

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 mm² cable will have a higher current carrying capacity than a 5 mm² 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

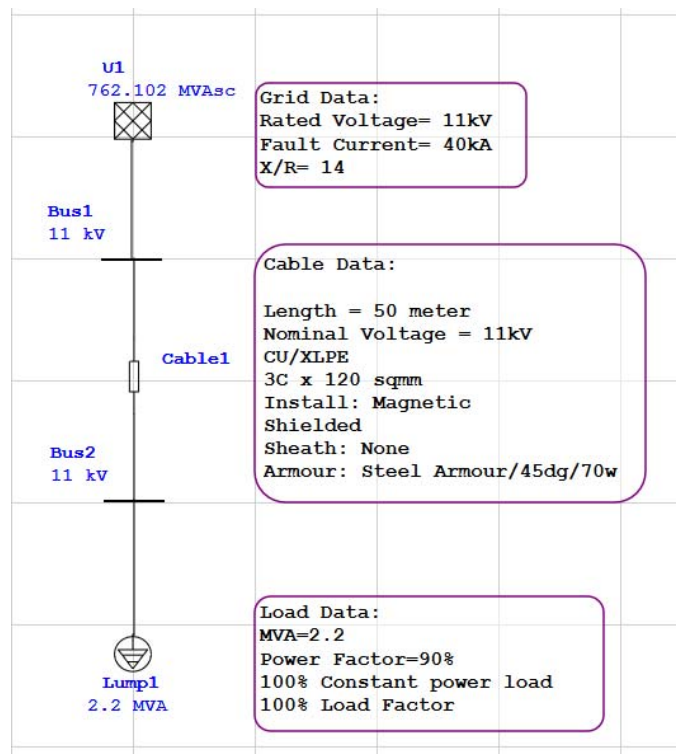
The purpose of this exercise is to calculate ampacity of a HV and LV cable as per IEC standards 60502-2 and 60364-5-52 respectively and to size the cable by considering different constraints.

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.

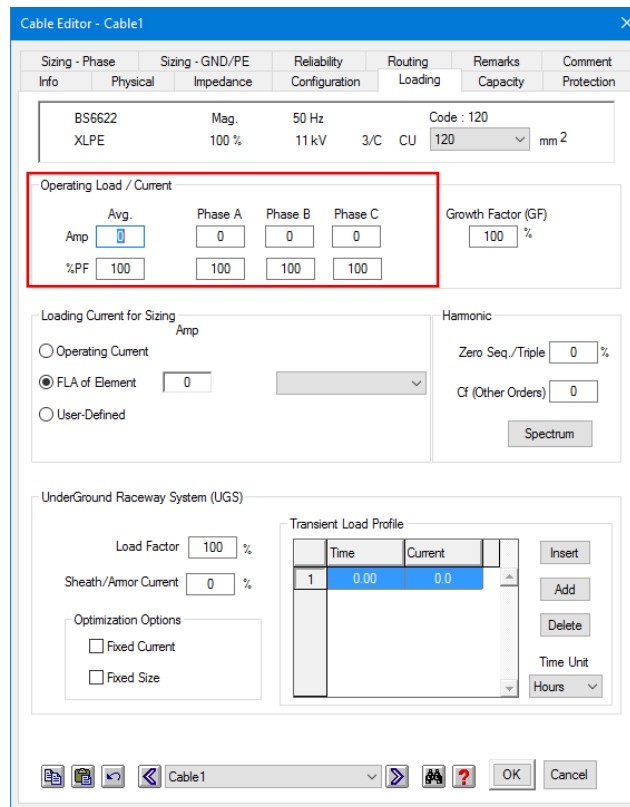


Note: According to IEC 60502-2, the cable must be shielded (and unarmored if 1/C). Refer attached Appendix B for IEC-60502-2 standard.

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.



Sizing - Phase		Sizing - GND/PE		Reliability	Routing	Remarks	Comment
Info	Physical	Impedance	Configuration	Loading	Capacity	Protection	
BS6622	Mag.	50 Hz	Code : 120				
XLPE	100 %	11 kV	3/C CU	120	mm ²		

Operating Load / Current					Growth Factor (GF)
Avg.	Phase A	Phase B	Phase C		
Amp 0	0	0	0		100 %
%PF 100	100	100	100		

Loading Current for Sizing

☐ Operating Current

☒ FLA of Element 0

☐ User-Defined

Harmonic

Zero Seq./Triple 0 %

Cf (Other Orders) 0

Spectrum

UnderGround Raceway System (UGS)

