

DOCWin2.0 exercises

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Document	Data	Prepared by	Approved by	Note

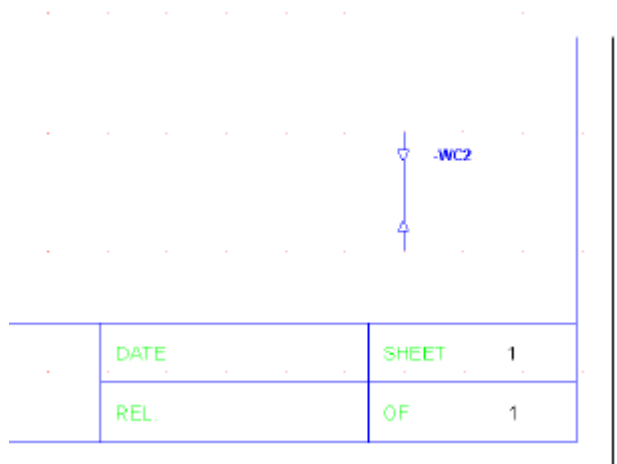
1. Object and aim

The document collects exercises for DOCWin2.0 users, to be used during learning session.

2. Cable sizing

2.1. Drawing

- Click with the left mouse button on the low-voltage cable symbol in the objects toolbar
- Click with the left mouse to draw a low voltage cable in the drawing



2.2. Object data

- Double click the already drawn cable to open the property sheet
- In the first page insert the following data:

Name		UM	
Description			not M
Reference standard for the thermal sizing	IEC 60364		M
Maximum allowed voltage drop	2	%	not M
Lenght	25	m	M
Insulating material	EPR		M
Conductor material	Cu		M
Max. allowed temperature under load condition	accept the Standard value	°C	M
Max. allowed temprature under short circuit condition	accept the Standard value	°C	M
Disposal method	Overhead		
	On unperforated trays		
	Distance <= 2 cable diameters		

UM: Unit of mesaurement
M: mandatory
notM: not mandatory

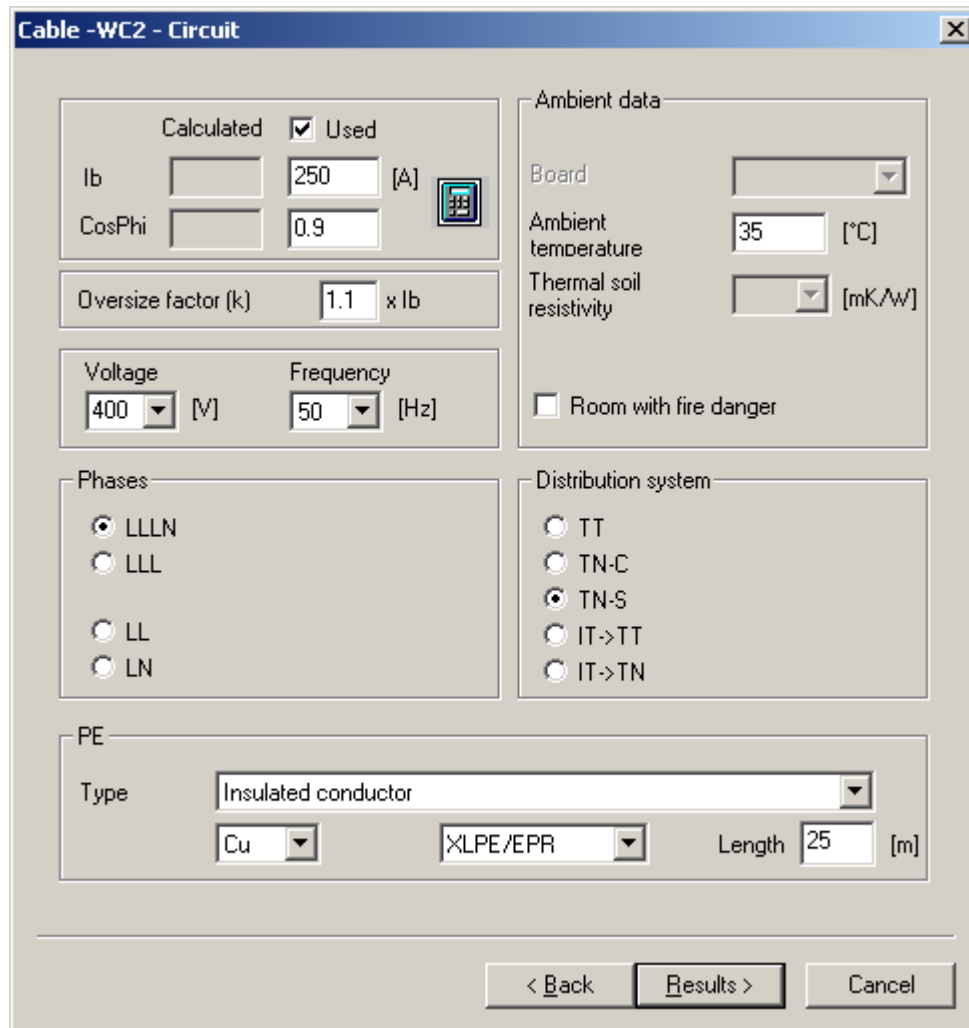
- Click on 'Particulars' and insert the data required in the window below. Related to the selected disposal method only controls are active.
- Set to 3 the adjacent circuits hipotyzing that they have a cross section similar to the cable to be sized.

- Click 'OK' button to close the installations detail window and click on 'Next' button to open the second page of the cable property sheet.

Name		UM	
Ib (load current) -to activate the control click on 'Used'	250	A	M
cosphi (power factor)	accept the default value		M
Oversizing factor - the cable will be sized for Ib x OF	1.1		M
Ambient temperature	35	°C	M

Number of phases	LLLN (three phase with distributed neutral)		
Distribution system	TN-S		
All the PE data	accept the default values		M

UM: Unit of measurement
M: mandatory
notM: not mandatory



- Click 'Results' button to read the third page of the cables property sheet.
- Use the control 'Proposed' to change the solution with another valid solution
- Use the 'Chosen' control to verify an already existent cable
- Click on the 'At working temperature' to switch between K2S2 at working temperature and K2S2 at maximum allowed temperature under load condition.
- Click on 'Carrying capacity correction factors' to read the effect of the sizing criteria on the carrying capacity given by the Standard in normal condition (30°C; no adjacent conductors ...).

