Cable Sizing

Theoretical Concepts

Cable is an important and essential part of power system. Current flowing through a cable generates different losses such as ohmic losses in conductors, during fault conditions in cable screens, shields, armoring and dielectric losses through the insulation.

All the components used for the cable (such as conductors, insulation, bedding, sheath, armor, etc.) must be capable of withstanding the temperature rise and heat emanating from the above mentioned losses.

The current carrying capacity of a cable is the maximum current that can flow continuously through a cable without damaging the cable's insulation and other components (e.g. bedding, sheath, etc.). It is also referred as the continuous current rating or ampacity of a cable.

It has been observed that cables with larger conductor cross-sectional areas (i.e. more copper or aluminum) have lower resistive losses and are able to dissipate the heat better than smaller cables. Therefore usually a 20 mm^2 cable will have a higher current carrying capacity than a 5 mm^2 cable. The cable ampacity depends on below mentioned factors based on cable construction and installation condition.

Cable Construction:

- Conductor material - normally copper or aluminum
- Insulation type - e.g. PVC, XLPE, EPR
- Conductor type - e.g. stranded or solid
- Conductor shape - e.g. circular or shaped
- Conductor surface coating - e.g. plain (no coating), tinned, silver or nickel

Installation Conditions:

- Above ground or underground
- Installation / arrangement - For underground cables - directly buried or buried in conduit. For above ground cables - cable tray / ladder, against a wall, in air, etc.
- Ambient or soil temperature of the installation site
- Cable bunching, i.e. the number of cables that are bunched together
- Cable spacing, i.e. whether cables are installed touching or spaced
- Soil thermal resistivity (for underground cables)
- Depth of laying (for underground cables)
- Number of cores - single core or multicore (e.g. 1/C or 3/C)

Considering all the above conditions a cable ampacity need to be determined to eliminate any possibility of overloading a cable.

The calculation of cable ampacity can be as per IEEE; IEC; NEC; ICEA and BS standards in ETAP.

In section-I: HV cable sizing is done as per standard IEC-60502-2 for 3/C and 1/C cable.

In section-II: LV cable sizing is done as per standard IEC-60364-5-52 for 3/C and 1/C cable.

Cable Sizing

Purpose and Description

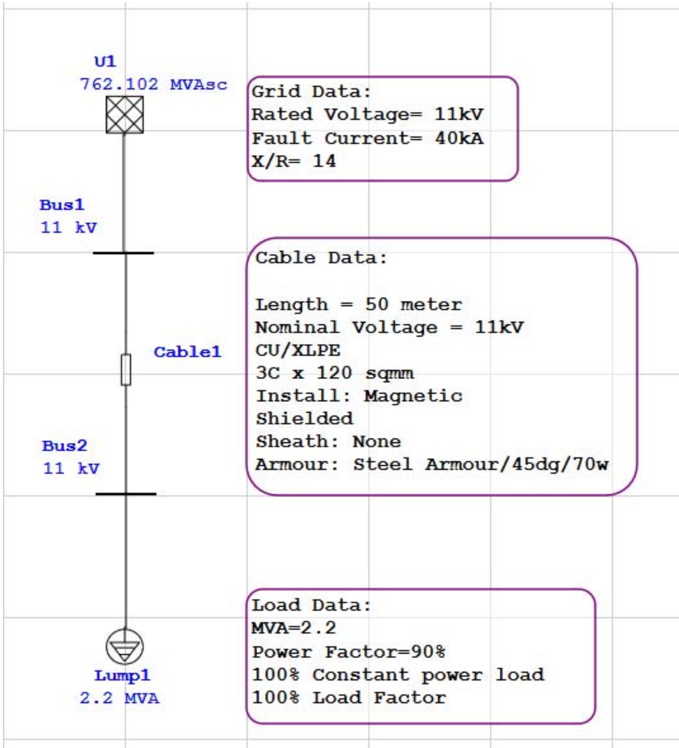
The purpose of this exercise is to calculate ampacity of a HV and LV cable as per IEC standards 60502-2 and 60364-5-52 respectively and to size the cable by considering different constraints.

Section-I HV cable sizing (IEC-60502-2)

Procedure:

Case A: To calculate cable de-rated ampacity

1. Create a new project with a name of 'HV cable sizing'.
2. Drag and place grid, buses, cable & lump load and connect them. Proceed to enter the input data as shown below.

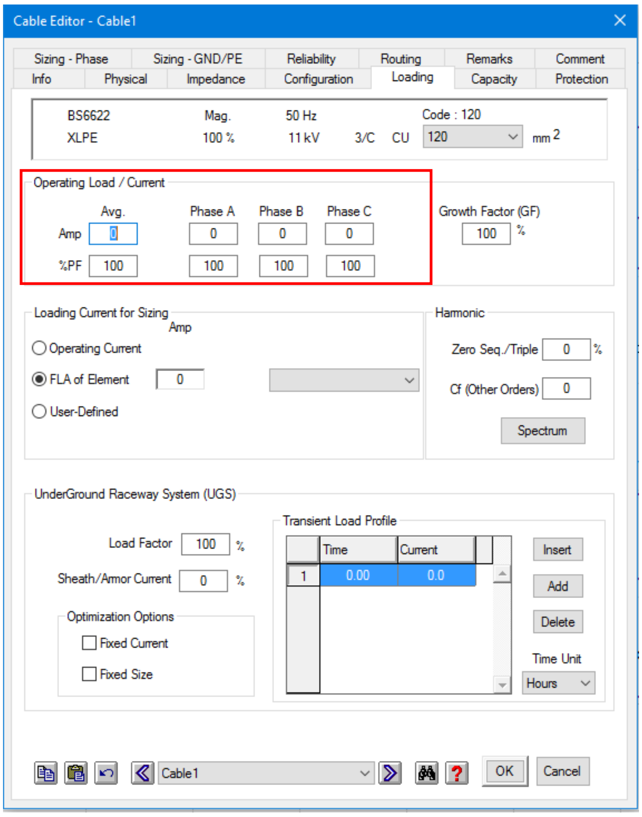


Note: According to IEC 60502-2, the cable must be shielded (and unarmored if 1/C). Refer attached Appendix B for IEC-60502-2 standard.

All the tabulated ratings for single-core cables assume that the cable screens are solidly bonded at both the ends, refer attached page from IEC-60502-2 standard.

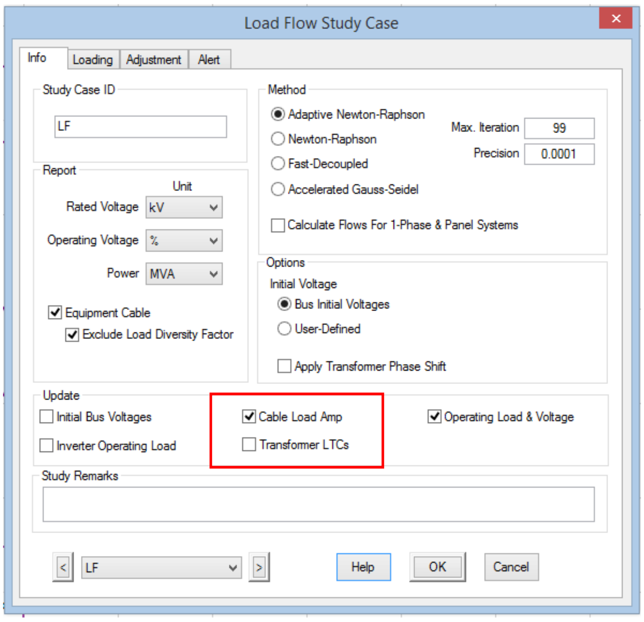
Cable Sizing

3. Check loading page of cable in Cable Editor. All operating load current values are zero.

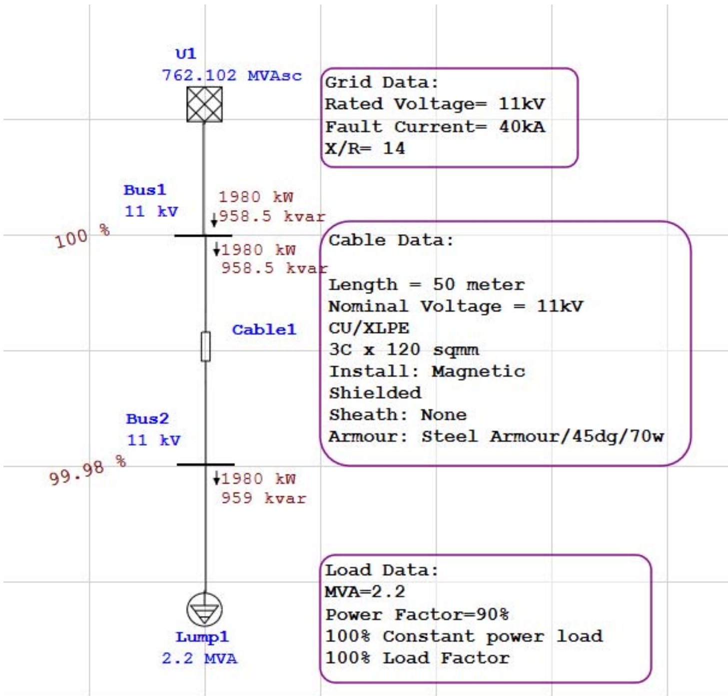


4. To update operating current in Cable Editor; go to Info page of Load Flow Study Case and select Cable Load Amp under Update section