Load Factor 100 %

Sheath/Armor Current 0 %

Optimization Options

☐ Fixed Current

☐ Fixed Size

Transient Load Profile		
Time	Current	
1	0.00	0.0

Insert

Add

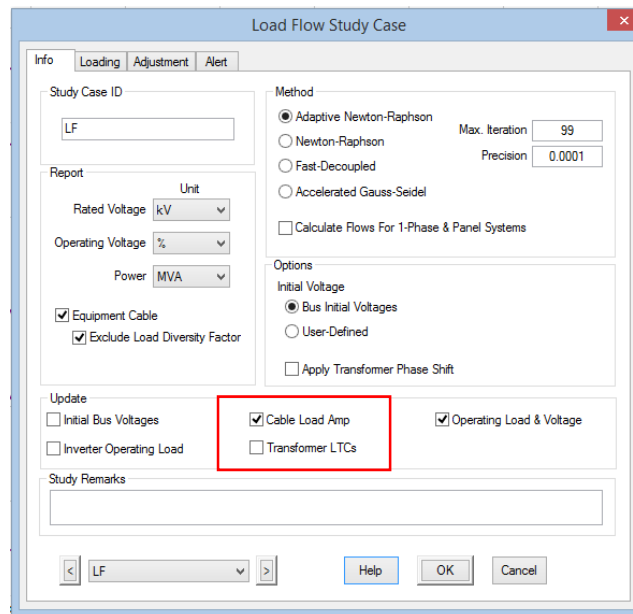
Delete

Time Unit

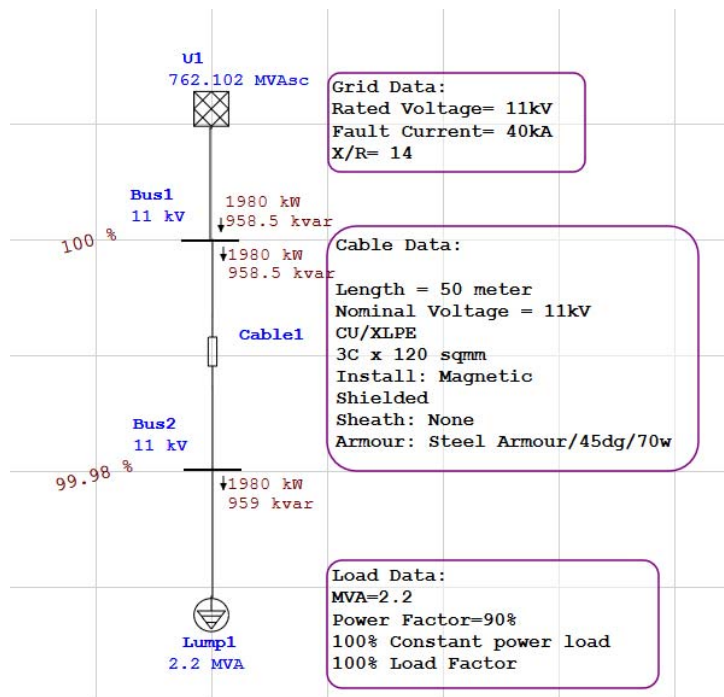
Hours

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

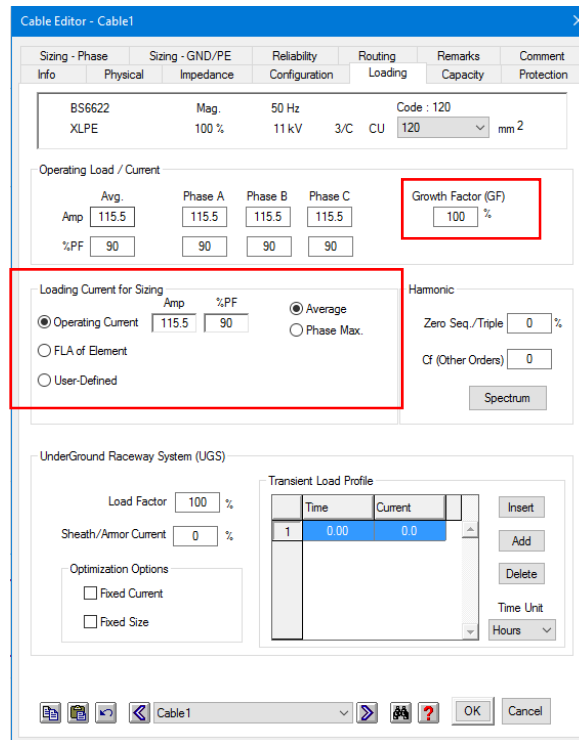


5. Run the load flow analysis on the system.



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



Cable Editor - Cable1

Sizing - Phase	Sizing - GND/PE	Reliability	Routing	Remarks	Comment
Info	Physical	Impedance	Configuration	Loading	Capacity
BS6622 XLPE	Mag. 100 %	50 Hz 11 kV	3/C CU	Code : 120 120	mm ²

Operating Load / Current

Avg.	Phase A	Phase B	Phase C	Growth Factor (GF)
Amp 115.5	115.5	115.5	115.5	100 %
%PF 90	90	90	90	

Loading Current for Sizing

☒ Operating Current Amp: 115.5 %PF: 90 ☒ Average
☐ FLA of Element ☐ Phase Max.
☐ User-Defined

UnderGround Raceway System (UGS)

Load Factor: 100 %
 Sheath/Armor Current: 0 %

Optimization Options:
☐ Fixed Current
☐ Fixed Size

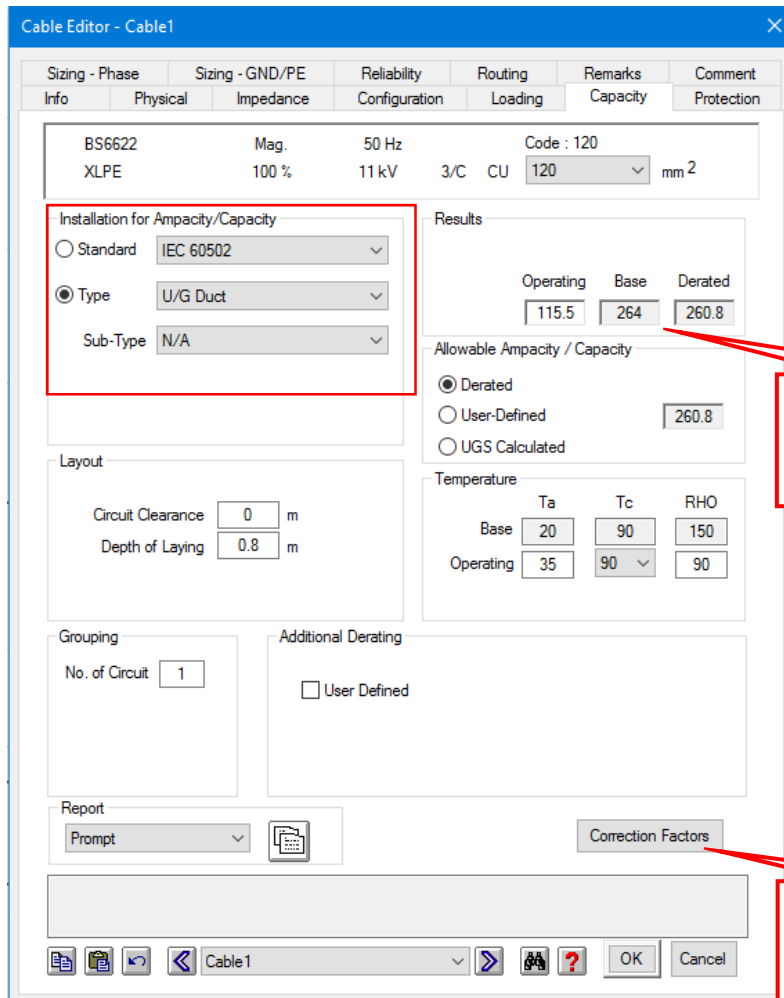
Transient Load Profile

Time	Current
1 0.00	0.0

Buttons: Insert, Add, Delete, Time Unit (Hours), Spectrum, OK, Cancel

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

Cable Sizing



Cable Editor - Cable1

Sizing - Phase	Sizing - GND/PE	Reliability	Routing	Remarks	Comment
Info	Physical	Impedance	Configuration	Loading	Capacity

BS6622 Mag. 50 Hz Code : 120
XLPE 100 % 11 kV 3/C CU 120 mm²

Installation for Ampacity/Capacity

☐ Standard IEC 60502
☒ Type U/G Duct
Sub-Type N/A

Results

Operating	Base	Derated
115.5	264	260.8

Allowable Ampacity / Capacity

☒ Derated
☐ User-Defined 260.8
☐ UGS Calculated

Temperature

	Ta	Tc	RHO
Base	20	90	150
Operating	35	90	90

Layout

Circuit Clearance 0 m
Depth of Laying 0.8 m

Grouping

No. of Circuit 1

Additional Derating

☐ User Defined

Report

Prompt

Correction Factors

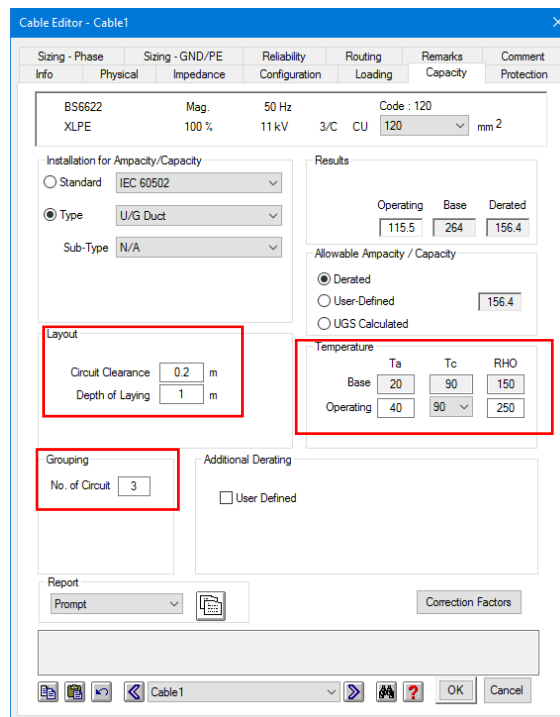
OK Cancel

For base current value refer to table B.6 to B.9 of standard IEC 60502-2.