2.3. Results

Cable -WC2 - Results

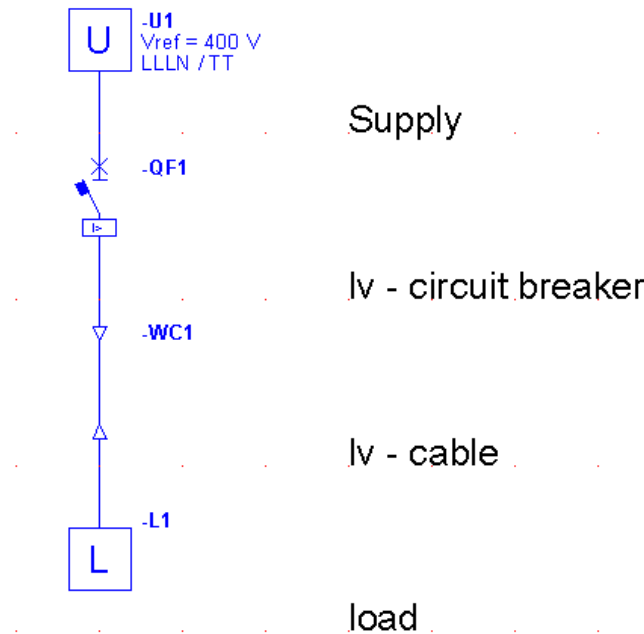
Phases		Neutral		<input checked="" type="checkbox"/> PE
Proposed	1 x 150 [mm ²]	1	x 95 [mm ²]	95 [mm ²]
Chosen	<div style="border: 1px solid black; padding: 2px;"> 1 x 150 [mm²] 2 x 70 [mm²] 3 x 35 [mm²] 4 x 25 [mm²] </div>	1	x 95 [mm ²]	95 [mm ²]
Further results		K²S² <input checked="" type="checkbox"/> At working temperature		
Resistance (R)	3.815 [mOhm]	Phases at T	5e+008 [A ² s]	
Reactance (X)	2.200 [mOhm]	Neutral	2e+008 [A ² s]	
I _{zc}	280.61 [A]	PE	2.8e+008 [A ² s]	
dV%	0.48 [%]	Short circuit currents		
Power loss	715.24 [W]	Maximum	[kA]	
Temperature	78.65 [°C]	Minimum	[kA]	
Note		<input type="button" value="Details..."/>		
<input type="button" value="Carrying capacity correction factors..."/>				
		<input type="button" value=" < Back"/> <input type="button" value=" Finish"/> <input type="button" value=" Cancel"/>		

IEC60364

Correction factor	
Ambient temperature	0.95742 [Kta]
Adjacent conductors	0.79 [Kadia]
Soil thermal resistivity	1 [Kwd]
Total	
0.75636	
<input type="button" value=" OK"/>	

3. Size and protect a cable

3.1. Drawing



3.2. Objects data

3.2.1. Plant data

Name		UM	
Rated voltage	400	V	M
Distribution system	TT		M
Phases	LLLN		M
Earth resistance	10	Ohm	M

3.2.2. Utility

Name		UM	
LLL Ik	15	kA	M
LLL Ik power factor	0.3		M
LN Ik	6	kA	M
LN Ik power factor	0.6		M
LPE Ik	6	kA	M
LPE Ik power factor	0.6		M

3.2.3. Circuit breaker

Name		UM	
Standard	Industrial application		
Neutral	Protected		
Breaking current	Icu		
Icw	Not needed		
Impulse withstand voltage	6	kV	
Protection against indirect contacts	RCCB		

3.2.4. Cable

Name		UM	
All	accept the default values		
Length	40	m	M

3.2.5. Load

Name		UM	
Rated current	350	A	M
Rated power factor	0.9		M

3.3. Calculation and release setting

Short circuit current calculation according IEC 60909-1 required.

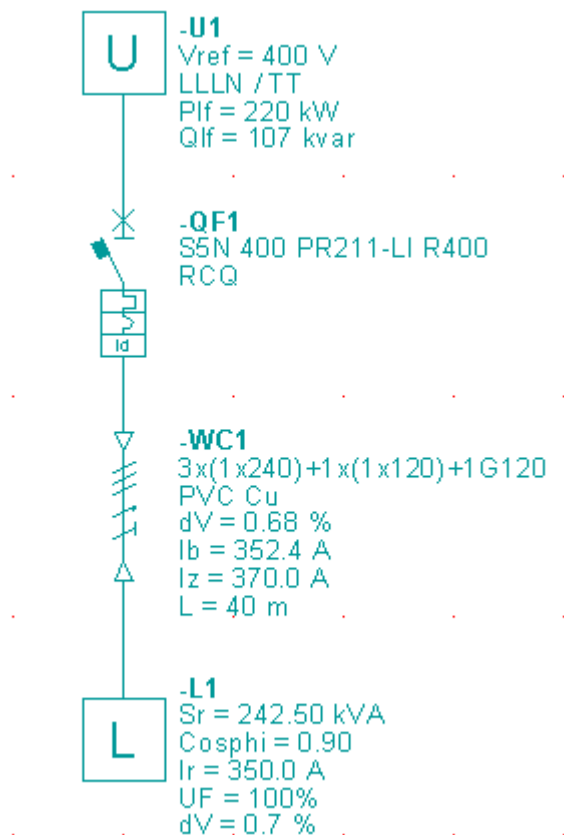
Cables impedances at working temperature (for the minimum short circuit current calculation).

Calculation performed at 10ms only for all the fault types.

