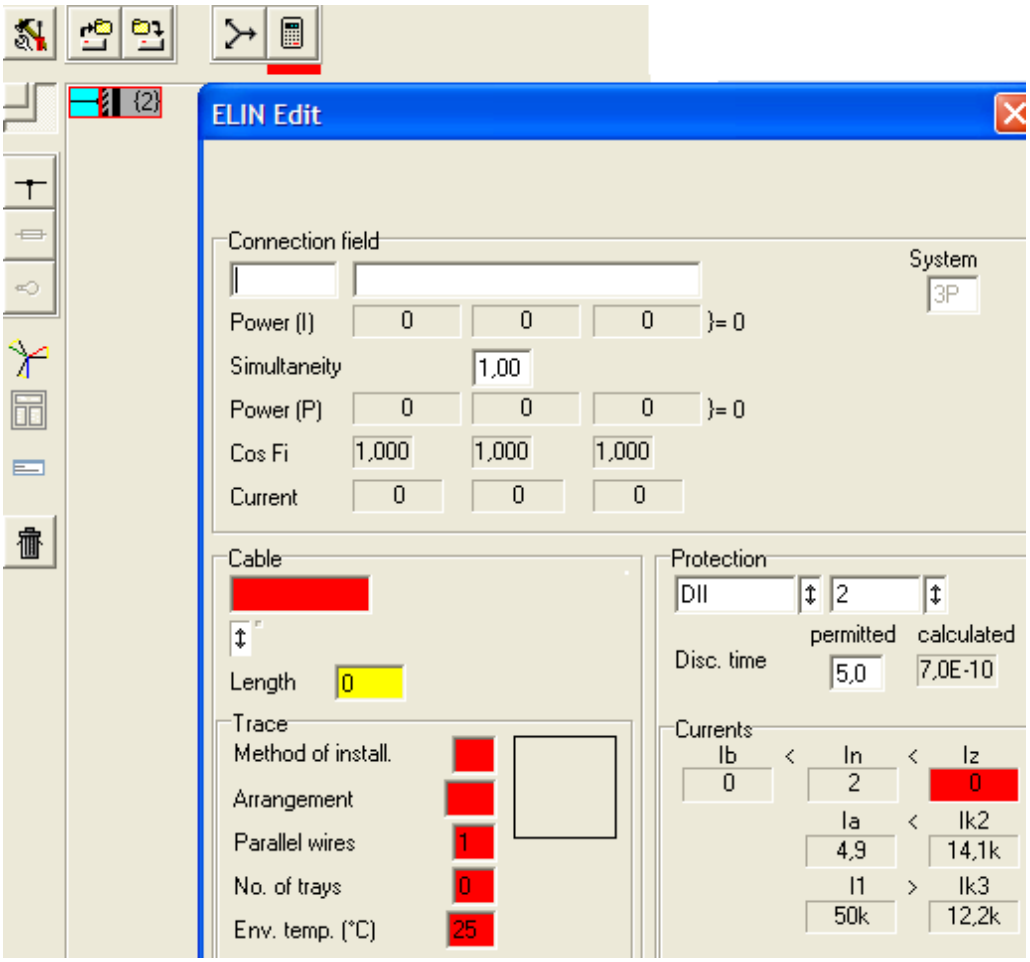
6.3 Inserting distributor

It should be inserted:

- label and description of distributor
- main supply cable type (click in the red field opens data base of cables)
- main supply cable length to connection point (yellow field)
- method of installation (click in the red field opens data base of IEC table in textual form; click in the white square field opens data base of IEC table in graphical form)

Data for protection should not be inserted, program will select automatically.

With a command **manually** all data of power consumption (load) can be written in this screen – this is possible for all distributors, except the first one.