Cable Sizing

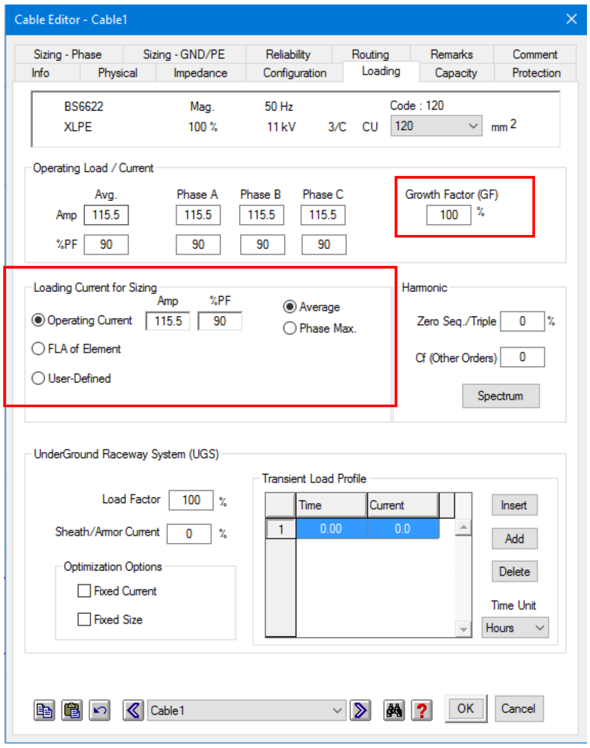


5. Run the load flow analysis on the system.



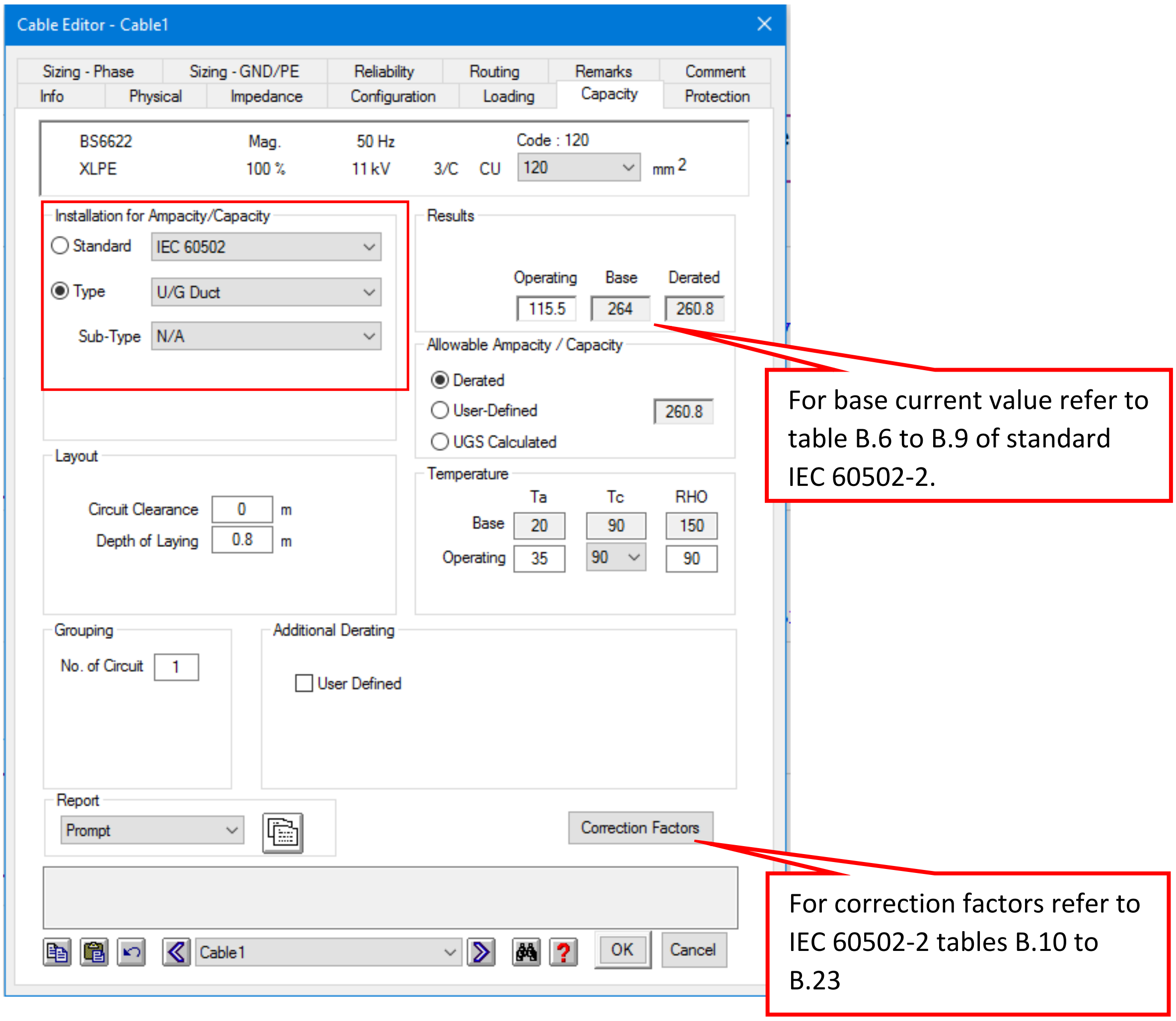
6. Check the loading page of Cable Editor. Operating current is updated in the Cable Editor. Select ‘Loading current for sizing’ as Operating Current and increase growth factor by 15%

Cable Sizing



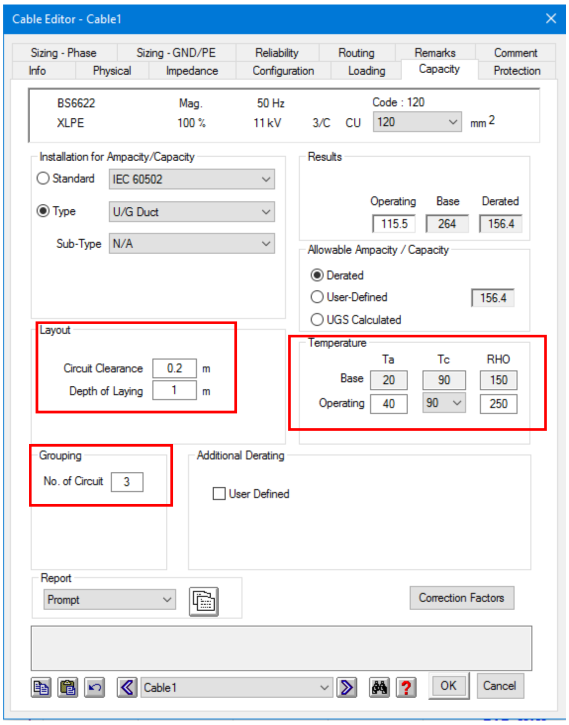
7. Go to Capacity page of Cable Editor. Choose standard as IEC 60502 and type of installation as U/G Duct.

Cable Sizing

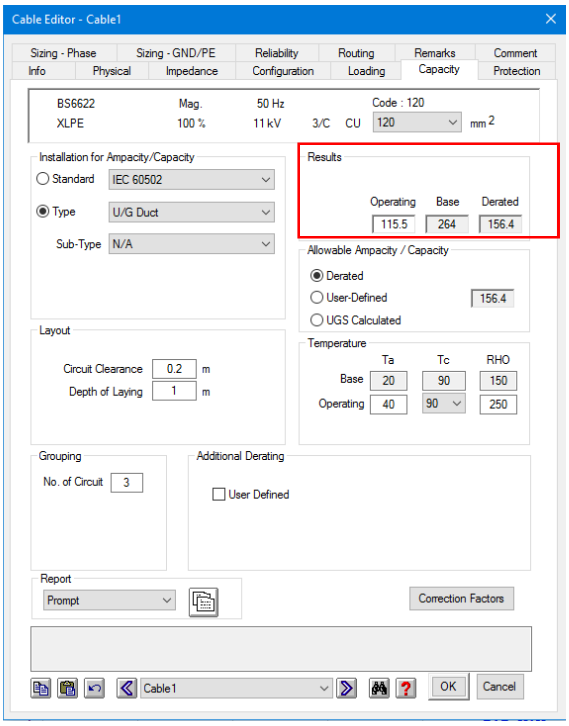


8. The capacity page shows the base current, operating current and derated current for cable. Note the de-rated current for cable is 260.8 A for default values of installation details. Provide Temperature, Grouping and Layout details for the cable as shown below.

Cable Sizing



9. The cable de-rated ampacity calculated is 156.4 A based on above mentioned installation conditions



10. Follow same procedure for Single core HV cable ampacity calculation. Based on installation conditions and cable details as shown below by creating a new system for single core cable.

Cable Sizing

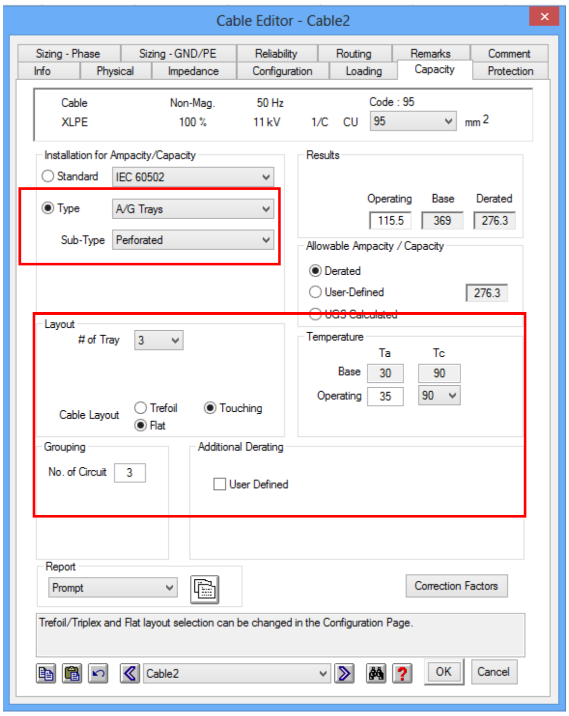
Single Core cable details:

Cable selected: 11 kV, CU, XLPE, 1/C, non mag., 95 mm^2, length 100 m, Unarmored and shielded.

Library Quick Pick - Cable

	Unit	Freq	Type	kV	% Class	#/C	Insul	Source	Install
1	Metric	50	CU	11	100	1/C	XLPE	BS6622	Mag.
2	Metric	50	CU	11	100	1/C	XLPE	BS6622	Non-Mag.
3	Metric	50	CU	11	100	1/C	XLPE	Cable	Non-Mag.
4	Metric	50	CU	11	100	1/C	XLPE	Caled BS6622	Non-Mag.
5	Metric	50	CU	11	100	1/C	XLPE	Prys BS6622	Non-Mag.

Note – Select the library file provided in the HV cable Sizing Solution to select the above cable.



11. Hand calculation for 3/C & 1/C de-rated ampacity of cable is as shown below:

<u>Three Core Cable</u>

Cable selected: 11 kV, 3/C, CU, XLPE, Magnetic, 120 mm^{2,} length 50 m, steel armored and shielded

Method of installation of cable: U/G DUCT

Base Ampacity of cable selected = 264 A

Cable Sizing

Following standard condition are used as per IEC-60502-2 for calculation of base ampacity according to table B.6 to B.9:

Maximum conductor temperature (Tc)	90 deg-C
Ambient air temperature(Ta)	30 deg-C
Ground temperature	20 deg-C
Depth of laying (For U/G cable)	0.8 meter
Thermal resistivity of soil (RHO)	1.50 K m/watt
Thermal resistivity of earthenware ducts	1.2 K m/watt

Correction factor for Ambient Temperature:

Ambient Air Temperature	40 Deg C	
Derating factor	0.85	Ref. Table B.11 of IEC-60502-2

Correction factor for depth of laying for 3/C cable:

Depth of laying	1 meter	
Derating factor	0.99	Ref. Table B.13 of IEC-60502-2

Correction factor for soil thermal resistivity:

Soil thermal resistivity	250 Deg C-cm/w	
Derating factor	0.88	Ref. Table B.17, of IEC-60502

Correction factor for grouping of cables:

No of cables in the group	3	
Spacing between ducts	0.2 meter	
Derating factor	0.80	Ref. Table B.20 of IEC-60502

De-rated Ampacity = Base current x correction factor for ambient temperature x Correction factor for depth of laying for 3/C cable x correction factor for soil thermal resistivity x correction factor for grouping of cables

= 264 x 0.85 x 0.99 x 0.88 x 0.80

= **156.39 A**

Cable Sizing

Single Core cable

Cable selected: 11 kV, CU, XLPE, 1/C, non mag., 95 mm^2, length 100 m, Unarmored and shielded

Library Quick Pick - Cable

	Unit	Freq	Type	kV	% Class	#/C	Insul	Source	Install
1	Metric	50	CU	11	100	1/C	XLPE	BS6622	Mag.
2	Metric	50	CU	11	100	1/C	XLPE	BS6622	Non-Mag.
3	Metric	50	CU	11	100	1/C	XLPE	Cable	Non-Mag.
4	Metric	50	CU	11	100	1/C	XLPE	Caled BS6622	Non-Mag.
5	Metric	50	CU	11	100	1/C	XLPE	Prys BS6622	Non-Mag.