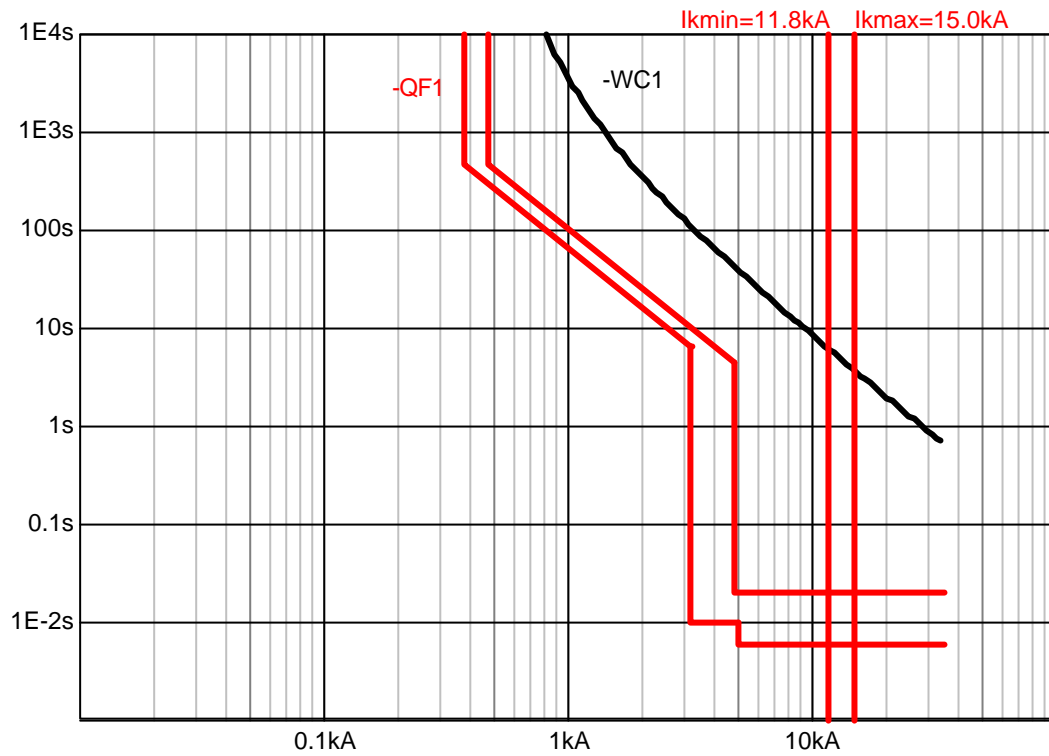
Automatic protection link allowed.

After the calculation set the electronic release with the following parameters.

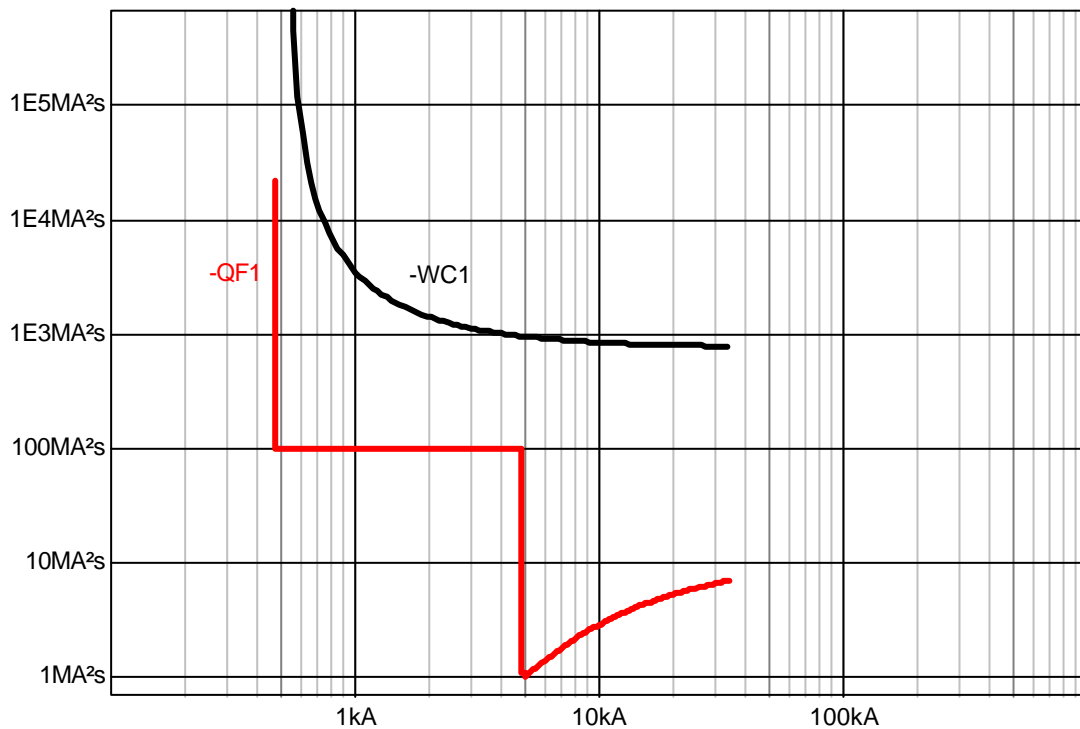
Electronic relay: -QF1 S5N 400 PR211-LI R400
 L (Long time): Settings: 0.9 Curve: D
 I (Inst.) Settings: 10