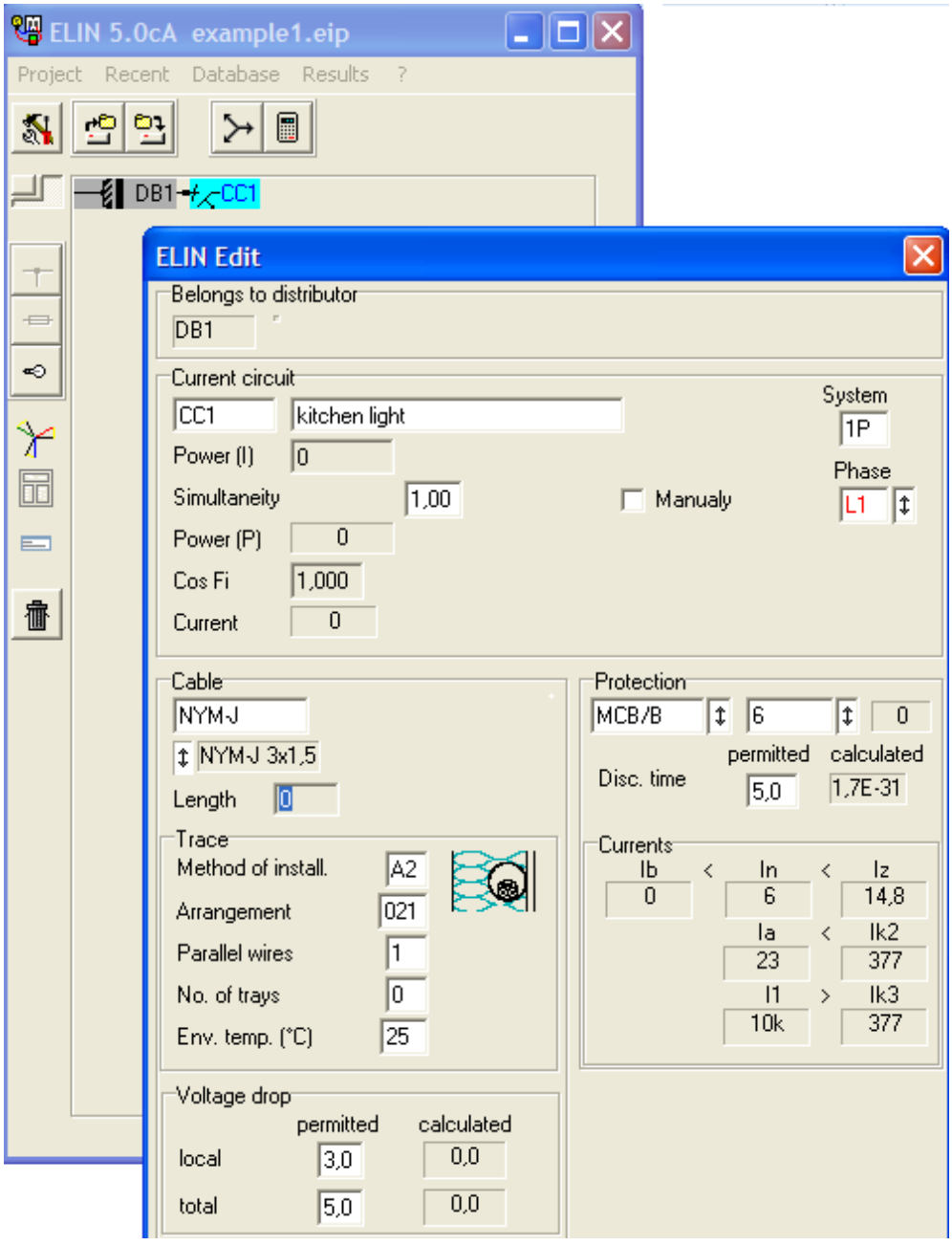


First enter is cable type then number of wires, crosssection does not matter because it will be calculated later.

If there is a sign  on the side of the value it means it can be changed by program. Otherwise with a sign  we fixed the value and program will use it as constant.

Using command **Add distributor**, icon , a new distributor is added. If the cursor is on the left side of distributor it will be in parallel connection, otherwise if cursor is in the right side it will be subdistributor. For distributor 1P/3P should be immediately fixed.