For correction factors refer to IEC 60502-2 tables B.10 to B.23

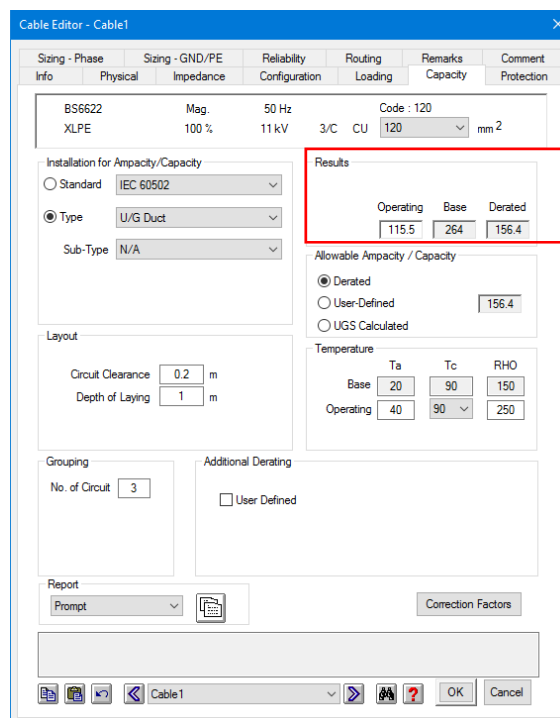
- The capacity page shows the base current, operating current and derated current for cable. Note the de-rated current for cable is 260.8 A for default values of installation details. Provide Temperature, Grouping and Layout details for the cable as shown below.

Cable Sizing



Sizing - Phase	Sizing - GND/PE	Reliability	Routing	Remarks	Comment												
Info	Physical	Impedance	Configuration	Loading	Capacity												
BS6622 XLPE	Mag. 100 %	50 Hz 11 kV	3/C CU	Code : 120 120	mm ²												
Installation for Ampacity/Capacity <input type="radio"/> Standard IEC 60502 <input checked="" type="radio"/> Type U/G Duct Sub-Type N/A																	
Layout Circuit Clearance 0.2 m Depth of Laying 1 m																	
Grouping No. of Circuit 3																	
Results Operating 115.5 Base 264 Derated 156.4																	
Allowable Ampacity / Capacity <input checked="" type="radio"/> Derated <input type="radio"/> User-Defined 156.4 <input type="radio"/> UGS Calculated																	
Temperature <table border="1"> <thead> <tr> <th></th> <th>Ta</th> <th>Tc</th> <th>RHO</th> </tr> </thead> <tbody> <tr> <td>Base</td> <td>20</td> <td>90</td> <td>150</td> </tr> <tr> <td>Operating</td> <td>40</td> <td>90</td> <td>250</td> </tr> </tbody> </table>							Ta	Tc	RHO	Base	20	90	150	Operating	40	90	250
	Ta	Tc	RHO														
Base	20	90	150														
Operating	40	90	250														

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



Sizing - Phase	Sizing - GND/PE	Reliability	Routing	Remarks	Comment												
Info	Physical	Impedance	Configuration	Loading	Capacity												
BS6622 XLPE	Mag. 100 %	50 Hz 11 kV	3/C CU	Code : 120 120	mm ²												
Installation for Ampacity/Capacity <input type="radio"/> Standard IEC 60502 <input checked="" type="radio"/> Type U/G Duct Sub-Type N/A																	
Results Operating 115.5 Base 264 Derated 156.4																	
Allowable Ampacity / Capacity <input checked="" type="radio"/> Derated <input type="radio"/> User-Defined 156.4 <input type="radio"/> UGS Calculated																	
Temperature <table border="1"> <thead> <tr> <th></th> <th>Ta</th> <th>Tc</th> <th>RHO</th> </tr> </thead> <tbody> <tr> <td>Base</td> <td>20</td> <td>90</td> <td>150</td> </tr> <tr> <td>Operating</td> <td>40</td> <td>90</td> <td>250</td> </tr> </tbody> </table>							Ta	Tc	RHO	Base	20	90	150	Operating	40	90	250
	Ta	Tc	RHO														
Base	20	90	150														
Operating	40	90	250														

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

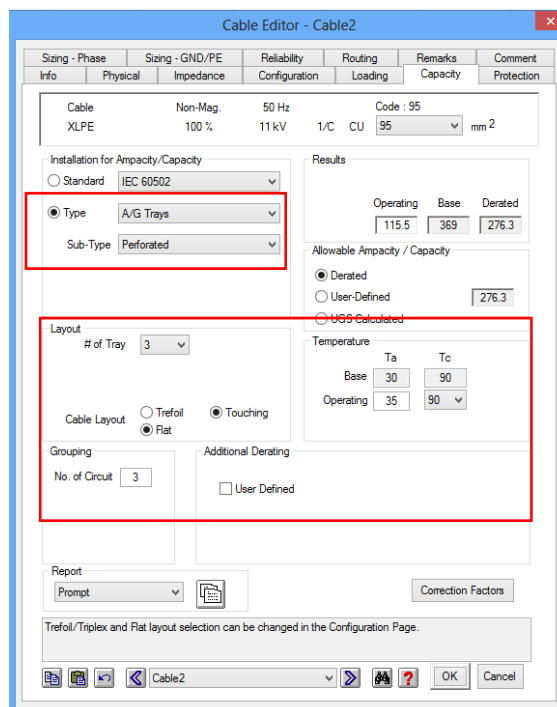
Single Core cable details:

Cable selected: 11 kV, CU, XLPE, 1/C, non mag., 95 mm², 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	Pys BS6622	Non-Mag.

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



The image shows the 'Cable Editor - Cable2' dialog box. It has several tabs: Sizing - Phase, Sizing - GND/PE, Reliability, Routing, Remarks, and Comment. The 'Sizing - Phase' tab is active. It contains fields for Cable (Non-Mag, 50 Hz, 11 kV, 1/C, CU, Code: 95, 95 mm²), Installation for Ampacity/Capacity (Standard, IEC 60502), Type (A/G Trays), Sub-Type (Perforated), Layout (# of Tray: 3, Cable Layout: Trefoil, Touching, Flat), Grouping (No. of Circuit: 3), and Additional Derating (User Defined). The Results section shows Operating, Base, and Derated ampacity values. The Temperature section shows Ta, Tc, Base, and Operating values. The Report section has a Prompt dropdown and a Correction Factors button. The bottom of the dialog has a status bar with icons and the text 'Trefoil/Tripex and Flat layout selection can be changed in the Configuration Page.'