Time current curve LLL

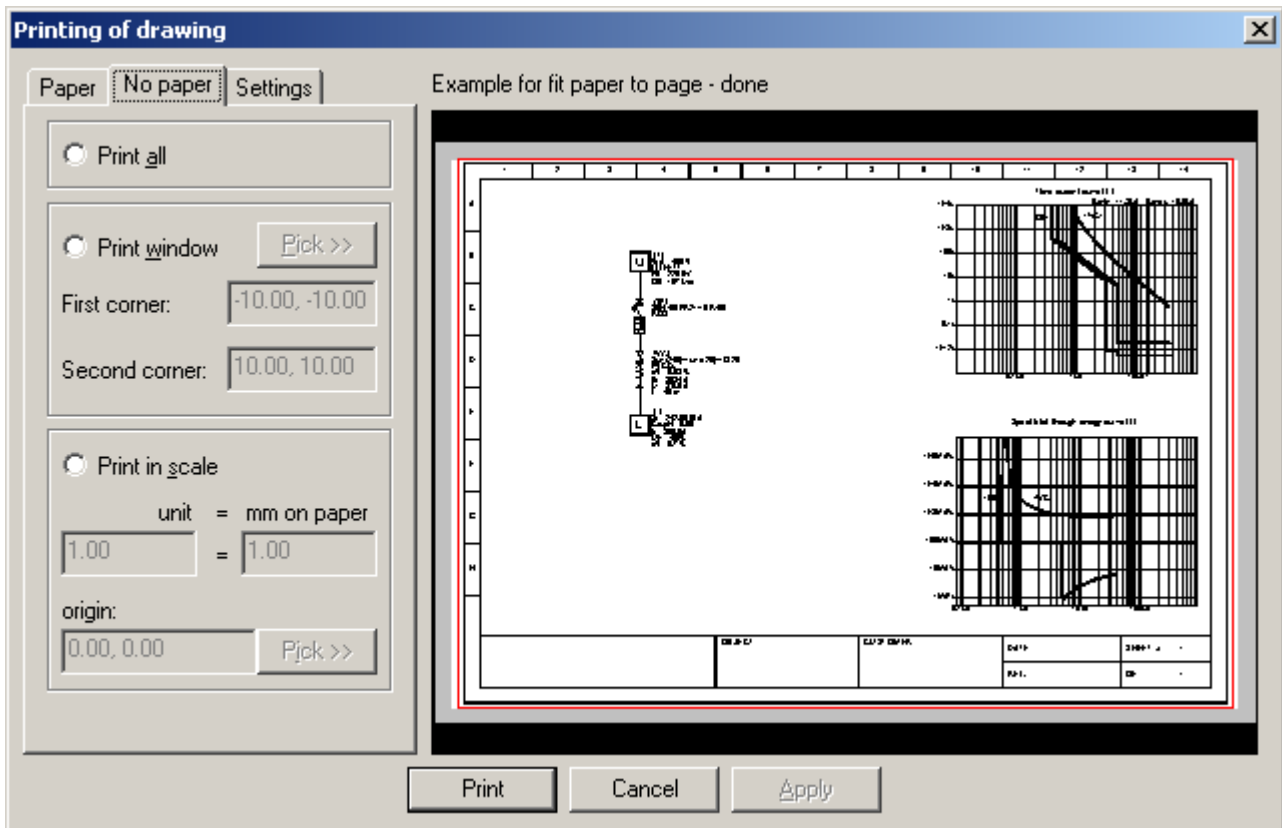


Specific let through energy curve LLL



3.4. Printouts

Print a single line diagram showing the time-current curves and the let through energy curves;
Print a report for the cable and the CB using the native format and exporting the information using the rtf format.



Code 1SDA008321R1
Description S5N 400 PR211-LI R400
Current Ib 352,4 [A]
Relay: Electronic
Rated current 400 [A]
Function L: On L= 0,90 t= D
Function I: On I = 10

Residual current relay
Code 1SDA037393R1
Description RCQ

List of circuitbreakers

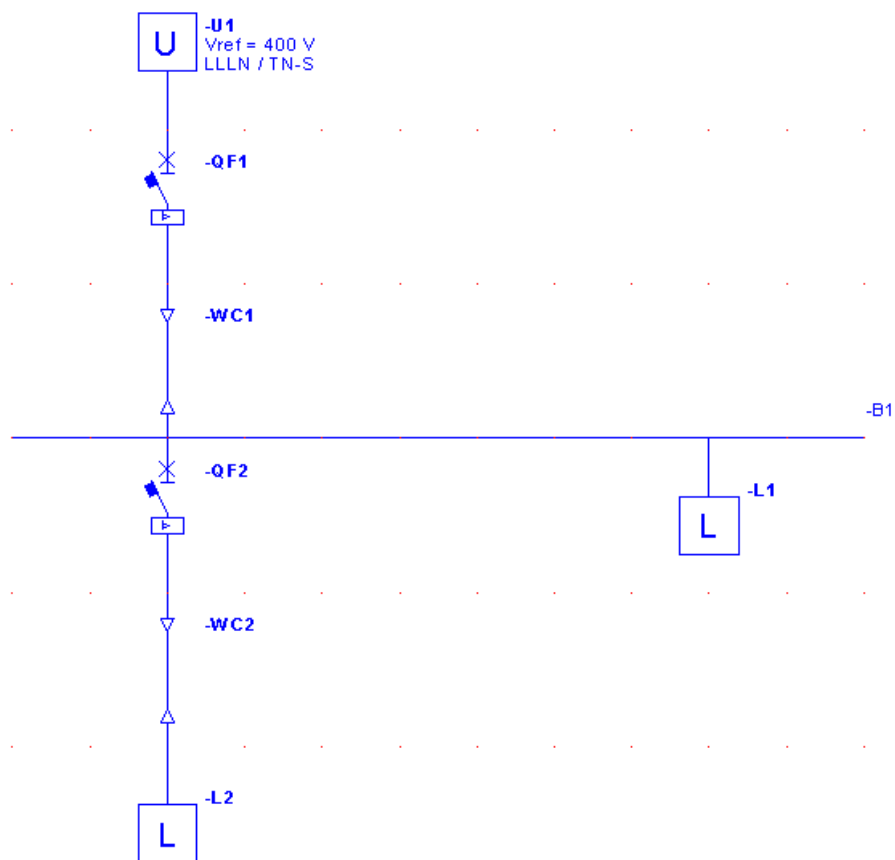
Circuit	-QF 1		
Code	1SDA008321R1		
Description	S5N 400 PR211-LI R400		
Rated voltage		400	[V]
Temperature		40	[°C]
Current Ib		352,4	[A]
Relay:	Electronic		
Rated current		400	[A]
Rated magnetic current		4800	[A]
Settings of thermomagnetic relay			
Thermal setting			[A]
Preload			[A]
Magnetic setting			[A]
Settings of electronic relay			
Function L:	On	L= 0,90	t= 0
Function S:	Off	S=	t= Zone selectivity:
Function I:	On	I= 10	
Function G:	Off	G=	t= Zone selectivity:
Function LR:	Off	LR=	
Function U:	Off		
Residual current relay			
Code	1SDA037393R1		
Description	RCQ		
Settings		Id=	0 [mA]
		t=	0 [s]

4. Discrimination

4.1. Aim of the job

- Size the cables
- Choice appropriate CB
- Set the releases to have discrimination between the CBs

4.2. Plant drawing



- Use the command 'Renumber' to give to all the object the same sign in the figure.
- Load L1 is representing others switchboards that we do not need to size in detail in this project.

4.3. Object data

4.3.1. Plant data

Name		UM	
Rated voltage	400	V	M
Distribution system	TN-S		M
Phases	LLLN		M
Earth resistance	10	Ohm	M
Calculation according to	IEC 60909 (Ik) IEC 60364 (cables) IEC 60947-2 (CBs)		

4.3.2. Utility

Name		UM	
LLL Ik	15	kA	M
LLL Ik power factor	0.2		M
LN Ik	15	kA	M
LN Ik power factor	0.2		M
LPE Ik	3	kA	M
LPE Ik power factor	0.6		M

4.3.3. Circuit breaker QF1 and QF2

Name		UM	
Neutral	Protected		
Breaking current	Icu		
Icw	Not needed		
Impulse withstand voltage	6	kV	
Protection against indirect contacts	Instantaneous function		

4.3.4. Load:L1

Name		UM	
Rated apparent power	350	A	M
Rated power factor	0.9		M
Utilization factor	90	%	

4.3.5. Load:L2

Name		UM	
Rated apparent power	70	A	M
Rated power factor	0.9		M
Utilization factor	100	%	