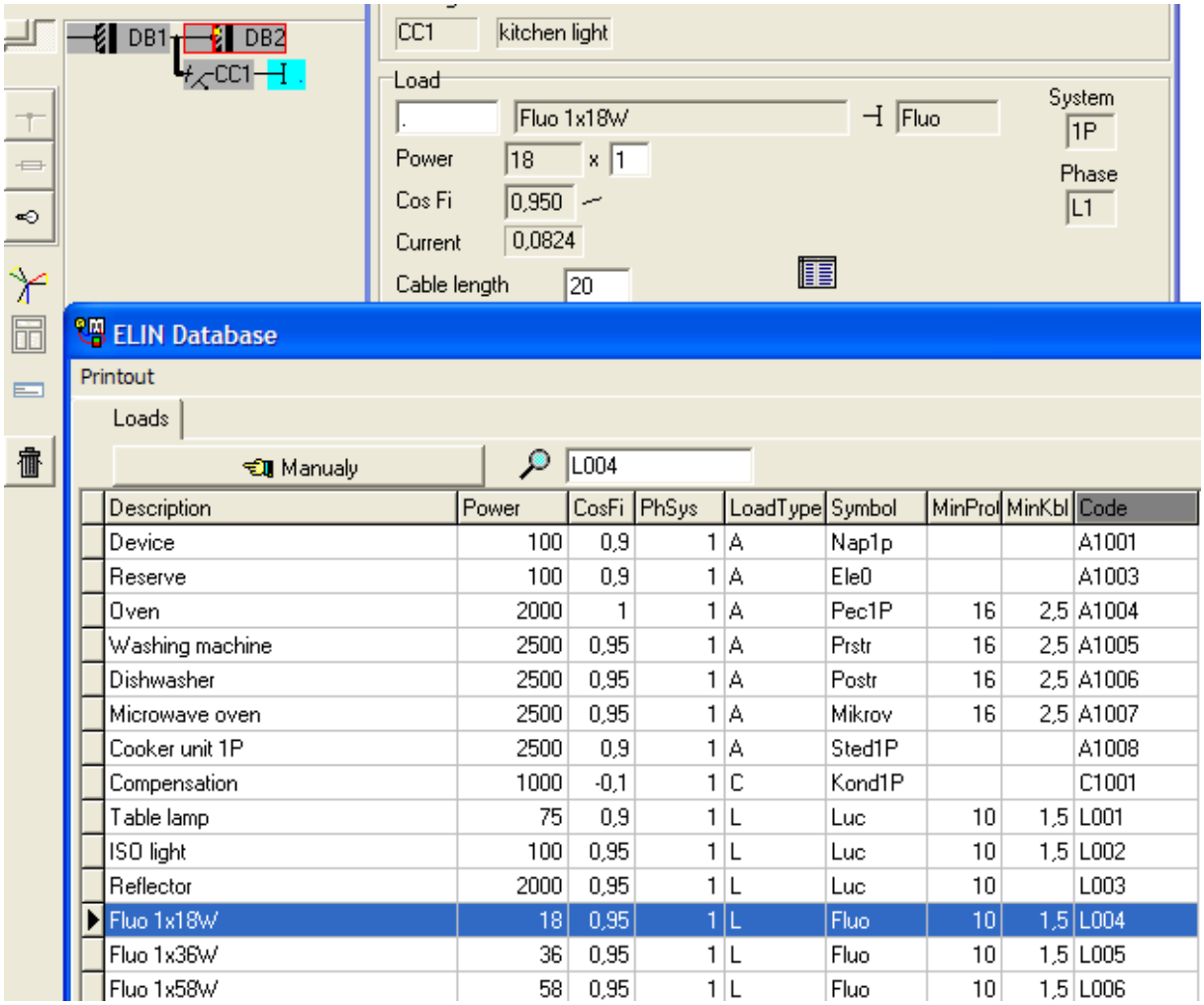
6.4 Inserting current-circuit



Using button **Add circuit**, it opens menu for 1P/3P circuit. Entering the needed data on the same way as for distributor data, except cable length which will be copied from load screen. With a command **manually** all data of power consumption can be written in this screen, so there is no need to enter load.

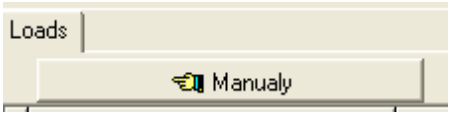
6.5 Inserting load

Using icon  for inserting load only selected (1P or 3P) loads from database are seen. The selected item with its data (power, cosFi, kind of load, graphical symbol) is inserted.