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

Three Core Cable

Cable selected: 11 kV, 3/C, CU, XLPE, Magnetic, 120 mm², 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

$$\begin{aligned}
 \text{De-rated Ampacity} &= \text{Base current} \times \text{correction factor for ambient temperature} \times \text{Correction factor for depth of laying for 3/C cable} \times \text{correction factor for soil thermal resistivity} \times \text{correction factor for grouping of cables} \\
 &= 264 \times 0.85 \times 0.99 \times 0.88 \times 0.80 \\
 &= \mathbf{156.39 \text{ A}}
 \end{aligned}$$

Cable Sizing

Single Core cable

Cable selected: 11 kV, CU, XLPE, 1/C, non mag., 95 mm², 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

$$\begin{aligned}
 \text{De-rated Ampacity} &= \text{Base current} \times \text{Correction factor for Ambient Temperature} \times \text{Correction factor for cables grouped together} \\
 &= 369 \times 0.96 \times 0.78 \\
 &= \mathbf{276.3 \text{ A}}
 \end{aligned}$$

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.

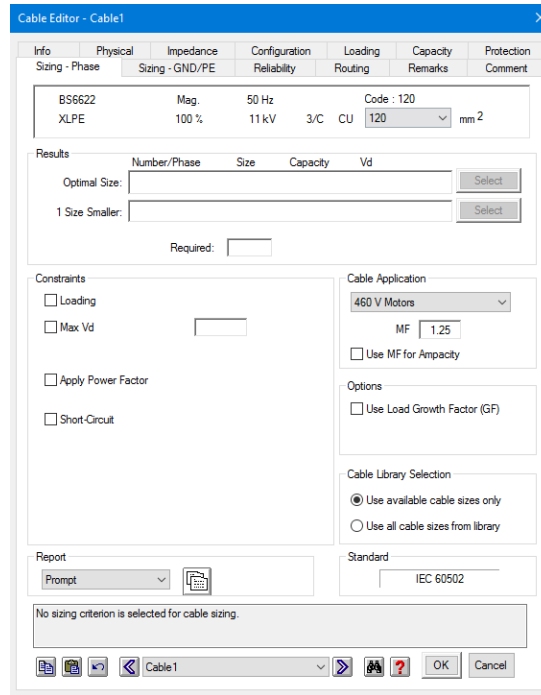
Note - single core HV cable sizing can be done only for non-armored type cable as mentioned in standard 60502-2

Cable Sizing

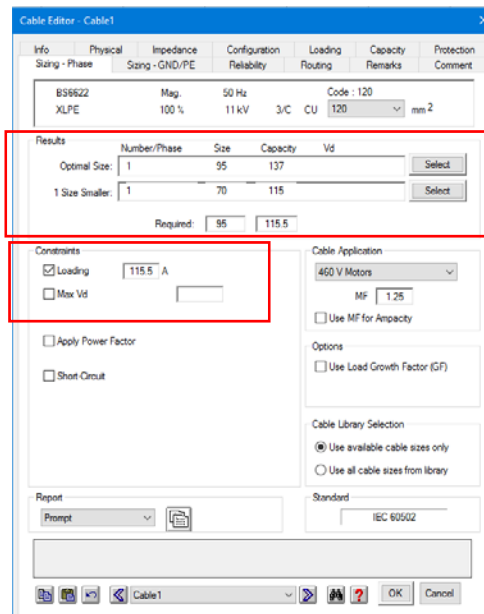
Case B: Calculation of sizing of cable

Three Core Cable Sizing

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

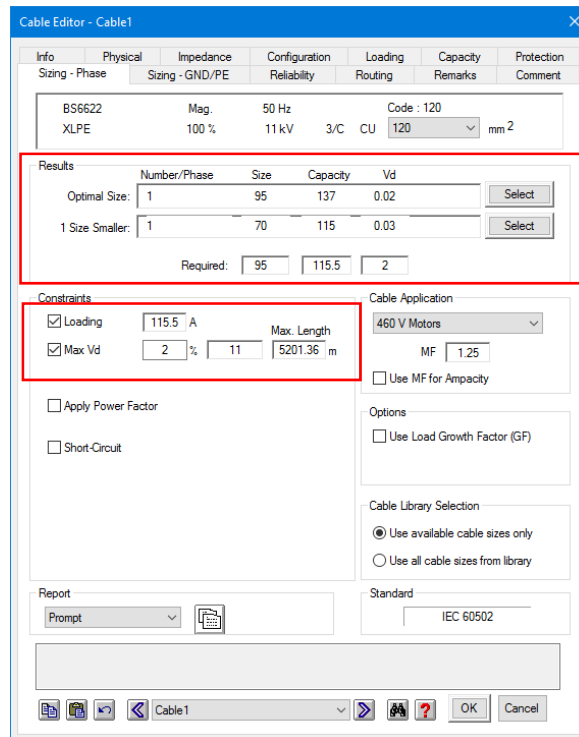


14. Select 'Loading' option under constraints section and check cable size calculated based on the current flowing through the cable.



Cable Sizing

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



Cable Editor - Cable1

Info Physical Impedance Configuration Loading Capacity Protection
Sizing - Phase Sizing - GND/PE Reliability Routing Remarks Comment

BS6622 Mag. 50 Hz Code : 120
XLPE 100 % 11 kV 3/C CU 120 mm²

Results

	Number/Phase	Size	Capacity	Vd
Optimal Size:	1	95	137	0.02
1 Size Smaller:	1	70	115	0.03

Required: 95 115.5 2

Constraints

☒ Loading 115.5 A Max. Length 5201.36 m
☒ Max Vd 2 % 11

☐ Apply Power Factor
☐ Short-Circuit

Cable Application

460 V Motors
 MF 1.25
☐ Use MF for Ampacity

Options

☐ Use Load Growth Factor (GF)

Cable Library Selection

☒ Use available cable sizes only
☐ Use all cable sizes from library

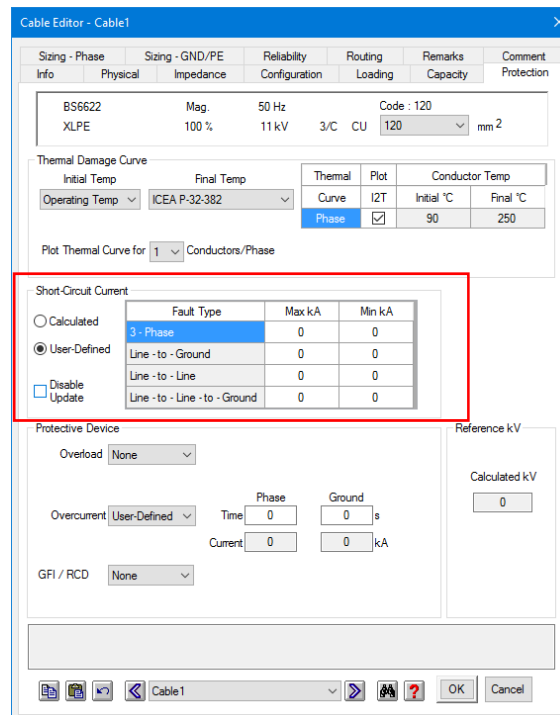
Standard

IEC 60502

Report Prompt

OK Cancel

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 Editor - Cable1

Sizing - Phase Sizing - GND/PE Reliability Routing Remarks Comment
Info Physical Impedance Configuration Loading Capacity Protection