Method of installation of cable: A/G Trays
Base Ampacity of cable selected = 369 A

Correction factor for Ambient Temperature:

Ambient Air Temperature	35 Deg C	
Derating factor	0.96	Ref. Table B.10 of IEC-60502-2

Correction factor for cables grouped together:

No of trays	3	
No of circuit	3	
Cable layout	Flat /Touching	
Derating factor	0.78	Ref. Table B.23 of IEC-60502-2

De-rated Ampacity = Base current x Correction factor for Ambient Temperature x Correction factor for cables grouped together

= 369 x 0.96 x 0.78

= **276.3 A**

12. Similarly, de-rated cable ampacity for 3 core and 1 core cable with different types of installation method such as U/G Duct, A/G Trays (perforated) etc. can be carried out.

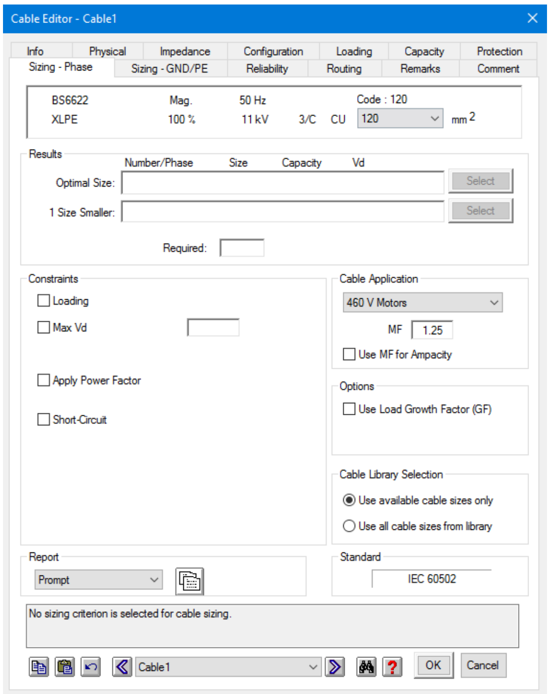
Note - single core HV cable sizing can be done only for non-armored type cable as mentioned in standard 60502-2

Cable Sizing

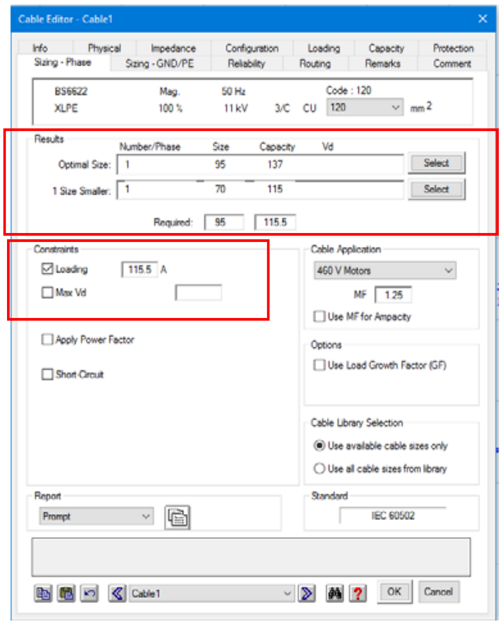
Case B: Calculation of sizing of cable

Three Core Cable Sizing

13. Check the Sizing Phase page of cable editor for 3 Core cable selected earlier

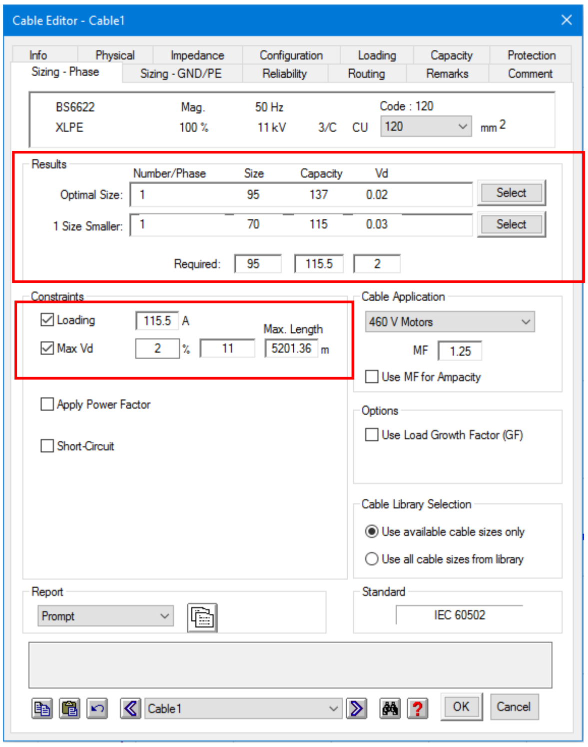


14. Select 'Loading' option under constraints section and check cable size calculated based on the current flowing through the cable.

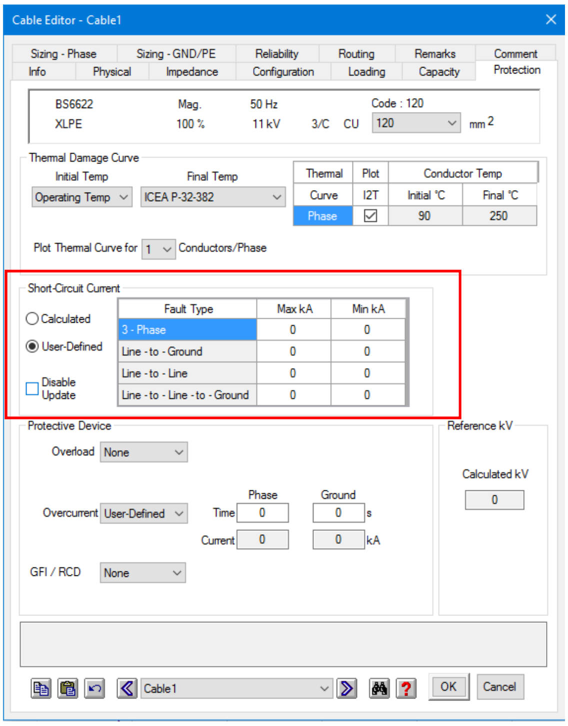


Cable Sizing

15. Select ‘Max Vd’ option under Constraints section and check the cable size calculated based on the allowable voltage drop across cable.

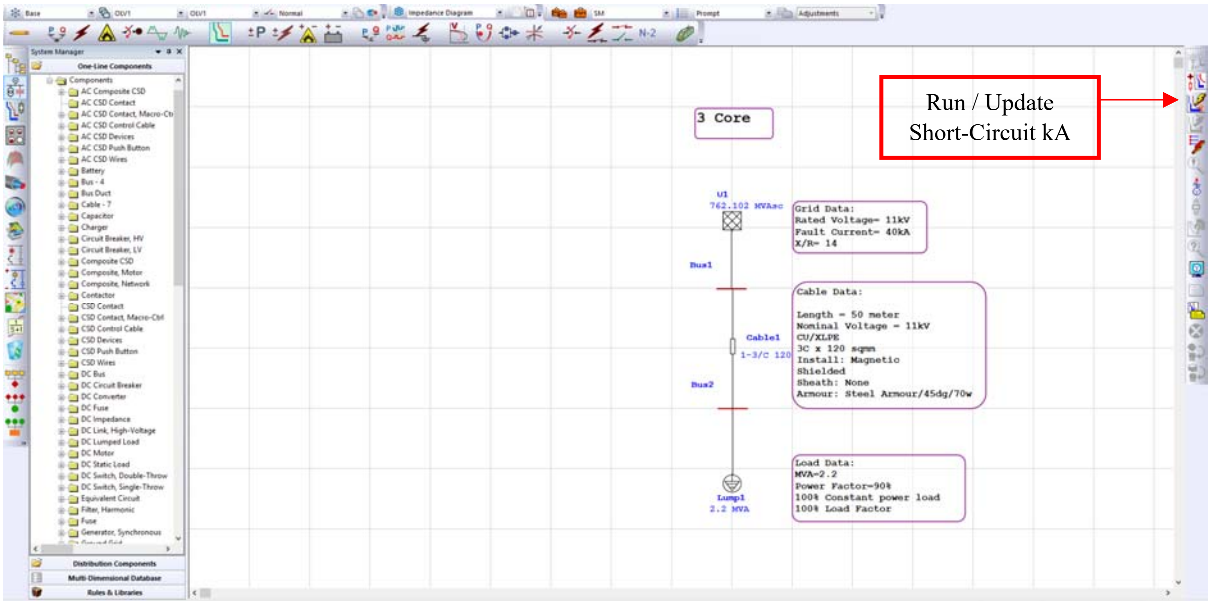


16. Cable sizing also can be done depend upon short circuit condition. To do this check protection page of cable. By default all the short circuit current values are zero.

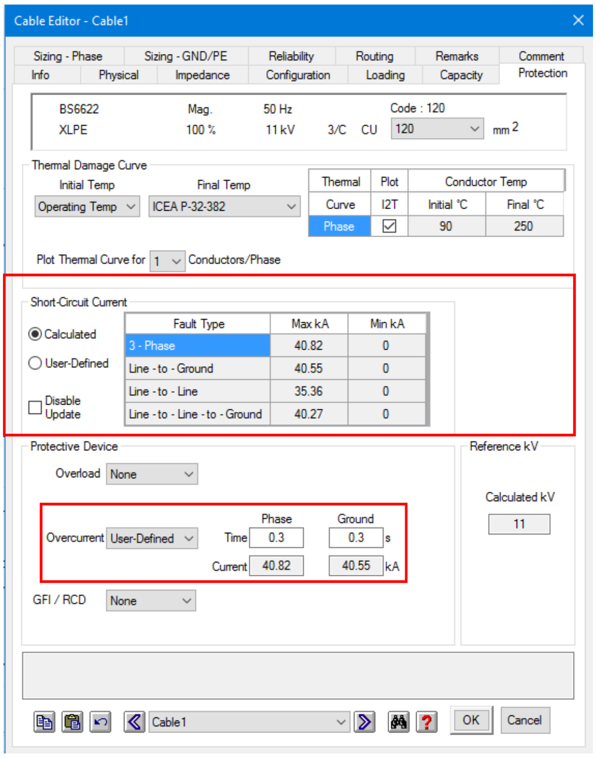


Cable Sizing

17. Go to relay co-ordination module, create a fault on bus 1 and bus 2 through Star Mode Study Case based on other default study case options, and run the Run/Update short circuit KA.