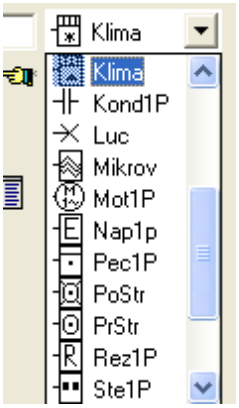


Using icon  changing of load is possible. If multiplyer is needed there is a field to enter it.

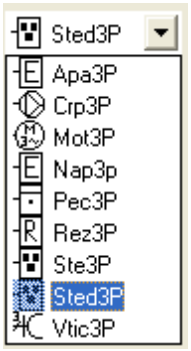
If there is no suitable load in database it is possible to enter new load just for this project – **manual insert** and there is also a sign  below the description**.**



A double click will help at adding graphical symbol with a list of symbols (separately for 1P/3P):



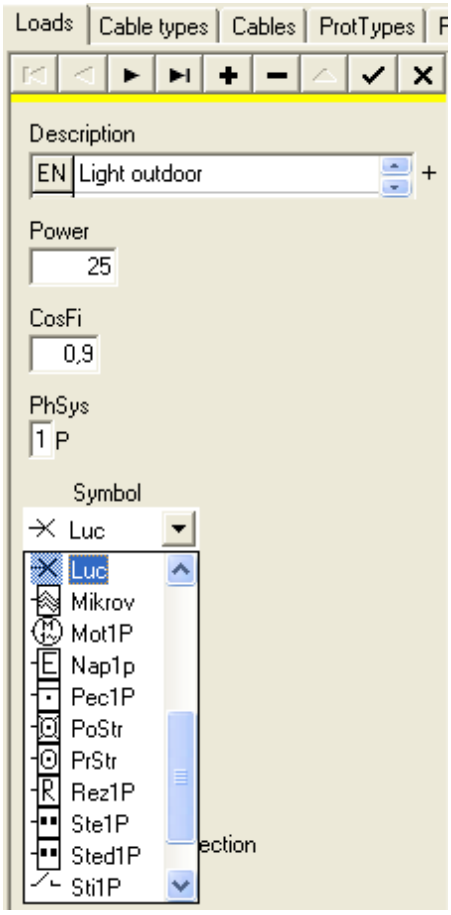
1P loads



3P loads

If a new load should be in a database to be accesible for all projects, then we should make a new one by opening database. In database open flyer loads

and use sign  for a new insert.



Code must be entered and it should be unique.

By clicking  it is saved, or by using **X** the procedure is cancelled.

If there is no need to enter a new load in database, it can be only edited the existing one. The icon  should be used and afterwards saving.

By clicking  it is saved, or by using **X** the procedure is cancelled.

If load should be changed when the load is already inserted the icon  should be used and all possibilities to change the load are free.

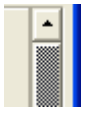
By clicking  it is saved, or by using **X** the procedure is cancelled.

6.6 Calculation

Calculation is made by pressing button  . If there is some error in calculations the icon get a red underline to pay attention. Also the icon of distributor or current-circuit get a red frame, and the fields with error in the screens are red. After removing bad data or entering needed data a new calculation shall be done.

If there is a sign  on the side of the value it means it can be changed by program. Otherwise with a sign  we fixed the value and program will use it as constant.

At first moment all one-phase loads are connected to phase L1. To get a simmetrically loaded net a button  should be used. Using button  diagram of power can be observed.

If there are more elements (distributors and circuits) then one screen a sign on the left  and icon  on the right appear. Using  program jumps to the last observed element. Using cursor on the right we can move over the whole project.

6.7 Outputs

To be sure that the printouts are the last, program **ELIN** calculates once more before making files in different forms (look 5.1 and 5.2).

7. Frequently asked questions

- *why I_{k3} is red*
  Mainly because of **discrimination factor** (default 1,55) between protection devices; change the value in 1,00 and increase by steps (setting screen)

- *why I_n is red*
  There is no protection device with enough I_n selected in setting screen

- *how to make your own printouts (not in DEMO)*
  Use file *.iz in Excel format to make your own printout

For all other questions, troubles or suggestions we are ready to answer on:

e-mail: elsyst@siol.net
mobile: +386 41 427 965
web: www.elsyst.si

8. APPENDIX

In this chapter we tried to explain **ELIN** abbreviations for method of installation and arrangement in accordance to IEC standard (IEC 60364-5-52).