BS6622 Mag. 50 Hz Code : 120
XLPE 100 % 11 kV 3/C CU 120 mm²

Thermal Damage Curve

Initial Temp Final Temp
 Operating Temp ICEA P-32-382
 Thermal Plot Conductor Temp
 Curve I2T Initial °C Final °C
 Phase 90 250

Plot Thermal Curve for 1 Conductors/Phase

Short-Circuit Current

☐ Calculated
☒ User-Defined
☐ Disable Update

Fault Type	Max kA	Min kA
3 - Phase	0	0
Line - to - Ground	0	0
Line - to - Line	0	0
Line - to - Line - to - Ground	0	0

Protective Device

Overload None
 Overcurrent User-Defined
 Phase Time 0 s
 Ground Current 0 kA
 GFI / RCD None

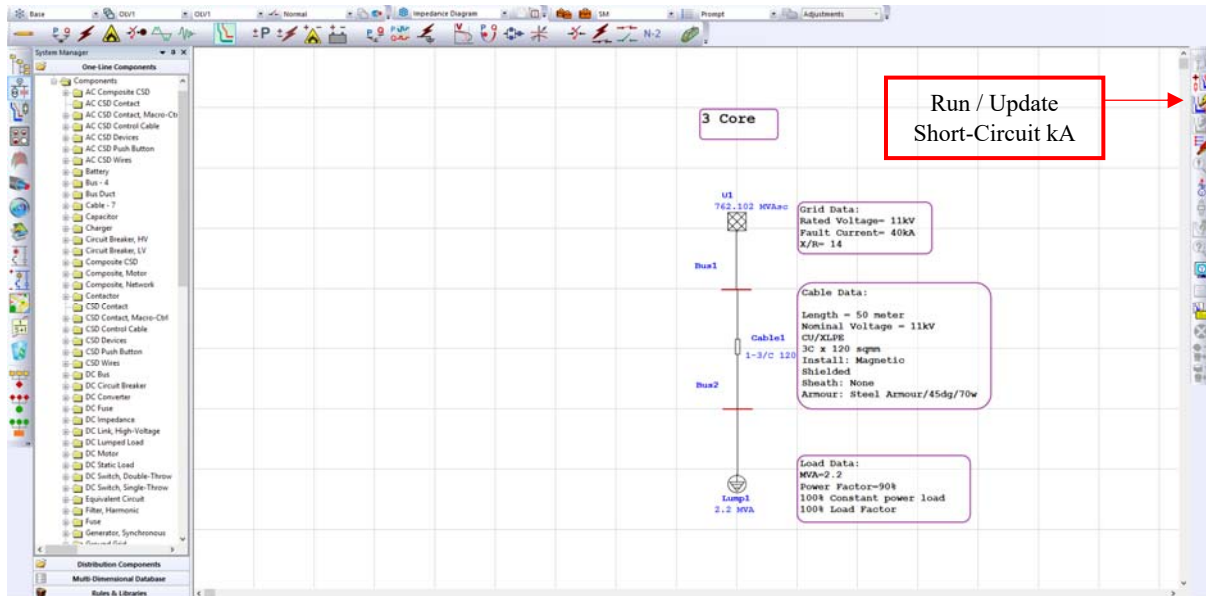
Reference kV

Calculated kV 0

OK Cancel

Cable Sizing

- 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.



- 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 Editor - Cable1

Info	Physical	Impedance	Reliability	Configuration	Routing	Remarks	Comment
BS6622	Mag.	50 Hz	Code : 120				
XLPE	100 %	11 kV	3/C	CU	120	mm ²	

Thermal Damage Curve

Initial Temp: Operating Temp
Final Temp: ICEA P-32-382
Thermal Plot: Curve
Conductor Temp: Initial °C: 90, Final °C: 250

Plot Thermal Curve for: 1 Conductors/Phase

Short-Circuit Current

☒ Calculated
☐ User-Defined
☐ Disable Update

Fault Type	Max kA	Min kA
3-Phase	40.82	0
Line - to - Ground	40.55	0
Line - to - Line	35.36	0
Line - to - Line - to - Ground	40.27	0

Protective Device

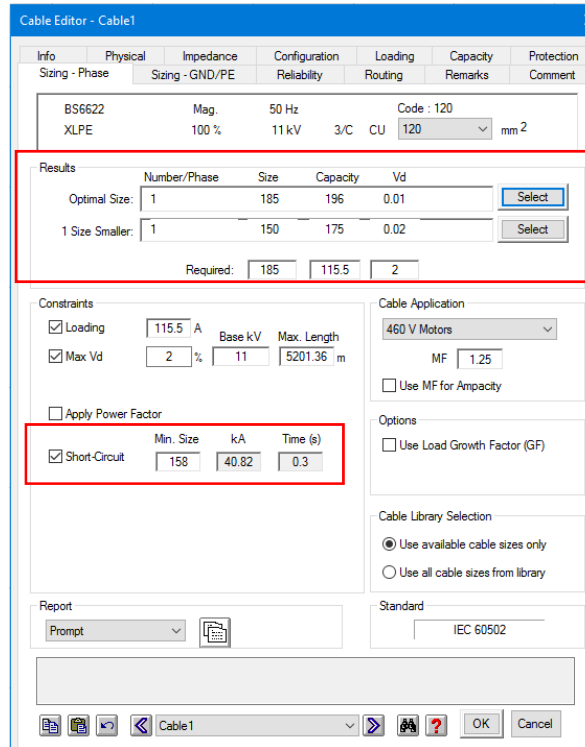
Overload: None
Overcurrent: User-Defined
Time: 0.3 s
Current: 40.82 kA (Phase), 40.55 kA (Ground)
GFI / RCD: None

Reference kV

Calculated kV: 11

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.



Cable Editor - Cable1

Info Physical Impedance Configuration Loading Capacity Protection
Sizing - Phase Sizing - GND/PE Reliability Routing Remarks Comment

BS6622 Mag. 50 Hz Code : 120
XLPE 100 % 11 kV 3/C CU 120 mm²

Results

	Number/Phase	Size	Capacity	Vd
Optimal Size:	1	185	196	0.01
1 Size Smaller:	1	150	175	0.02

Required: 185 115.5 2

Constraints

☒ Loading 115.5 A Base kV 11 Max. Length 5201.36 m
☒ Max Vd 2 %
☐ Apply Power Factor
☒ Short-Circuit Min. Size 158 kA 40.82 Time (s) 0.3

Cable Application

460 V Motors
MF 1.25
☐ Use MF for Ampacity

Options

☐ Use Load Growth Factor (GF)