4.3.6. Cable: WC1

Cable - WC1 - General data

Description:

Calculation method:

- Thermal dimensioning in compliance with IEC60364
- Maximum allowed voltage drop: 2 [%]
- Protection coordination
- Economic dimensioning: hours/year

Cable:

Length [m]: 25 Tmax [°C]: 90 Short circuit Tmax [°C]: 250

Single-core

EPR/LPE Cu

Method of installation:

- Overhead
- On perforated trays
- Horizontal (distance <= 2 cable diameters)

Particulars... Method of 13

< Back Next > Cancel

Cable - WC1 - Circuit

Calculated Used

Ib: 74.9 [A] CosPhi: 0.9

Oversize factor (k): 1 x Ib

Voltage: 400 [V] Frequency: 50 [Hz]

Phases:

- LLLN
- LLL
- LL
- LR

PE:

Type: Insulated conductor

Cu XLPE/EPR Length: 25 [m]

Ambient data:

Board:

Ambient temperature: 30 [°C]

Thermal soil resistivity: [mKAW]

Room with fire danger

Distribution system:

- TT
- TN-C
- TN-S
- IT-TT
- IT-TR

< Back Results > Cancel

4.3.7. Cable WC2

Cable - WC2 - General data

Description:

Calculation method:

- Thermal dimensioning in compliance with: IEC60364
- Maximum allowed voltage drop: 4 [%]
- Protection coordination
- Economic dimensioning: hours/year

Cable:

Length [m]: 35 Tmax [°C]: 90 Short circuit Tmax [°C]: 250

Single-core

EPR/XLPE Cu

Method of installation:

In the ground

With added mechanical protection

0.25m

Particulars... Method of: 63

< Back Next > Cancel

Cable - WC2 - Circuit

Calculated Used

Ib: 71.7 / 71.7 [A]

CosPhi: 0.9 / 0.9

Overize factor (k): 1.1 x Ib

Voltage: 400 [V] Frequency: 50 [Hz]

Ambient data:

Board:

Ambient temperature: 20 [°C]

Thermal soil resistivity: 2.5 [mK/W]

Room with fire danger

Phases:

- LLLN
- LLL
- LL
- LR

Distribution system:

- TT
- TN-C
- TN-S
- IT>TT
- IT>TR

PE:

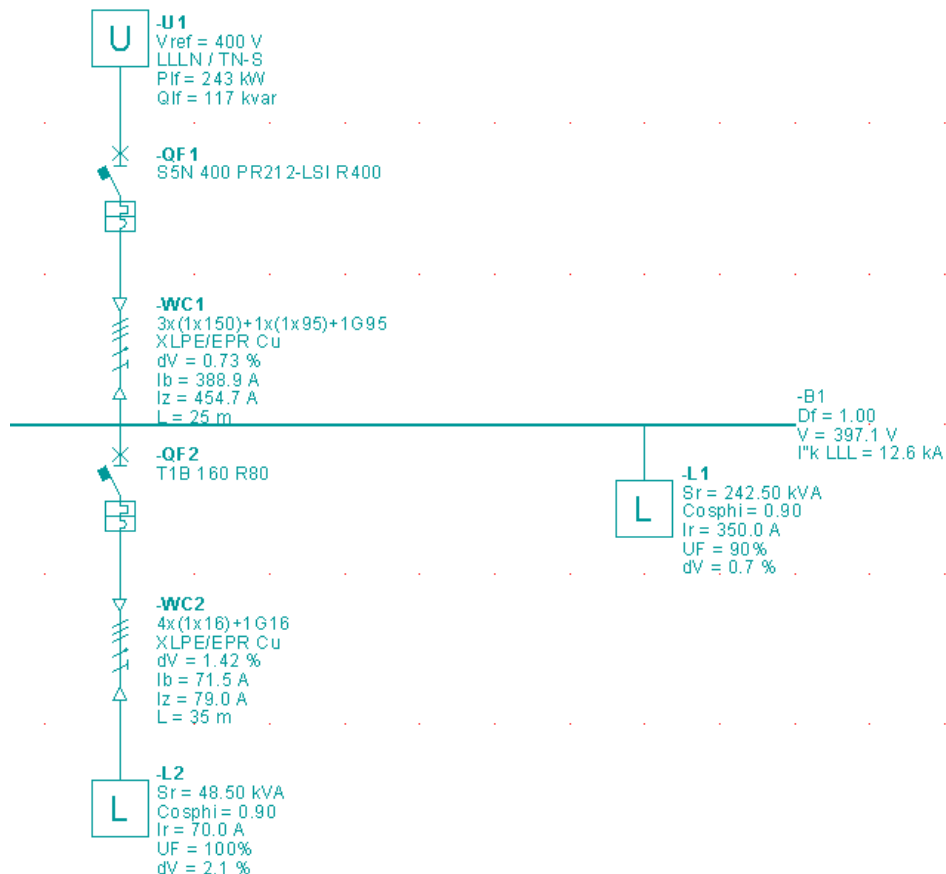
Type: Insulated conductor

Cu XLPE/EPR Length 35 [m]

< Back Results > Cancel

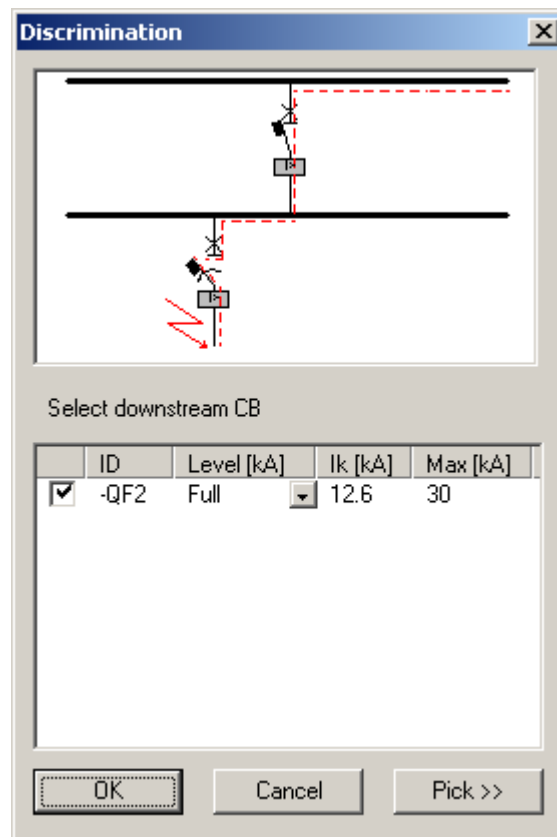
4.4. Calculation and results

Activate the 'Automatic discrimination link' option in the second page of the calculation property sheet. Be careful with this option when more than 4-5 CBs are present in the project: the calculation time can increase a lot.