ELIN 4 (IEC 60364-5-52)			
TraNac	TipIns	No.	Description of Typ of installation/Typ of arrangement
A1000	**A1**		**Insulated conductors in conduit in a therm. insulated wall**
A1011		1	Insulated conductors or single-core cables in conduit in a therm. insulated wall
A1031		3	Multi-core cables direct in a therm. insulated wall
A1121		12	Insulated conductors or single-core cable in mouldings
A1151		15	Insulated conductors or single- or multi-core cable in conduit in architrave
A1161		16	Insulated conductors or single- or multi-core cable in conduit in window frames
A2000	**A2**		**Multi-core cable in conduit in a therm. insulated wall**
A2021		2	Multi-core cables in conduit in a therm. insulated wall
B1000	**B1**		**Insulated conductors in conduit in/on a wooden wall**
B1041		4	Insulated conductors or single-core cable in conduit on a wooden wall or spaced less than <0,3D conduit
B1061		6	Insulated conductors or single-core cable in cable trunking on a wooden wall, run horiz.
B1071		7	Insulated conductors or single-core cable in cable trunking on a wooden wall, run vert.
B1101		10	Insulated conductors or single-core cable in suspended cable trunking
B1131		13	Insulated conductors or single-core cable in skirting trunking
B1401		40	Single-core or multi-core cable in a building void V>= 20De
B1421		42	Insulated conductors in cable ducting in a building void V>= 20De
B1441		44	Insulated conductors in cable ducting in masonry having a therm res. < 2K*m/W, 5De < V <50De
B1461		46	Single-core or multi-core cable a ceiling void or in a suspended floor 5De < V <50De
B1501		50	Insulated conductors or single-core cable in flush cable trunking
B1521		52	Insulated conductors or single-core cable in embedded trunking
B1541		54	Single-core or multi-core cable in conduit in an unventilated cable channel run horiz.or vert. V>= 20De
B1551		55	Insulated conductors in an open or ventilated cable channel
B1561		56	Sheathed single-core or multi-core cable open or ventilated cable channel, run horiz. or vert.
B1591		59	Insulated conductors or single-core cables in conduit in masonry

ELIN 4 (IEC 60364-5-52)			
TraNac	TipIns	No.	Description of Typ of installation/Typ of arrangement
B2000	**B2**		**Multi-core cable in conduit in/on a wooden wall**
B2051		5	Multi-core cable in flush cable trunking in the floor
B2081		8	Multi-core cable in cable trunking on a wooden wall run horiz.
B2091		9	Multi-core cable in cable trunking on a wooden wall run vert.
B2111		11	Multi-core cable in suspended cable trunking
B2141		14	Multi-core cable in skirting trunking
B2401		40	Multi-core cable in a building void 1,5De <= V < 20De
B2421		42	Insulated conductors in cable ducting in a building void 1,5De <= V < 20De
B2441		44	Insulated conductors in cable ducting in masonry having a therm res. <2K*m/W, 1,5De <= V <5De
B2461		46	Single or multi-core cable in a ceiling void or in a suspended floor 1,5De <= V <5De
B2511		51	Multi-core cable v flush cable trunking in the floor
B2531		53	Multi-core cable in embedded trunking
B2541		54	Multi-core cable in conduit in an unventilated cable channel run horiz.or vert. 1,5De <= V < 20De
B2601		60	Multi-core cables in conduit in masonry
C0000	**C**		**Single-core or multi core cable in conduit on a wooden wall**
C1201		20	Single-core or multi-core cables fixed on, or spaced <0,3D cable diameter from a wooden wall
C1571		57	Single-core or multi-core cable direct in masonry having a therm res <2K*m/W, without added mechanical protection
C1581		58	Single-core or multi-core cable in masonry having a therm res.< 2K*m/W, with added mechanical protection
C1211		21	Single-core or multi-core cable fixed directly under a wooden ceiling
C2301		30	Single-core or multi-core cable on unperforated tray
D0000	**D**		**Multi-core cable in ducts in the ground**
D0701		70	Multi-core cable in conduit in the ground, clearance a=0
D0702		70	Multi-core cable in conduit in the ground, duct to duct clearance a=0,25m
D0703		70	Multi-core cable in conduit in the ground, duct to duct clearance a=0,5m
D0704		70	Multi-core cable in conduit in the ground, duct to duct clearance a=1,0m
D0711		71	Single-core cable in conduit in the ground, clearance a=0
D0712		71	Single-core cable in conduit in the ground, duct to duct clearance a=0,25m
D0713		71	Single-core cable in conduit in the ground, duct to duct clearance a=0,5m
D0714		71	Single-core cable in conduit in the ground, duct to duct clearance a=1,0m
D0721		72	Sheathed single-core or multi-core cable in the ground without added mechanical protection, direct in the ground, clearance a=0