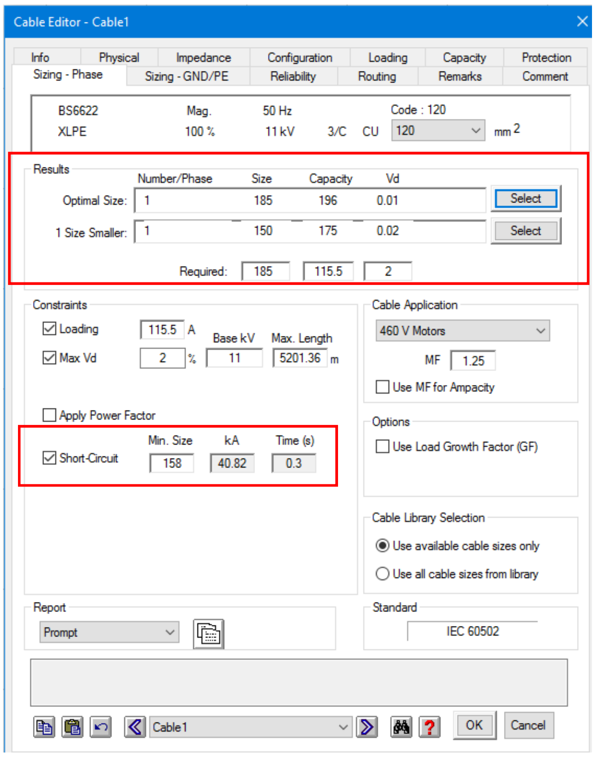


18. Go to protection page of cable, select Calculated option under Short-Circuit Current and select user defined option for Overcurrent option under Protective Device section

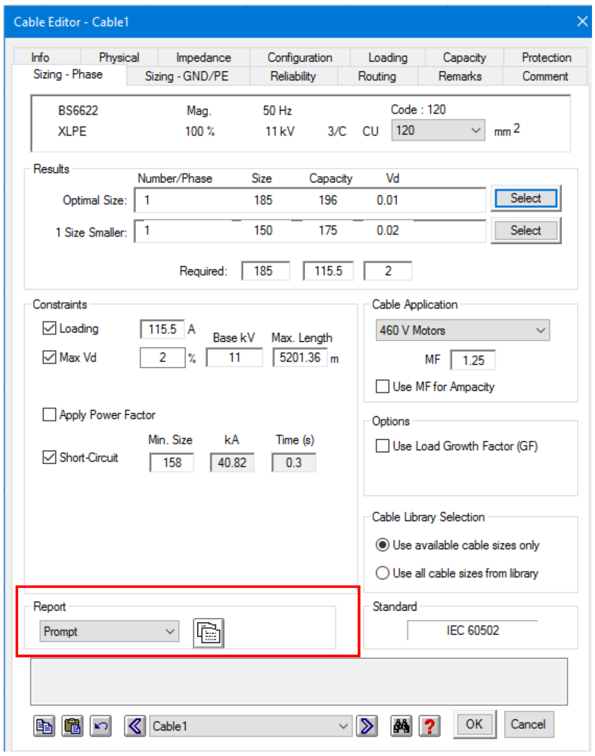


Cable Sizing

19. Go back to the sizing page of 3 core cable in Cable editor and select short circuit option under constraints section. Check new cable size calculated based on short circuit conditions.

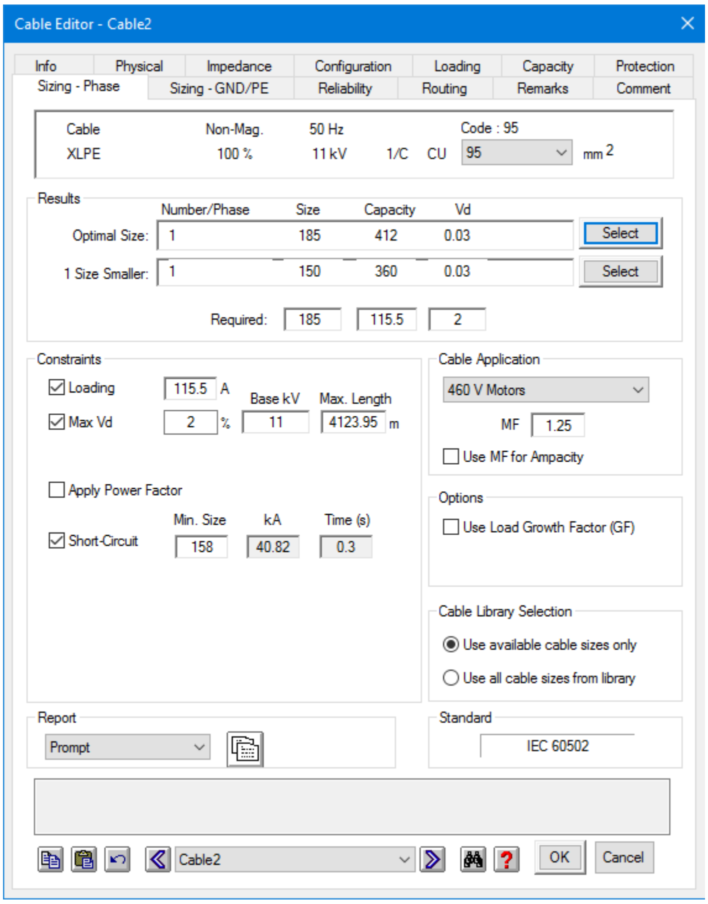


20. Check the cable sizing report by clicking on report option as shown below.



Cable Sizing

21. Repeat the cable sizing calculation for 1 Core cable selected earlier to get below mentioned results.



Annex B
(informative)

Tabulated continuous current ratings for cables having extruded insulation and a rated voltage from 3,6/6 kV up to 18/30 kV

B.1 General

This annex deals solely with the steady-state continuous current ratings of single-core and three-core cables having extruded insulation. The tabulated current ratings provided in this annex have been calculated for cables having a rated voltage of 6/10 kV and constructions as detailed in Clause B.2.

These ratings can be applied to cables of similar constructions in the voltage range of 3,6/6 kV to 18/30 kV.

Some parameters such as screen cross-sectional area and oversheath thickness have an influence on the rating of large cables. In addition, the method of screen bonding has to be taken into account in the rating of single-core cables.

The tabulated current ratings have been calculated using the methods set out in IEC 60287.

NOTE 1 For cyclic current ratings, see IEC 60853.

NOTE 2 For short-circuit temperature limits, see IEC 60986.

B.2 Cable constructions

The cable constructions and dimensions for which current ratings have been tabulated are based on those given in this standard. The constructions and dimensions used are not related to specific national designs but reflect different model cables. Armoured three-core cables are assumed to have flat wire armour and single-core cables are assumed to be unarmoured. All the cables have copper tape core screens except the single-core XLPE insulated cable, which has a copper wire screen. The nominal cross-sectional areas of the screens for the model cables is given in Table B.1.

Table B.1 – Nominal screen cross-sectional areas

Nominal area of conductor, mm²	16	25	35	50	70	95	120	150	185	240	300	400
Nominal cross-sectional area of screen, per core, mm²												
EPR insulated cable	3	3	4	4	4	5	5	5	6	6	7	8
XLPE insulated cable	16	16	16	16	16	16	16	25	25	25	25	35

The oversheath is taken to be polyethylene for the single core cables and PVC for the three-core cables.

Correction Factor tables

(By standard IEC-60502)

Table B.11 – Correction factors for ambient ground temperatures other than 20 °C

Maximum conductor temperature °C	Ambient ground temperature °C							
	10	15	25	30	35	40	45	50
90	1,07	1,04	0,96	0,93	0,89	0,85	0,80	0,76

Table B.10 – Correction factors for ambient air temperatures other than 30 °C

Maximum conductor temperature °C	Ambient air temperature °C							
	20	25	35	40	45	50	55	60
90	1,08	1,04	0,96	0,91	0,87	0,82	0,76	0,71

Table B.13 – Correction factors for depths of laying other than 0,8 m for cables in ducts

Depth of laying m	Single-core cables Nominal conductor size mm^2		Three-core cable
	≤185 mm^2	>185 mm^2	
0,5	1,04	1,05	1,03
0,6	1,02	1,03	1,02
1	0,98	0,97	0,99
1,25	0,96	0,95	0,97
1,5	0,95	0,93	0,96
1,75	0,94	0,92	0,95
2	0,93	0,91	0,94
2,5	0,91	0,89	0,93
3	0,90	0,88	0,92

Cable Sizing

Table B.17 – Correction factors for soil thermal resistivities other than 1,5 K•m/W for three-core cables in ducts

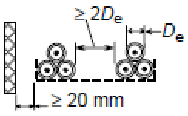
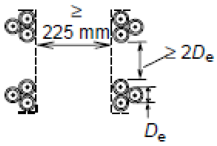
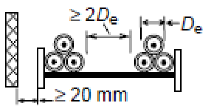
Nominal area of conductor	Values of soil thermal resistivity K•m/W						
mm^2	0,7	0,8	0,9	1	2	2,5	3
16	1,12	1,11	1,09	1,08	0,94	0,89	0,84
25	1,14	1,12	1,10	1,08	0,94	0,89	0,84
35	1,14	1,12	1,10	1,08	0,94	0,88	0,84
50	1,14	1,12	1,10	1,08	0,94	0,88	0,84
70	1,15	1,13	1,11	1,09	0,94	0,88	0,83
95	1,15	1,13	1,11	1,09	0,94	0,88	0,83
120	1,15	1,13	1,11	1,09	0,93	0,88	0,83
150	1,16	1,13	1,11	1,09	0,93	0,88	0,83
185	1,16	1,14	1,11	1,09	0,93	0,87	0,83
240	1,16	1,14	1,12	1,10	0,93	0,87	0,82
300	1,17	1,14	1,12	1,10	0,93	0,87	0,82
400	1,17	1,14	1,12	1,10	0,92	0,86	0,81

Table B.20 – Correction factors for groups of three-core cables in single way ducts in horizontal formation

Number of cables in group	Spacing between duct centres mm				
	Touching	200	400	600	800
2	0,85	0,88	0,92	0,94	0,95
3	0,75	0,80	0,85	0,88	0,91
4	0,69	0,75	0,82	0,86	0,89
5	0,65	0,72	0,79	0,84	0,87
6	0,62	0,69	0,77	0,83	0,87
7	0,59	0,67	0,76	0,82	0,86
8	0,57	0,65	0,75	0,81	-
9	0,55	0,64	0,74	0,80	-
10	0,54	0,63	0,73	-	-
11	0,52	0,62	0,73	-	-
12	0,51	0,61	0,72	-	-

Cable Sizing

Table B.23 – Reduction factors for groups of more than one circuit of single-core cables (Note 2) – To be applied to the current-carrying capacity for one circuit of single-core cables in free air

Method of installation		Number of trays	Number of three-phase circuits (Note 5) 1	2	3	Use as a multiplier to rating for
Perforated trays (Note 3)	Touching 	1	0,98	0,91	0,87	Three cables in horizontal formation
		2	0,96	0,87	0,81	
		3	0,95	0,85	0,78	
Ladder supports, cleats etc. (Note 3)	Touching 	1	1,00	0,97	0,96	Three cables in horizontal formation
		2	0,98	0,93	0,89	
		3	0,97	0,90	0,86	
Perforated trays (Note 3)		1	1,00	0,98	0,96	Three cables in trefoil formation
		2	0,97	0,93	0,89	
		3	0,96	0,92	0,86	
Vertical perforated trays (Note 4)	 Spaced	1	1,00	0,91	0,89	
		2	1,00	0,90	0,86	
Ladder supports, cleats, etc. (Note 3)		1	1,00	1,00	1,00	
		2	0,97	0,95	0,93	
		3	0,96	0,94	0,90	

60502-2 © IEC:2005 – 109 –

B.5.4 Three-core cables

Current ratings are given for three-core cables installed under the following conditions:

a) single cable in air spaced at least 0,3 times the cable diameter from any vertical surface;

b) single cable buried direct in the ground at a depth of 0,8 m;

c) single cable in a buried earthenware duct having dimensions calculated in the same manner as for the single-core cables in ducts. The depth of burial of the duct is 0,8 m.