The figure below (accessible from the QF1 property sheet) illustrates that QF1 and QF2 may ensure the discrimination value requested by the user:

- Requested value : Full
- Short circuit current at QF2 (downstream CB) : 12.6kA
- energy discrimination ensured by the combination : 30kA



The user can print a report like the following documenting the discrimination value

Discrimination links

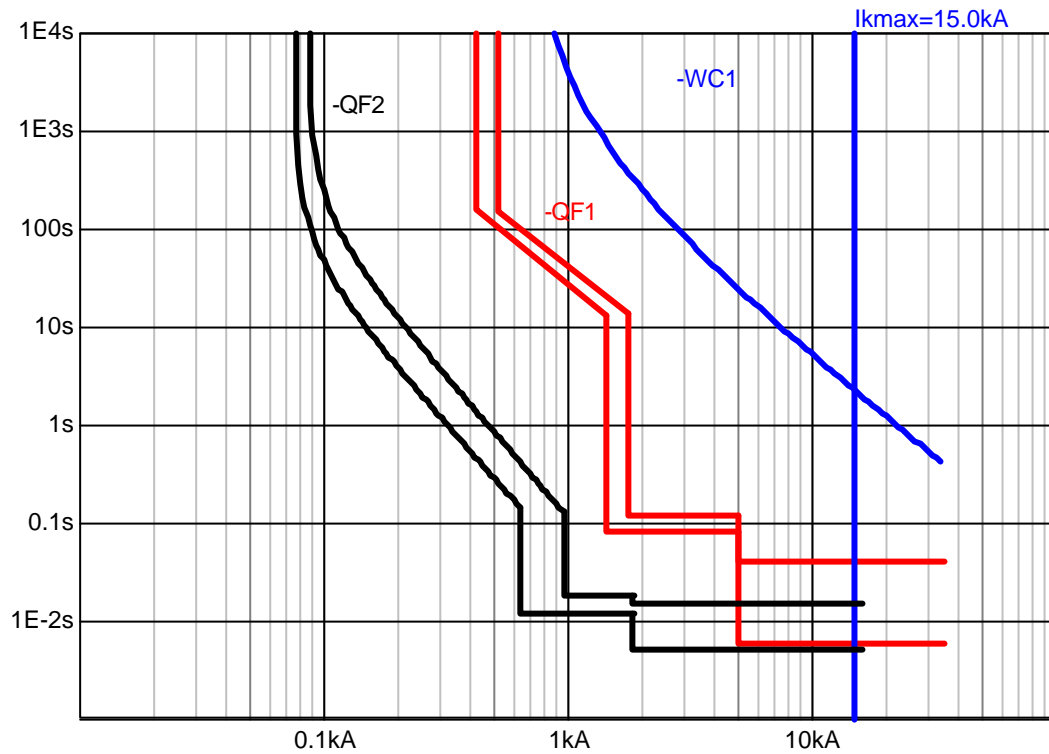
Upstream circuit-breaker	-QF1 S5N 400 PR212-LSI R400	
Downstream circuit-breaker	-QF2 T1B 160 R80	
Requested discrimination level		Full [kA]
Effective discrimination level		30.00000 [kA]

The time-current diagram demonstrates how to reach the energy discrimination value using appropriate settings for the electronic release.

Note that the L function of the electronic and thermomagnetic releases are automatically setted by the program.

Try to change the S threshold: if the protection against indirect contacts is not satisfactory, you will receive a warning message.

Time current curve LLL

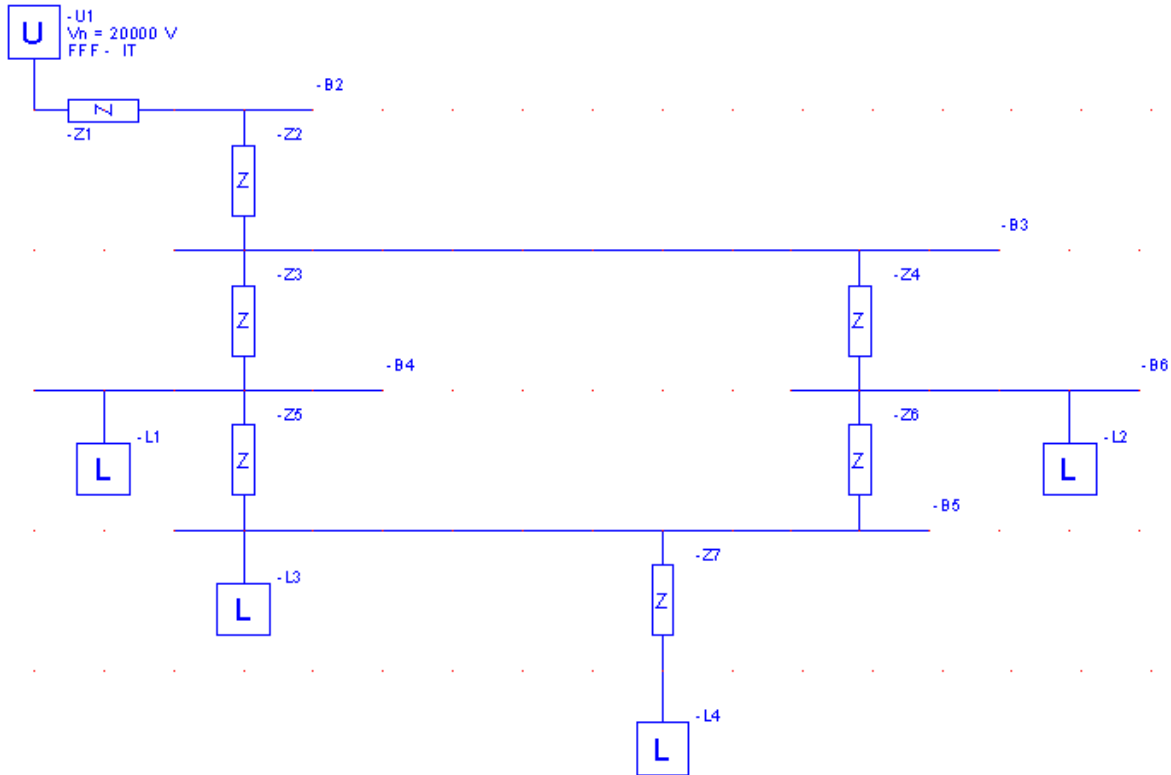


Electronic relay: -QF1 S5N 400 PR212-LSI R400
 L (Long time): Settings: 1 Curve: B
 S (Short time): t=const Settings: 4 Curve: B