ELIN 4 (IEC 60364-5-52)			
TraNac	TipIns	No.	Description of Typ of installation/Typ of arrangement
D0722		72	Sheathed single-core or multi-core cable in the ground without added mechanical protection, direct in the ground, clearance a=D
D0723		72	Sheathed single-core or multi-core cable in the ground without added mechanical protection, direct in the ground, clearance a=0,125m
D0724		72	Sheathed single-core or multi-core cable in the ground without added mechanical protection, direct in the ground, clearance a=0,25m
D0725		72	Sheathed single-core or multi-core cable in the ground without added mechanical protection, direct in the ground, clearance a=0,5m
D0731		73	Sheathed single-core or multi-core cable in the ground with added mechanical protection, direct in the ground, clearance a=0
D0732		73	Sheathed single-core or multi-core cable in the ground with added mechanical protection, direct in the ground, clearance a=D
D0733		73	Sheathed single-core or multi-core cable in the ground with added mechanical protection, direct in the ground, clearance a=0,125m
D0734		73	Sheathed single-core or multi-core cable in the ground with added mechanical protection, direct in the ground, clearance a=0,25m
D0735		73	Sheathed single-core or multi-core cable in the ground with added mechanical protection, direct in the ground, clearance a=0,5m
E0000	**E**		**Multi-core cable in free air**
E0310		31	Multi-core cable on hor. or ver. perforated tray, touching
E0311		31	Multi-core cable on hor. perforated tray, touching
E0312		31	Multi-core cable on hor. perforated tray, spacing
E0313		31	Multi-core cable on ver. perforated tray, touching
E0314		31	Multi-core cable on ver. perforated tray, spacing
E0320		32	Multi-core cable on ladder supports, cleats, etc., touching
E0321		32	Multi-core cable on ladder supports, cleats, touching
E0322		32	Multi-core cable on ladder supports, cleats, spacing
E0341		34	Multi-core cable on ladder supports, touching
E0342		34	Multi-core cable on ladder supports, spacing
E0330		33	Multi-core cable with space >0,3D from wall
E0350		35	Single-core or multi-core cable suspended from or incorporating a support wire
F0000	**F**		**Single-core cables touching in free air**
F1310		31	Single-core cables on hor. or ver. perforated tray, touching
F1311		31	Single-core cables on hor. perforated tray, touching
F1312		31	Single-core cables on ver. perforated tray, touching
F1320		32	Single-core cables on ladder supports, cleats, touching
F1321		32	Single-core cables on ladder supports or cleats, touching
F1331		33	Single-core cables with space >0,3D from the wall, touching
F1341		34	Single-core cables on ladder supports, touching

ELIN 4 (IEC 60364-5-52)			
TraNac	TipIns	No.	Description of Typ of installation/Typ of arrangement
F1350		35	Single-core cables suspended from or incorporating a support wire
F2311		31	Single-core cables in trefoil on hor. perforated tray, spacing
F2312		31	Single-core cables in trefoil on ver. perforated tray, spacing
F2321		32	Single-core cables in trefoil on ladder supports, cleats, spacing
F2331		33	Single-core cables in trefoil with space >0,3D from the wall, spacing
F2341		34	Single-core cables in trefoil on ladder supports, spacing
G0000	**G**		**Single-core cables spacing in free air**
G1360		36	Single-core cables spaced in free air hor.
G2360		36	Single-core cables spaced in free air ver.