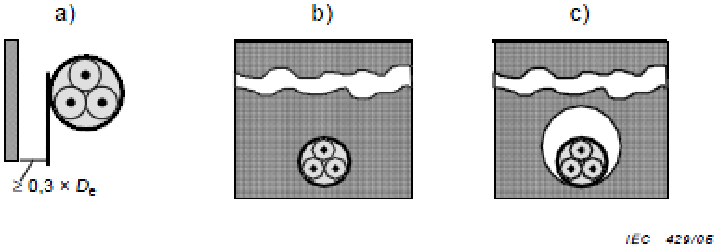


Figure B.4 – Three-core cables

B.6 Screen bonding

All the tabulated ratings for single-core cables assume that the cable screens are solidly bonded, i.e. bonded at both ends of the cables.

B.7 Cable loading

The tabulated ratings relate to circuits carrying a balanced three-phase load at a rated frequency of 50 Hz.

B.8 Rating factors for grouped circuits

The tabulated current ratings apply to a set of three single-core cables or one three-core cable forming a three-phase circuit. When a number of circuits are installed in close proximity the rating should be reduced by the appropriate factor from Tables B.18 to B.23.

These rating factors should also be applied to groups of parallel cables forming the same circuit. In such cases, attention should also be given to the arrangement of the cables to ensure that the load current is shared equally between the parallel cables.

B.9 Correction factors

The correction factors given in Tables B.10 to B.23 for temperature, installation conditions and grouping are averages over a range of conductor sizes and cable types. For particular cases, the correction factor may be calculated using the methods in IEC 60287-2-1.

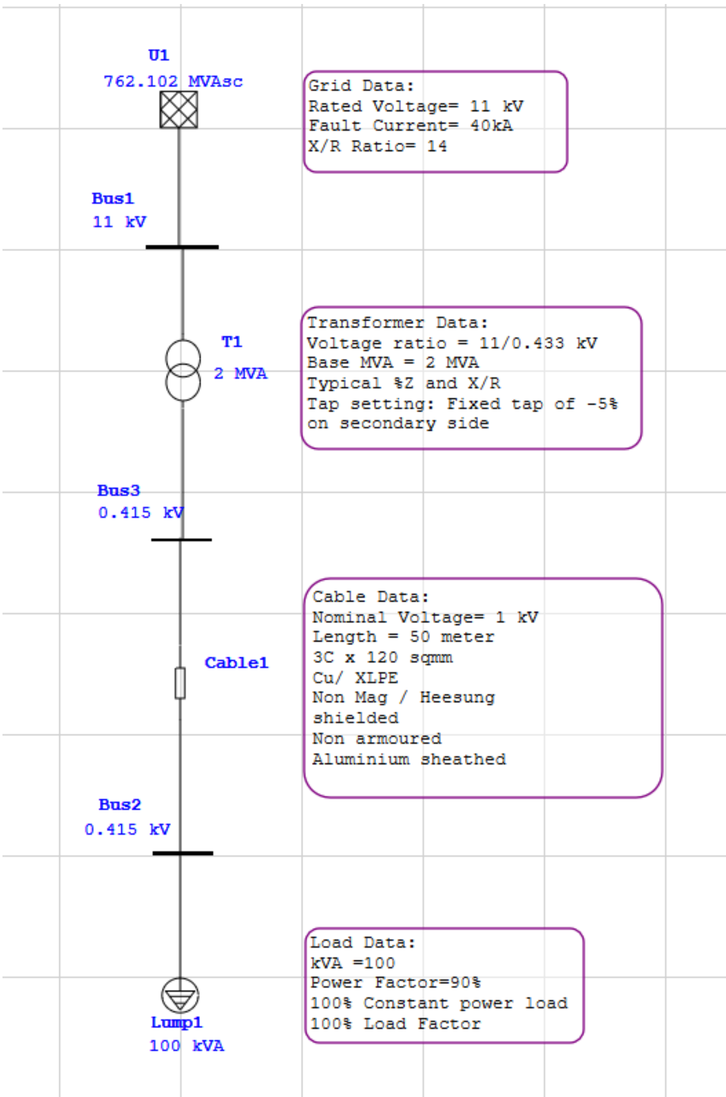
Cable Sizing

Section-II LV cable sizing (IEC-60364-5-52)

Procedure:

Case A: To identify cable de-rated ampacity

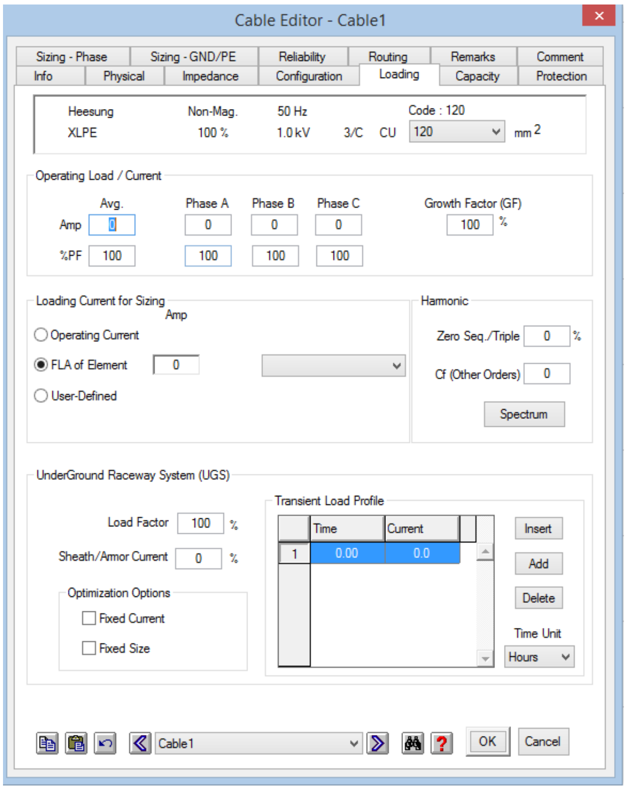
1. Create a new project with a name of 'LV cable sizing'.
2. Drag and place grid, buses, transformer, cable & lump load and connect them. Proceed to enter the input data as shown below.



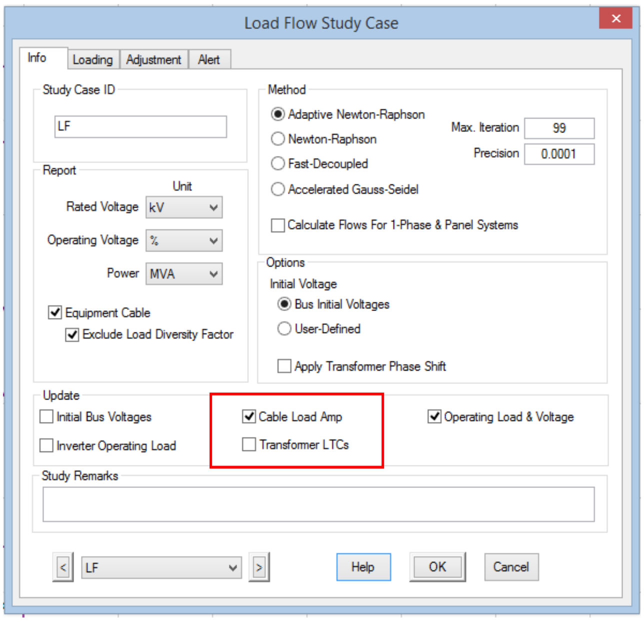
Note: According to IEC 60364-5-52, the cable must be unarmored. Please refer attached Appendix B for IEC-60364-5-52 standard.

Cable Sizing

3. Check loading page of cable in Cable Editor. All operating current values are zero.

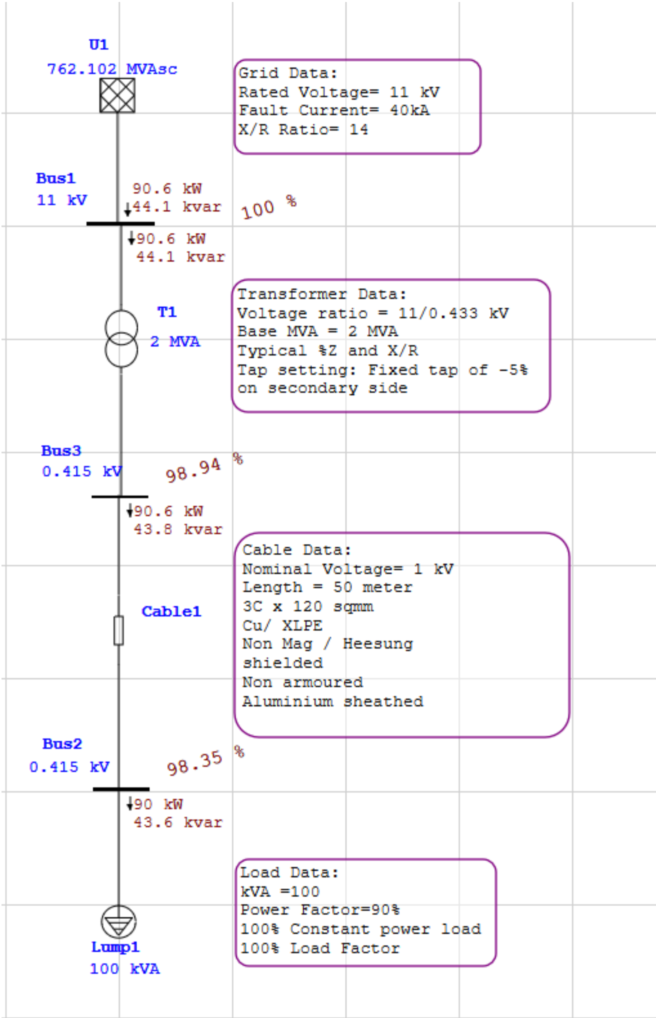


4. To update operating current in Cable Editor, go to Info page of Load Flow Study Case and select Cable Load Amp under Update section.