Thermomagnetic relay: -QF2 T1B 160 R80
 LT: Settings: 71.5395 [A] Preload: 71.5395 [A]
 INST: Settings: 800 [A]

5. Short circuit current calculation in a meshed, high voltage plant

5.1. Plant drawing



5.2. Object data

	V_r	Phases	Distribution system	I_{k3}	$\cos\phi_3$
Utility	20kV	LLL	IT	100 kA	0.15

	A_r [kVA]	$\cos\phi_r$	UF(Utilizatio factor)
L1	100	0.85	1
L2	150	0.80	1
L3	2500	0.75	0.8
L4	350	0.90	1

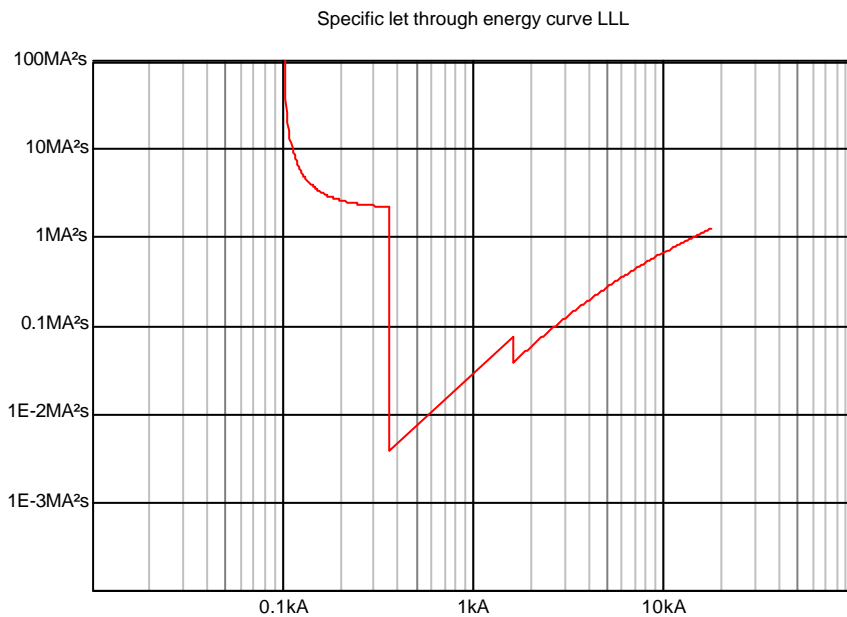
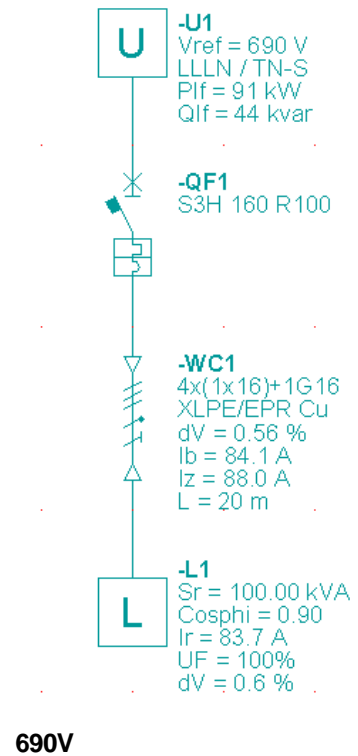
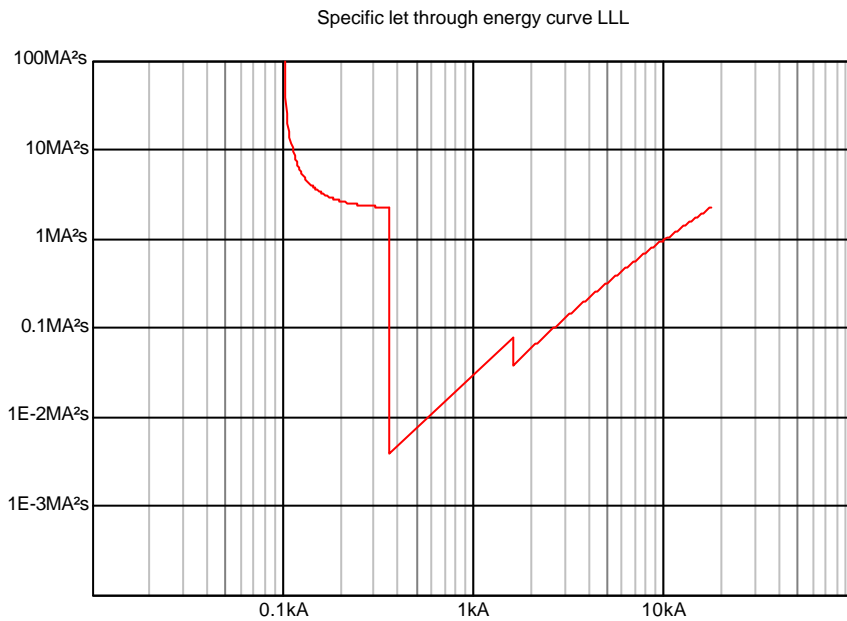
	R [Ω]	X [Ω]
Z1	0.01	0.015
Z2	0.1	0.1
Z3	0.02	0.015
Z4	0.2	0.2
Z5	0.14	0.1
Z6	0.2	0.3
Z7	0.1	0.1

6. Circuit breakers curves at 690V

DOCwin allows the user to draw the CBs curve at all the voltages.

The figures below illustrate a symple net at 690V, the specific let-through energy curve of the choosen breaker and the same curve at 400V.

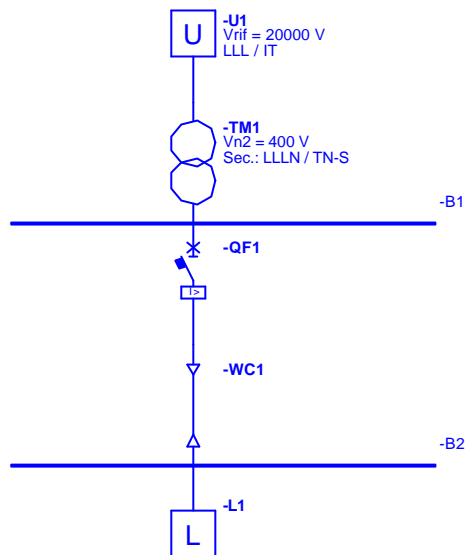
To obtain the second curve select all the object at the same time and apply the 'Properties' command.