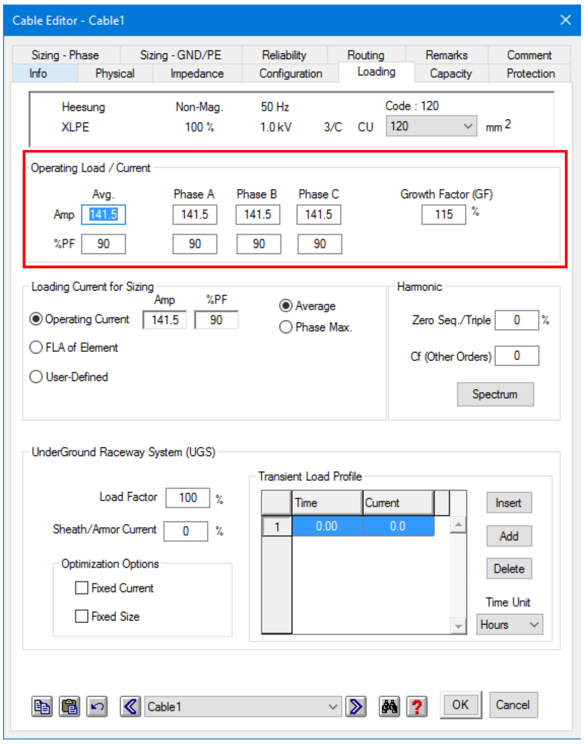
Cable Sizing

5. Run the load flow analysis on the system.

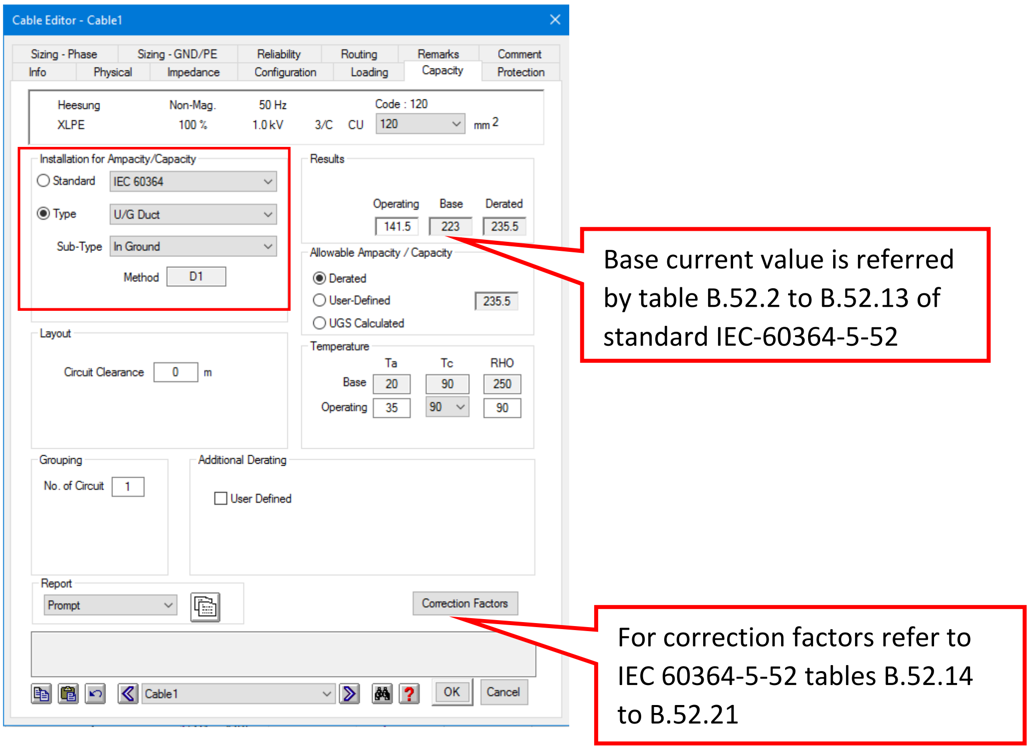


6. Check the loading page of Cable Editor. Operating current is updated in the Cable Editor. Select 'Loading current for sizing' as Operating Current and increase growth factor by 15%

Cable Sizing

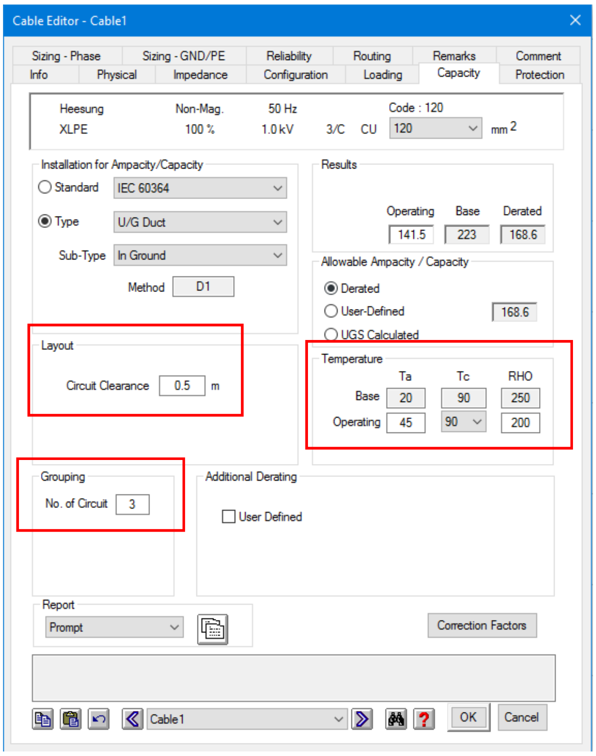


7. Go to Capacity page of Cable Editor. Choose standard as IEC 60364 and type of installation as U/G Duct.



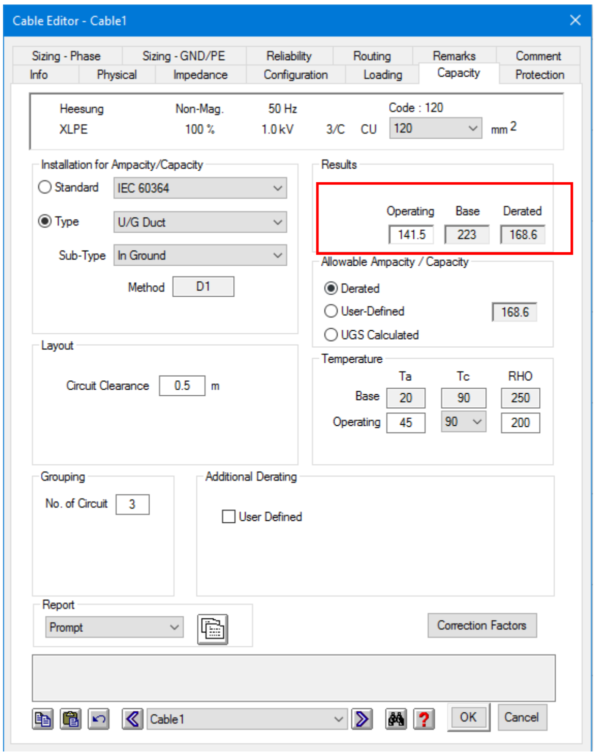
Cable Sizing

8. The capacity page shows the base current, operating current and derated current for cable. Note the de-rated current for cable is 223 A for default values of installation details. Provide Temperature, Grouping and Layout details for the cable as shown below.



9. The cable de-rated ampacity calculated is 168.6 A based on above mentioned installation conditions

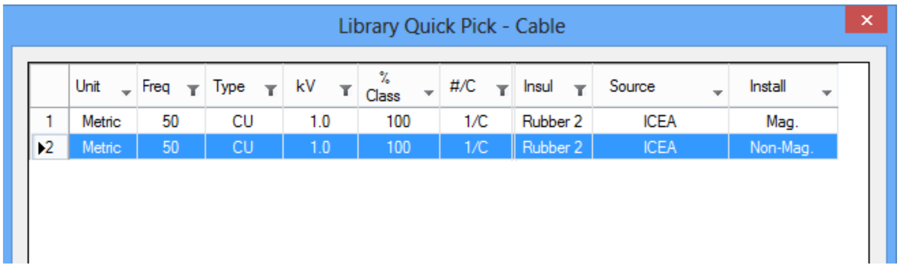
Cable Sizing



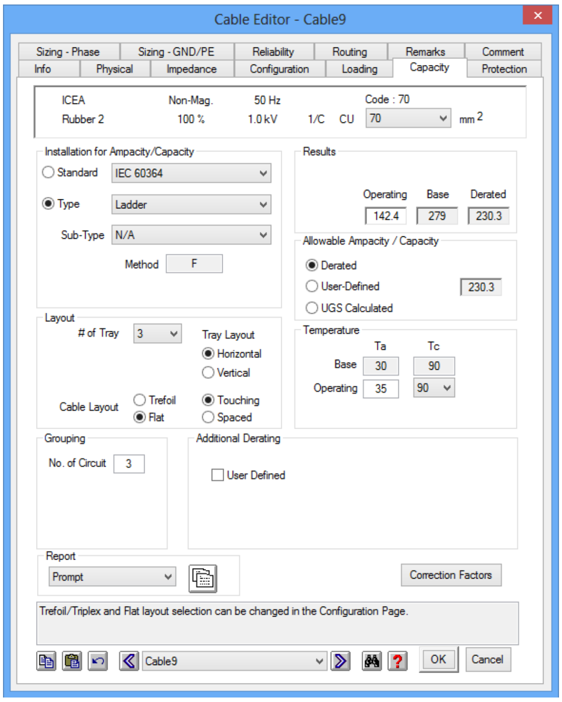
10. Follow same procedure for Single core LV cable ampacity calculation. Based on installation conditions and cable details as shown below by creating a new system for single core cable.

<u>Single Core cable details:</u>

Cable selected: 1 kV, CU, Rubber, 1/C, non mag. 70 mm^2, length 200 m, unarmored and Non-magnetic



Cable Sizing



11. Hand calculation for 3/C & 1/C de-rated ampacity of cable is as follow:

<u>Three Core Cable</u>

Cable selected: 1 kV, 3/C, CU, XLPE, Non-Mag, 120 mm^2, length 50 m, shielded, unarmored and source type - Heesung

Method of installation of cable: U/G duct

Base Ampacity of cable selected = 223 A

Following standard condition are used as per IEC-60364-5-52 for calculation of base ampacity according to table B.52.2 to B.52.13:

Maximum conductor temperature (Tc)	90 deg-C
Ambient air temperature(Ta)	30 deg-C
Ground temperature	20 deg-C
Thermal resistivity of soil (RHO)	2.50 K m/watt

Correction factor for Ambient Temperature:

Ambient Air Temperature	45 Deg C	
Derating factor	0.8	Ref. Table B.52.15 of IEC-60364-5-52

Correction factor for soil thermal resistivity:

Soil thermal resistivity	200 Deg C- cm/w	
Derating factor	1.05	Ref. Table B.52-16 of IEC 60364-5-52

Cable Sizing

Correction factor for cable laid in ducts in ground:

Circuit clearance	0.5 meter	
No of cables in the group	3	
Derating factor	0.9	Ref. Table B.52-19 of IEC 60364-5-52

De-rated Ampacity = Base current x correction factor for ambient temperature x correction factor for soil thermal resistivity x correction factor for cable laid in ducts in ground

= 223 x 0.8 x 1.05 x 0.9

= **168.56 A**

By above calculation it is clear that ETAP calculated cable ampacity is correct and as per standard IEC-60364-5-52.

<u>Single Core cable</u>

Cable selected: 1 kV, CU, Rubber, 1/C, non mag. 70 mm^2, length 200 m, unarmored

Method of installation of cable: Ladder
Base Ampacity of cable selected = 279 A

Correction factor for Ambient Temperature:

Ambient Air Temperature	35 Deg C	
Derating factor	0.96	Ref. table B.52-14 of IEC 60364-5-52

Correction factor for cables grouped together:

No of trays	3	
Tray layout	horizontal	
No of circuit	3	
Cable layout	Flat /Touching	
Derating factor	0.86	Ref. table B.52.21 of IEC 60364-5-52

De-rated Ampacity = Base current x Correction factor for Ambient Temperature x Correction factor for cables grouped together

= 279 x 0.96 x 0.86

= **230.34 A**

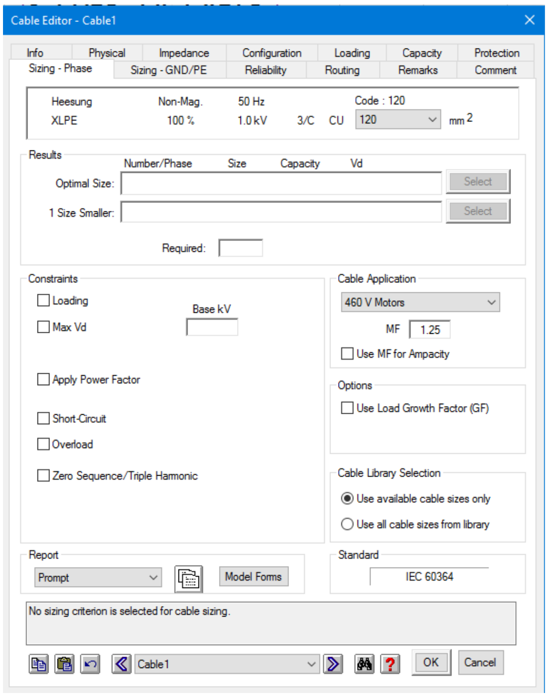
12. Similarly, de-rated cable ampacity for 3 core and 1 core cable with different types of installation method such as U/G Duct, A/G Trays (perforated) etc. can be carried out.

Cable Sizing

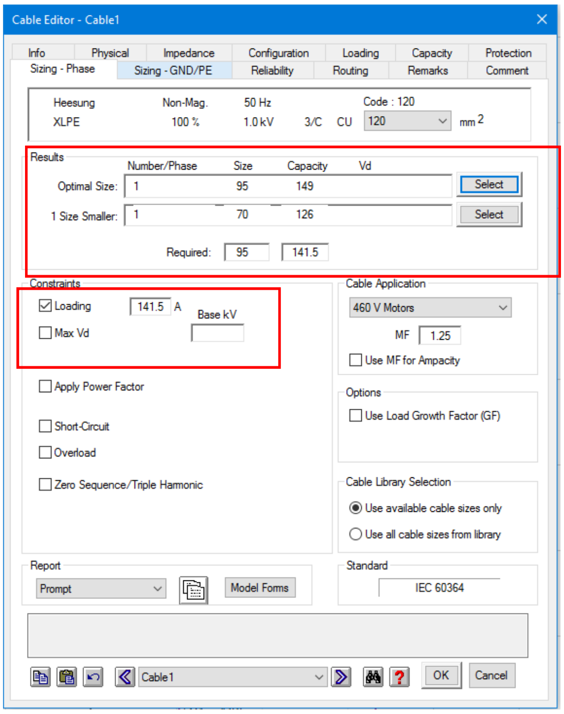
Case B: Calculation of sizing of cable

Three Core Cable Sizing

13. Check the Sizing Phase page of cable editor for 3 Core cable selected earlier

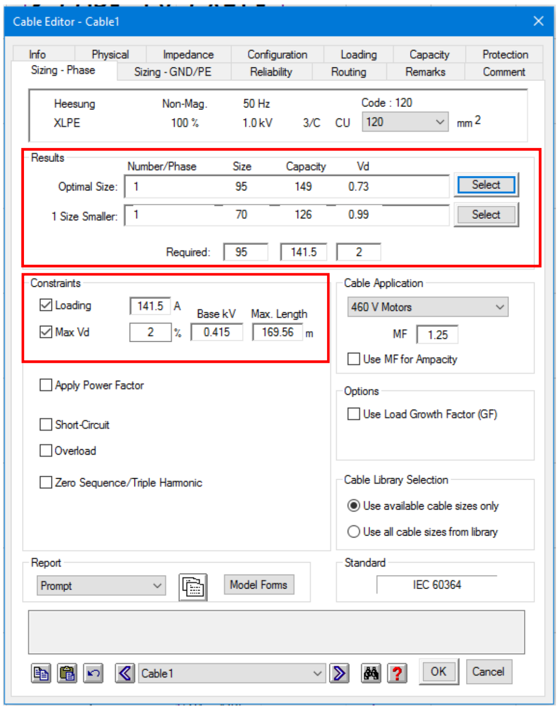


14. Select 'Loading' option under constraints section and check cable size calculated based on the current flowing through the cable.

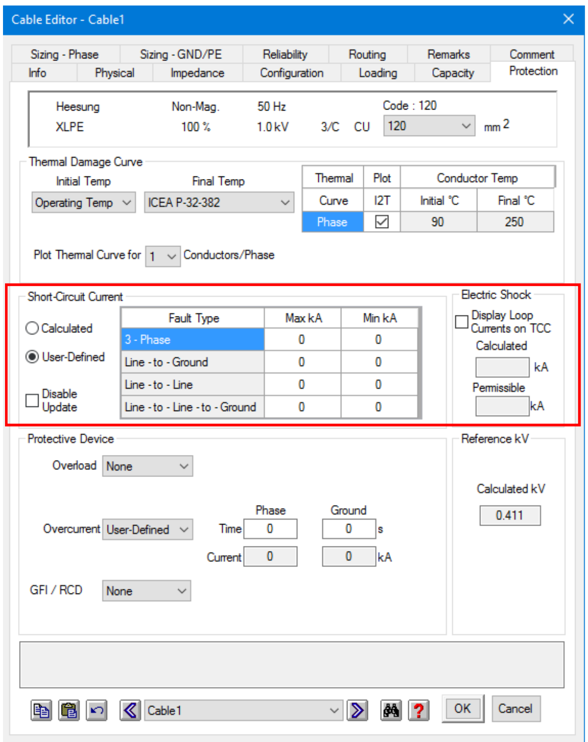


Cable Sizing

15. Select ‘Max Vd’ option under Constraints section and check the cable size calculated based on the allowable voltage drop across cable.

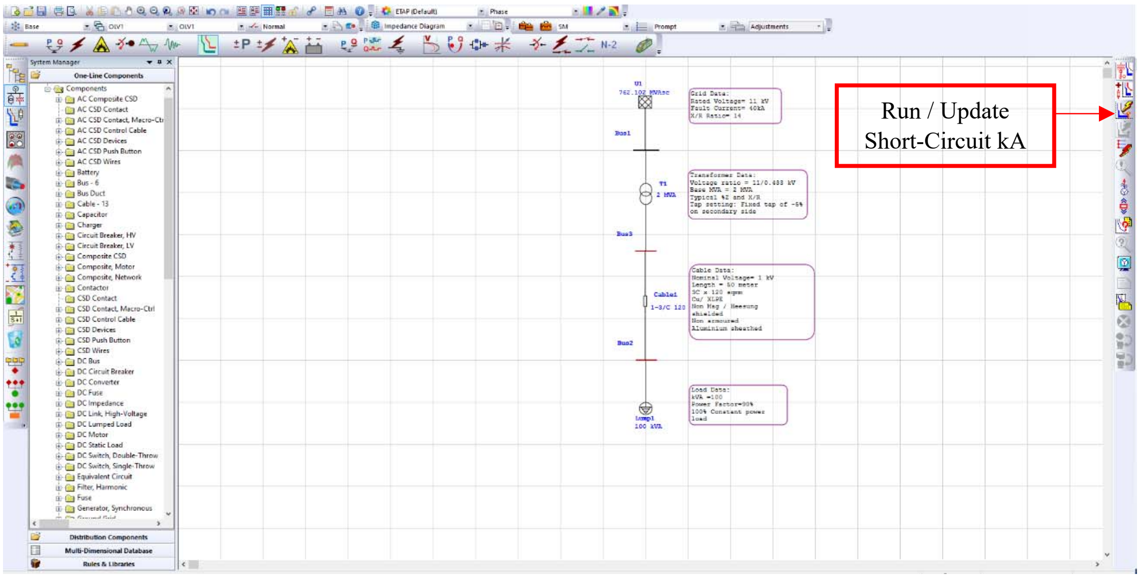


16. Cable sizing also can be done depend upon short circuit condition. To do this check protection page of cable. By default all the short circuit current values are zero.

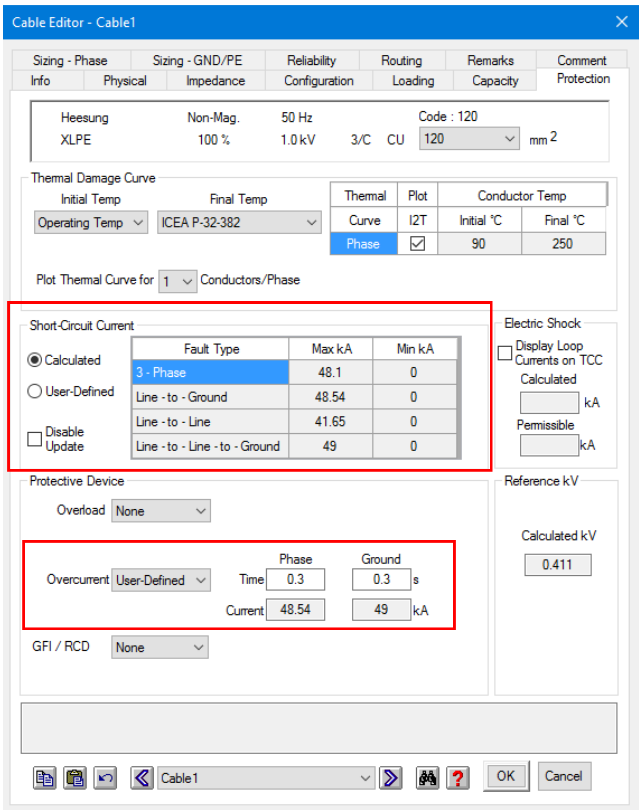


Cable Sizing

17. Go to relay co-ordination module, create a fault on bus 1 and bus 2 through Star Mode Study Case based on other default study case options, and run the Run/Update short circuit KA.

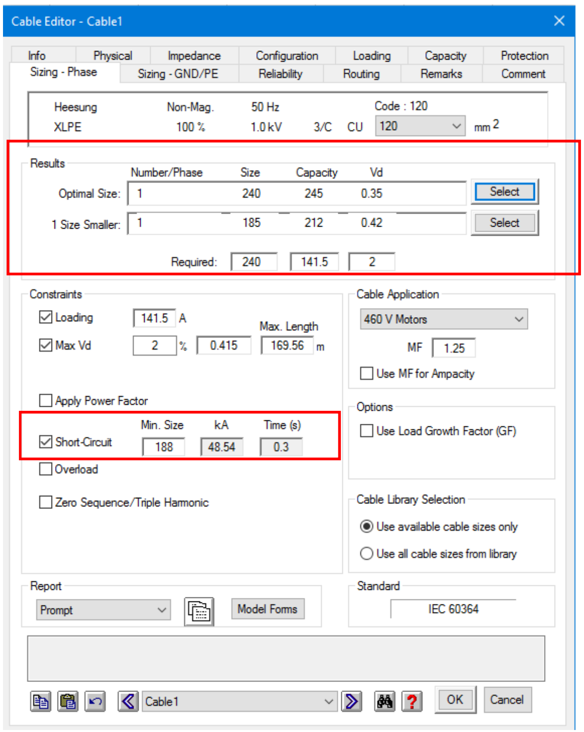


18. Go to protection page of cable, select Calculated option under Short-Circuit Current and select user defined option for Overcurrent option under Protective Device section

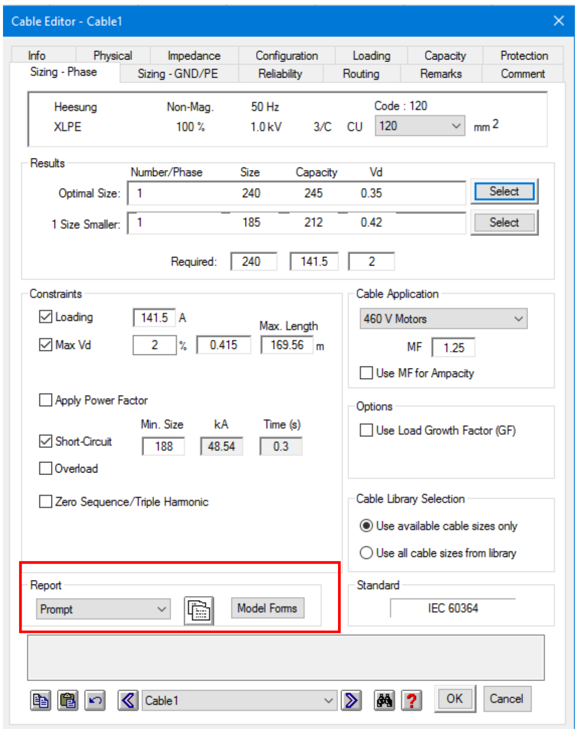


Cable Sizing

19. Go back to the sizing page of 3 core cable in Cable editor and select short circuit option under constraints section. Check new cable size calculated based on short circuit conditions.