400V

7. Transformers Taps using

7.1. Drawing



7.2. Object data

7.2.1. Plant data

Medium voltage level:

Name		UM	
Rated voltage	20000	V	<input type="radio"/>
Distribution system	IT		<input type="radio"/>
Phases	LLL		<input type="radio"/>

Low voltage level

Name		UM	
Rated voltage	400	V	<input type="radio"/>
Distribution system	TN-S		<input type="radio"/>
Phases	LLLN		<input type="radio"/>

7.2.2. Utility

Name		UM	
LLL Ik	15	kA	<input type="radio"/>
LLL Ik power factor	0.3		<input type="radio"/>

7.2.3. Transformer

Name		UM	
All	accept the default values		



7.2.4. Circuit breaker

Name		UM	
All	accept the default values		

7.2.5. Cable

Name		UM	
Length	100	m	<input type="radio"/>
All	accept the default values		

7.2.6. Load

Name		UM	
Rate apparent power	350	350 kVA	<input type="radio"/>
Rated power factor	0.9		<input type="radio"/>

7.3. Calculation

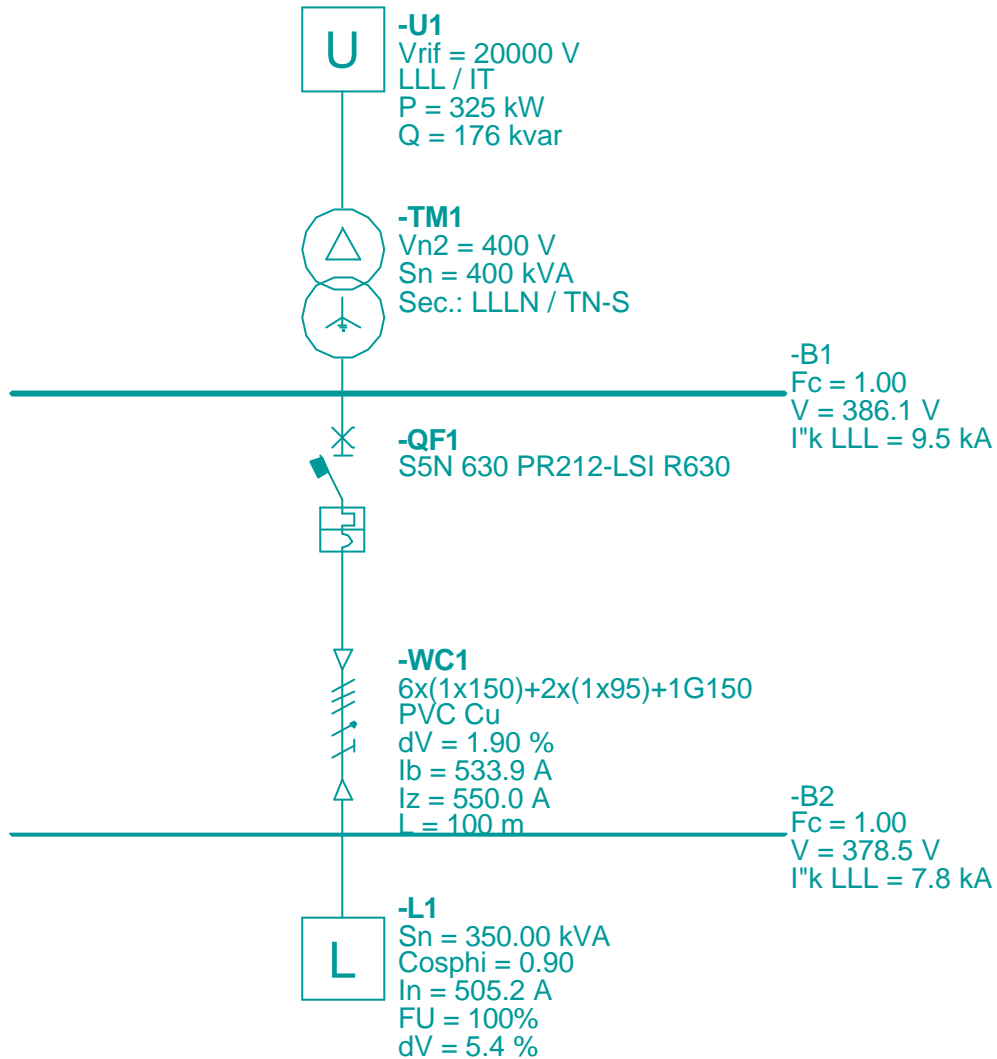
Run the calculation accepting the default settings:

Once the calculation is finished the under load voltages are:

?? at the busbar B1 386.1 V

?? at the busbar B2 378.5 V

The voltage drop at the load is 5.4% of the rated voltage.



7.4. Setting of the taps transformer

Open the dialog box of the transformer, click on the checkbox 'Taps' and insert the following data:


Name		UM	
Upper limit	5 ¹		%
Lower limit	- 5		%
Step	2.5		%
Tap	2.5		%

Lock the transformer by the padlock.

¹ The taps typical values of a transformer MV/LV are ? 5 % step 2.5 %. With these it is possible to obtain the following no-load voltage on the secondary of the transformer 380 – 390 – 400 – 410 – 420 V.

2 windings Trafo (-TM1)

2 windings Trafo

Model 

Cast Res.Distr.Transf.MV-LV 20000/400V 400kVA

< Browse database..

> Add to database

MV/LV
 LV/LV

Tri-phase
 Single-phase LL
 Single-phase LN

Winding
 Primary: Star
 Secondary: Star-grounded
 Switchboard:

Rated voltage
 Primary: 20000 [V]
 Secondary: 400 [V]

Tap
 Primary: LLL
 Secondary: LLN
 Taps:
 Upper limit: 5 [%]
 Lower limit: -5 [%]
 Step: 2.5 [%]

Distribution system
 Primary: IT
 Secondary: TN-S

Rated power
 400 [kVA]

Vcc%
 6 [%]

Losses
 1.2 [%] [Help..](#)

Description:
 Grounding resistance: 1 [Ω]

OK Cancel

Run the calculation accepting the default settings.

When the calculation is finished the under load voltages become:

?? at the busbar B1 396.2 V

?? at the busbar B2 388.8 V

Now the voltage drop at the load is 2.8 % of the rated voltage.