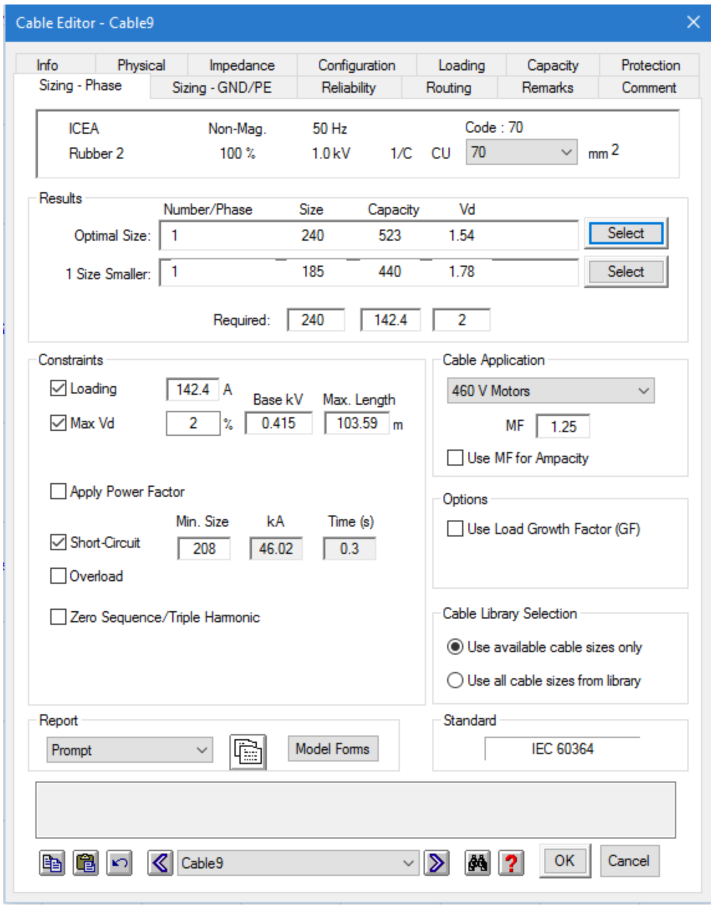


20. Check the cable sizing report by clicking on report option as shown below.



Cable Sizing

21. Repeat the cable sizing calculation for 1 core cable selected earlier to get below mentioned results.



Annex B
(informative)

Current-carrying capacities

B.52.1 Introduction

The recommendations of this annex are intended to provide for a satisfactory life of conductor and insulation subjected to the thermal effects of carrying current for prolonged periods of time in normal service. Other considerations affect the choice of the cross-sectional area of conductors, such as the requirements for protection against electric shock (IEC 60364-4-41), protection against thermal effects (IEC 60364-4-42), overcurrent protection (IEC 60364-4-43), voltage drop (Clause 525 of this standard), and limiting temperatures for terminals of equipment to which the conductors are connected (Clause 526 of this standard).

For the time being, this annex relates to non-armoured cables and insulated conductors having a nominal voltage not exceeding 1 kV a.c. or 1,5 kV d.c. This annex may be applied for armoured multi-core cables but does not apply to armoured single-core cables.

NOTE 1 If armoured single-core cables are used, an appreciable reduction of the current-carrying capacities given in this annex may be required. The cable supplier should be consulted. This is also applicable to non-armoured single-core cables in single way metallic ducts (see 521.5).

NOTE 2 If armoured multi-core cables are used, the values given in this annex will be on the safe side.

NOTE 3 Current-carrying capacities of insulated conductors are the same as for single core cables.

The values in Tables B.52.2 to B.52.13 apply to cables without armour and have been derived in accordance with the methods given in the IEC 60287 series using such dimensions as specified in IEC 60502 and conductor resistances given in IEC 60228. Known practical variations in cable construction (e.g. form of conductor) and manufacturing tolerances result in a spread of possible dimensions and hence current-carrying capacities for each conductor size. Tabulated current-carrying capacities have been selected so as to take account of this spread of values with safety and to lie on a smooth curve when plotted against conductor cross-sectional area.

For multi-core cables having conductors with a cross-sectional area of 25 mm^2 or larger, either circular or shaped conductors are permissible. Tabulated values have been derived from dimensions appropriate to shaped conductors.

B.52.2 Ambient temperature

B.52.2.1 The current-carrying capacities tabulated in this annex assume the following reference ambient temperatures:

– for insulated conductors and cables in air, irrespective of the method of installation: 30 °C;

– for buried cables, either directly in the soil or in ducts in the ground: 20 °C.

B.52.2.2 Where the ambient temperature in the intended location of the insulated conductors or cables differs from the reference ambient temperature, the appropriate correction factor given in Tables B.52.14 and B.52.15 shall be applied to the values of current-carrying capacity set out in Tables B.52.2 to B.52.13. For buried cables, further correction is not needed if the soil temperature exceeds the chosen ambient temperature by an amount up to 5 K for only a few weeks a year.

NOTE For cables and insulated conductors in air, where the ambient temperature occasionally exceeds the reference ambient temperature, the possible use of the tabulated current-carrying capacities without correction is under consideration.

Correction Factor tables

(By standard IEC-60364-5-52)

Table B.52.14 – Correction factor for ambient air temperatures other than 30 °C to be applied to the current-carrying capacities for cables in the air

Ambient temperature[a] °C	Insulation			
			Mineral[a]	
	PVC	XLPE and EPR	PVC covered or bare and exposed to touch 70 °C	Bare not exposed to touch 105 °C
10	1,22	1,15	1,26	1,14
15	1,17	1,12	1,20	1,11
20	1,12	1,08	1,14	1,07
25	1,06	1,04	1,07	1,04
30	1,00	1,00	1,00	1,00
35	0,94	0,96	0,93	0,96
40	0,87	0,91	0,85	0,92
45	0,79	0,87	0,78	0,88
50	0,71	0,82	0,67	0,84
55	0,61	0,76	0,57	0,80
60	0,50	0,71	0,45	0,75
65	–	0,65	–	0,70
70	–	0,58	–	0,65
75	–	0,50	–	0,60
80	–	0,41	–	0,54
85	–	–	–	0,47
90	–	–	–	0,40
95	–	–	–	0,32

[a] For higher ambient temperatures, consult the manufacturer.

Table B.52.15 – Correction factors for ambient ground temperatures other than 20 °C to be applied to the current-carrying capacities for cables in ducts in the ground

Ground temperature °C	Insulation	
	PVC	XLPE and EPR
10	1,10	1,07
15	1,05	1,04
20	1,00	1,00
25	0,95	0,96
30	0,89	0,93
35	0,84	0,89
40	0,77	0,85
45	0,71	0,80
50	0,63	0,76
55	0,55	0,71
60	0,45	0,65
65	–	0,60
70	–	0,53
75	–	0,46
80	–	0,38

Table B.52.16 – Correction factors for cables buried direct in the ground or in buried ducts for soil thermal resistivities other than 2,5 K · m/W to be applied to the current-carrying capacities for reference method D

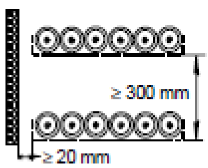
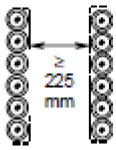
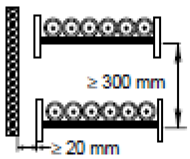
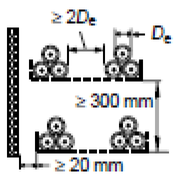
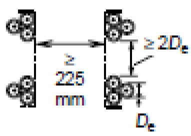
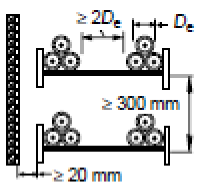
Thermal resistivity, K · m/W	0,5	0,7	1	1,5	2	2,5	3
Correction factor for cables in buried ducts	1,28	1,20	1,18	1,1	1,05	1	0,96
Correction factor for direct buried cables	1,88	1,62	1,5	1,28	1,12	1	0,90

Table B.52.19 – Reduction factors for more than one circuit, cables laid in ducts in the ground – Installation method D1 in Tables B.52.2 to B.52.5

A) Multi-core cables in single-way ducts				
Number of cables	Duct to duct clearance[a]			
	Nil (ducts touching)	0,25 m	0,5 m	1,0 m
2	0,85	0,90	0,95	0,95
3	0,75	0,85	0,90	0,95
4	0,70	0,80	0,85	0,90
5	0,65	0,80	0,85	0,90
6	0,60	0,80	0,80	0,90
7	0,57	0,76	0,80	0,88
8	0,54	0,74	0,78	0,88
9	0,52	0,73	0,77	0,87
10	0,49	0,72	0,76	0,86
11	0,47	0,70	0,75	0,86
12	0,45	0,69	0,74	0,85
13	0,44	0,68	0,73	0,85
14	0,42	0,68	0,72	0,84
15	0,41	0,67	0,72	0,84
16	0,39	0,66	0,71	0,83
17	0,38	0,65	0,70	0,83
18	0,37	0,65	0,70	0,83
19	0,35	0,64	0,69	0,82
20	0,34	0,63	0,68	0,82

Cable Sizing

Table B.52.21 – Reduction factors for groups of one or more circuits of single-core cables to be applied to reference current-carrying capacity for one circuit of single-core cables in free air – Method of installation F in Tables B.52.8 to B.52.13

Method of installation in Table A.52.3			Number of trays or ladders	Number of three-phase circuits per tray or ladder			Use as a multiplier to current-carrying capacity for
				1	2	3	
Perforated cable tray systems (note 3)	31	Touching 	1 2 3	0,98 0,96 0,95	0,91 0,87 0,85	0,87 0,81 0,78	Three cables in horizontal formation
Vertical perforated cable tray systems (note 4)	31	Touching 	1 2	0,96 0,95	0,86 0,84	– –	Three cables in vertical formation
Cable ladder systems, cleats, etc. (note 3)	32 33 34	Touching 	1 2 3	1,00 0,98 0,97	0,97 0,93 0,90	0,96 0,89 0,86	Three cables in horizontal formation
Perforated cable tray systems (note 3)	31		1 2 3	1,00 0,97 0,96	0,98 0,93 0,92	0,96 0,89 0,86	Three cables in trefoil formation
Vertical perforated cable tray systems (note 4)	31	Spaced 	1 2	1,00 1,00	0,91 0,90	0,89 0,86	
Cable ladder systems, cleats, etc. (note 3)	32 33 34		1 2 3	1,00 0,97 0,96	1,00 0,95 0,94	1,00 0,93 0,90	