Cable Library Selection

☒ Use available cable sizes only
☐ Use all cable sizes from library

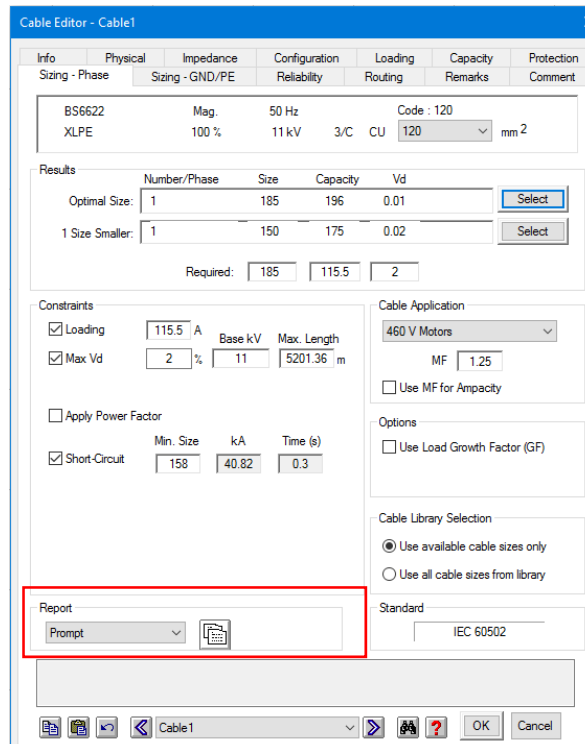
Standard

IEC 60502

Report Prompt

OK Cancel

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



Cable Editor - Cable1

Info Physical Impedance Configuration Loading Capacity Protection
Sizing - Phase Sizing - GND/PE Reliability Routing Remarks Comment

BS6622 Mag. 50 Hz Code : 120
XLPE 100 % 11 kV 3/C CU 120 mm²

Results

	Number/Phase	Size	Capacity	Vd
Optimal Size:	1	185	196	0.01
1 Size Smaller:	1	150	175	0.02

Required: 185 115.5 2

Constraints

☒ Loading 115.5 A Base kV 11 Max. Length 5201.36 m
☒ Max Vd 2 %
☐ Apply Power Factor
☒ Short-Circuit Min. Size 158 kA 40.82 Time (s) 0.3

Cable Application

460 V Motors
MF 1.25
☐ Use MF for Ampacity

Options

☐ Use Load Growth Factor (GF)

Cable Library Selection

☒ Use available cable sizes only
☐ Use all cable sizes from library

Standard

IEC 60502

Report

Prompt

OK Cancel

Cable Sizing

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

Cable Editor - Cable2

Info	Physical	Impedance	Configuration	Loading	Capacity	Protection
Sizing - Phase	Sizing - GND/PE	Reliability	Routing	Remarks	Comment	
Cable	Non-Mag.	50 Hz	Code : 95			
XLPE	100 %	11 kV	1/C CU	95	mm ²	

Results

	Number/Phase	Size	Capacity	Vd	
Optimal Size:	1	185	412	0.03	<input type="button" value="Select"/>
1 Size Smaller:	1	150	360	0.03	<input type="button" value="Select"/>

Required:

Constraints

☒ Loading A Base kV Max. Length m

☒ Max Vd %

☐ Apply Power Factor

☒ Short-Circuit Min. Size kA Time (s)

Cable Application

460 V Motors

MF

☐ Use MF for Ampacity

Options


☐ Use Load Growth Factor (GF)

Cable Library Selection

☒ Use available cable sizes only









☐ Use all cable sizes from library

Report



Standard

IEC 60502

     Cable2   

Cable Sizing

60502-2 © IEC:2005

– 103 –

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, mm ²	16	25	35	50	70	95	120	150	185	240	300	400
Nominal cross-sectional area of screen, per core, mm ²												
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.

Cable Sizing

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		Three-core cable
	Nominal conductor size mm ²		
	≤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

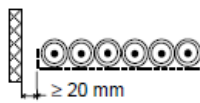

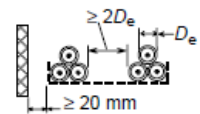
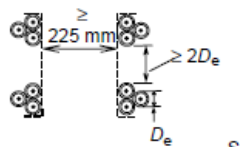
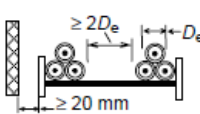
Nominal area of conductor mm ²	Values of soil thermal resistivity K·m/W						
	0,7	0,8	0,9	1	2	2,5	3
16	1,12	1,11	1,09	1,08	0,94	0,89	0,84
25	1,14	1,12	1,10	1,08	0,94	0,89	0,84
35	1,14	1,12	1,10	1,08	0,94	0,88	0,84
50	1,14	1,12	1,10	1,08	0,94	0,88	0,84
70	1,15	1,13	1,11	1,09	0,94	0,88	0,83
95	1,15	1,13	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)			Use as a multiplier to rating for
			1	2	3	
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)		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	

Cable Sizing

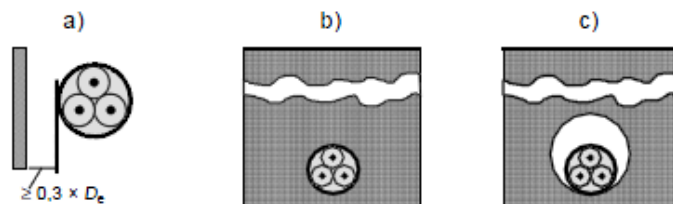
60502-2 © IEC:2005

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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.



IEC 429/06

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.

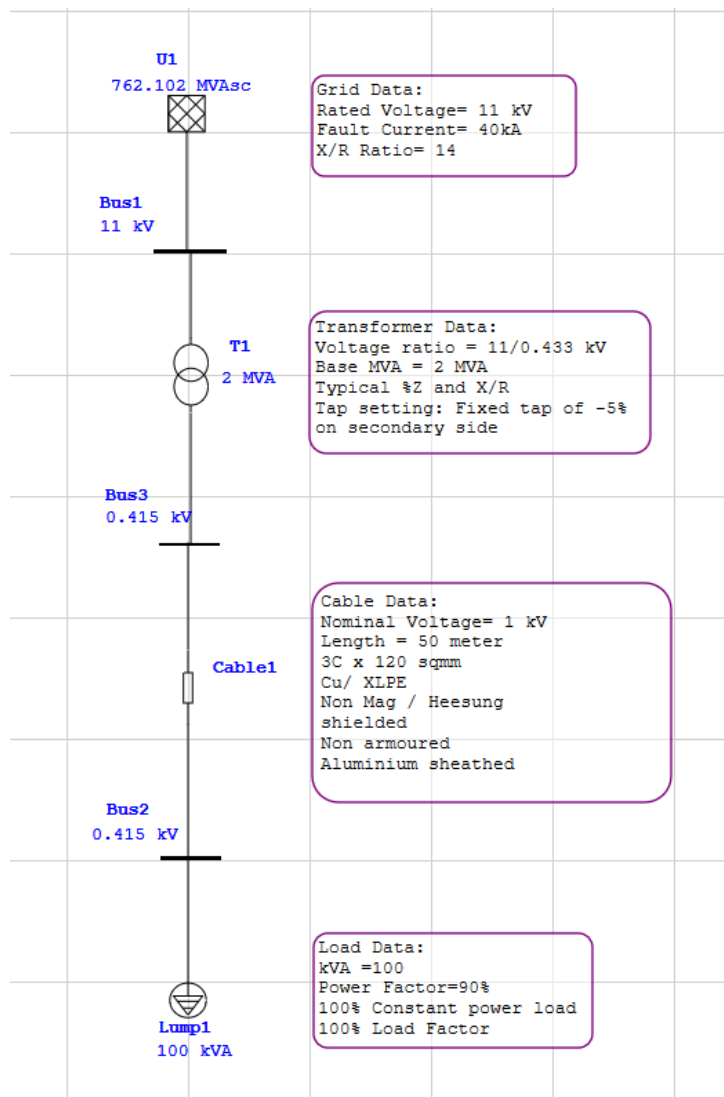
Cable Sizing

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

Procedure:

Case A: To identify cable de-rated ampacity

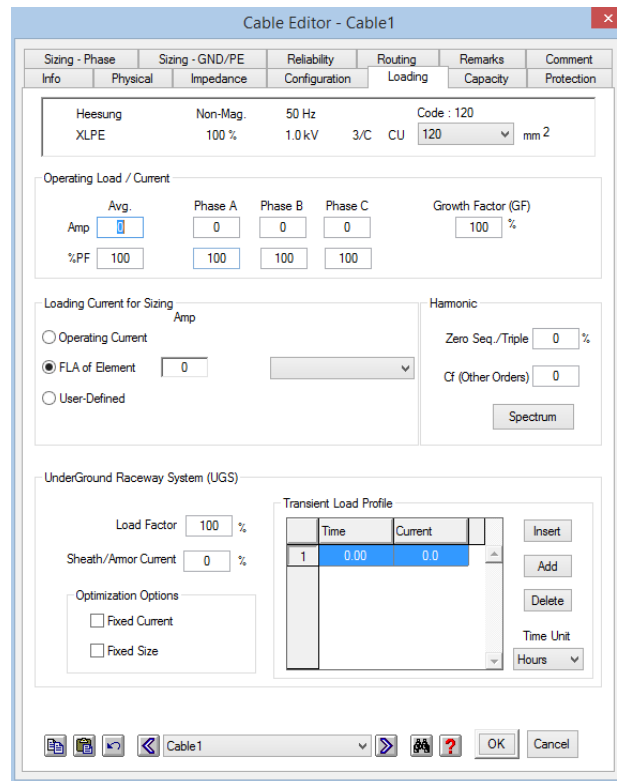
1. Create a new project with a name of 'LV cable sizing'.
2. Drag and place grid, buses, transformer, cable & lump load and connect them. Proceed to enter the input data as shown below.



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.

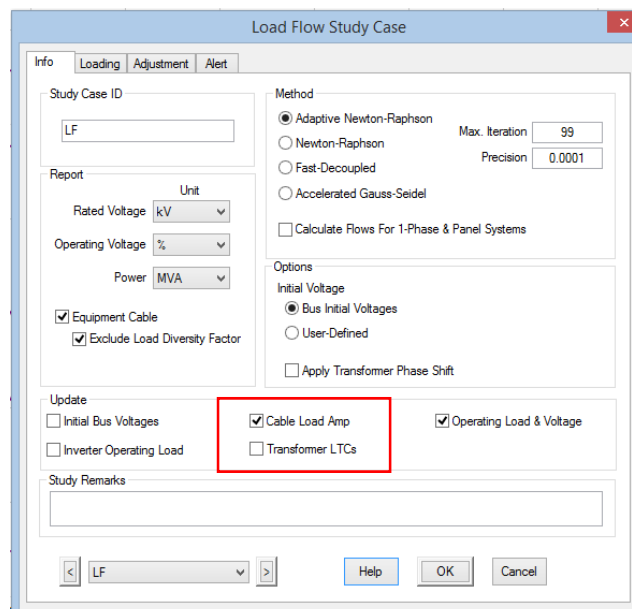


The Cable Editor - Cable1 dialog box is shown with the following settings:

- Info Tab:**
 - Heesung XLPE, Non-Mag, 50 Hz, Code: 120, 120 mm²
- Physical Tab:**
 - Operating Load / Current:
 - Avg. Amp: 0
 - Phase A: 0, Phase B: 0, Phase C: 0
 - Growth Factor (GF): 100 %
 - %PF: 100
- Reliability Tab:**
 - Loading Current for Sizing:
 - ☐ Operating Current
 - ☒ FLA of Element (0)
 - ☐ User-Defined
- Routing Tab:**
 - Hamonic:
 - Zero Seq./Triple: 0 %
 - Cf (Other Orders): 0
- Remarks Tab:**
 - UnderGround Raceway System (UGS):
 - Load Factor: 100 %
 - Sheath/Armor Current: 0 %
 - Optimization Options:
 - ☐ Fixed Current
 - ☐ Fixed Size
- Comment Tab:**
 - Transient Load Profile:

Time	Current
1	0.00

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.

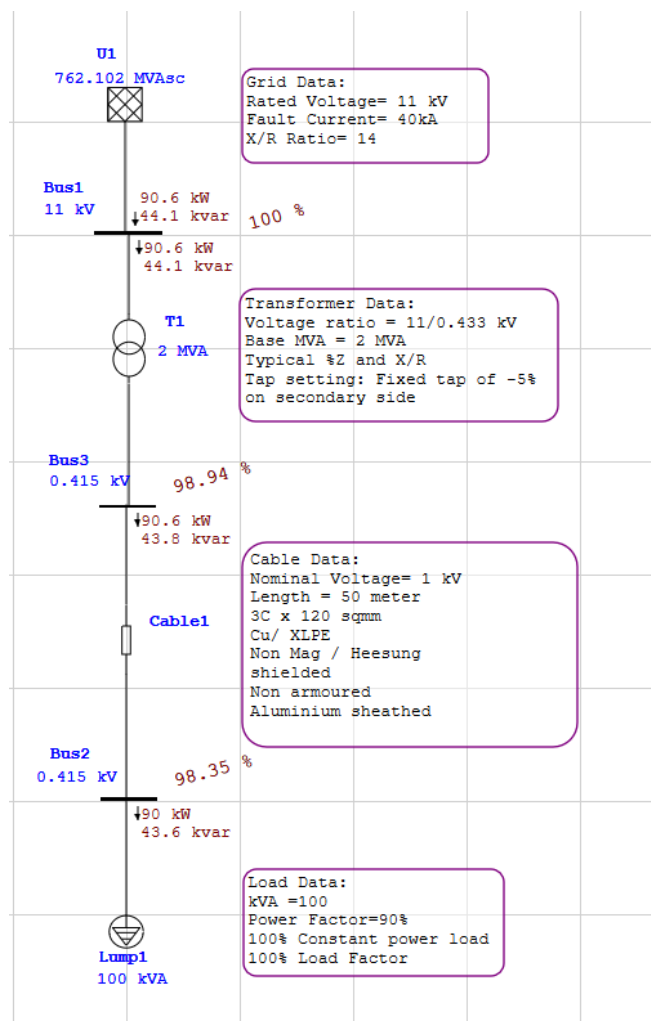


The Load Flow Study Case dialog box is shown with the following settings:

- Info Tab:**
 - Study Case ID: LF
 - Report:
 - Rated Voltage: kV
 - Operating Voltage: %
 - Power: MVA
 - ☒ Equipment Cable
 - ☒ Exclude Load Diversity Factor
- Loading Tab:**
 - Method:
 - ☒ Adaptive Newton-Raphson (Max. Iteration: 99, Precision: 0.0001)
 - ☐ Newton-Raphson
 - ☐ Fast-Decoupled
 - ☐ Accelerated Gauss-Seidel
 - ☐ Calculate Flows For 1-Phase & Panel Systems
 - Options:
 - Initial Voltage:
 - ☒ Bus Initial Voltages
 - ☐ User-Defined
 - ☐ Apply Transformer Phase Shift
- Adjustment Tab:**
 - Update:
 - ☐ Initial Bus Voltages
 - ☒ Cable Load Amp
 - ☐ Transformer LTCs
 - ☒ Operating Load & Voltage
 - ☐ Inverter Operating Load

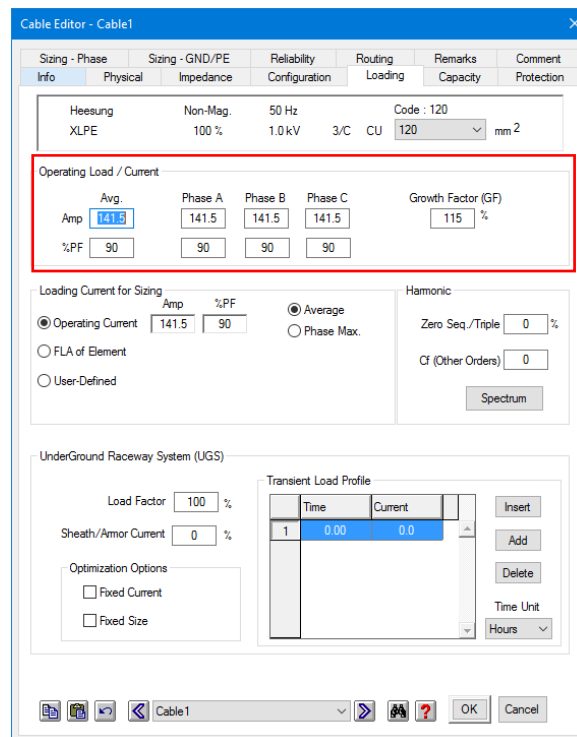
Cable Sizing

- Run the load flow analysis on the system.



- 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



Cable Editor - Cable1

Sizing - Phase	Sizing - GND/PE	Reliability	Routing	Remarks	Comment	
Info	Physical	Impedance	Configuration	Loading	Capacity	Protection
Heesung XLPE	Non-Mag. 100 %	50 Hz 1.0 kV	3/C CU	Code : 120 120	mm ²	

Operating Load / Current

Avg.	Phase A	Phase B	Phase C	Growth Factor (GF)
Amp 141.5	141.5	141.5	141.5	115 %
%PF 90	90	90	90	

Loading Current for Sizing

☒ Operating Current 141.5 Amp, 90 %PF
☐ FLA of Element
☐ User-Defined

☒ Average
☐ Phase Max.

Harmonic

Zero Seq./Triple 0 %
 Cf (Other Orders) 0
 Spectrum

UnderGround Raceway System (UGS)

Load Factor 100 %
 Sheath/Armor Current 0 %

Optimization Options

☐ Fixed Current
☐ Fixed Size

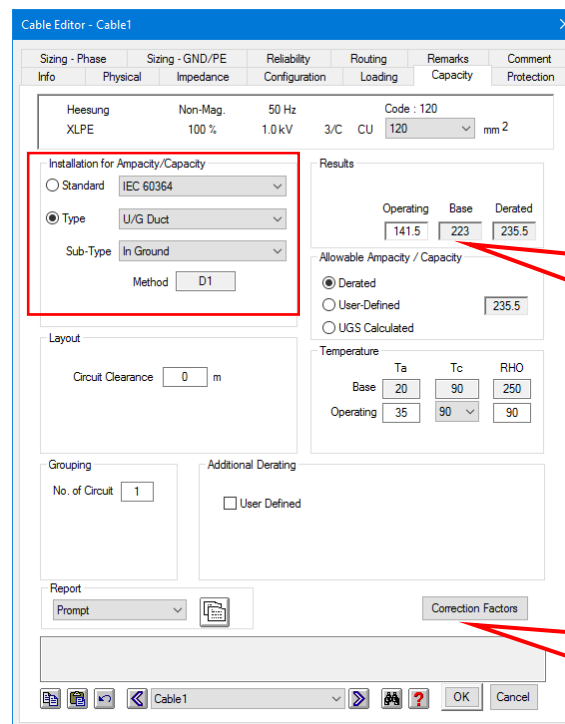
Transient Load Profile

Time	Current
1	0.00

Buttons: Insert, Add, Delete, Time Unit: Hours

Buttons: OK, Cancel

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



Cable Editor - Cable1

Sizing - Phase	Sizing - GND/PE	Reliability	Routing	Remarks	Comment	
Info	Physical	Impedance	Configuration	Loading	Capacity	Protection
Heesung XLPE	Non-Mag. 100 %	50 Hz 1.0 kV	3/C CU	Code : 120 120	mm ²	

Installation for Ampacity/Capacity

☐ Standard IEC 60364
☒ Type U/G Duct
 Sub-Type In Ground
 Method D1

Layout

Circuit Clearance 0 m

Grouping

No. of Circuit 1

Additional Derating

☐ User Defined

Report

Prompt

Results

Operating	Base	Derated
141.5	223	235.5

Allowable Ampacity / Capacity

☒ Derated
☐ User-Defined 235.5
☐ UGS Calculated

Temperature

	Ta	Tc	RHO
Base	20	90	250
Operating	35	90	90

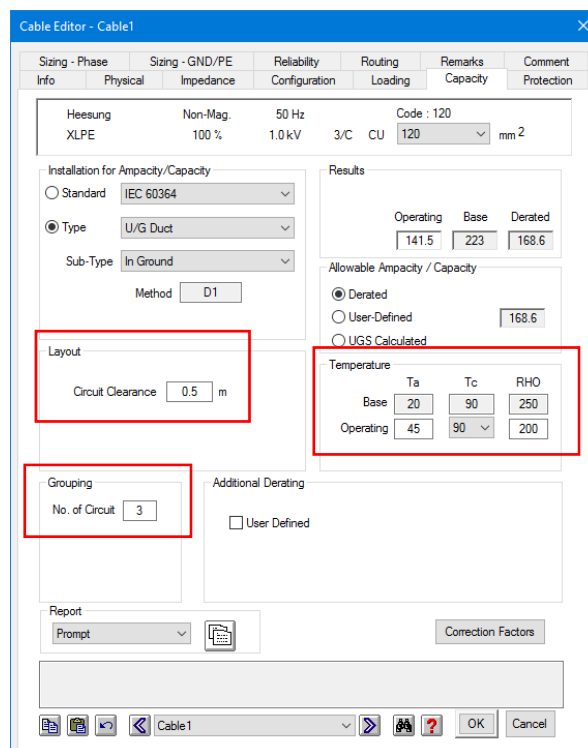
Buttons: OK, Cancel

Base current value is referred by table B.52.2 to B.52.13 of standard IEC-60364-5-52

For correction factors refer to IEC 60364-5-52 tables B.52.14 to B.52.21

Cable Sizing

- 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.



The screenshot shows the 'Cable Editor - Cable1' dialog box with the following settings:

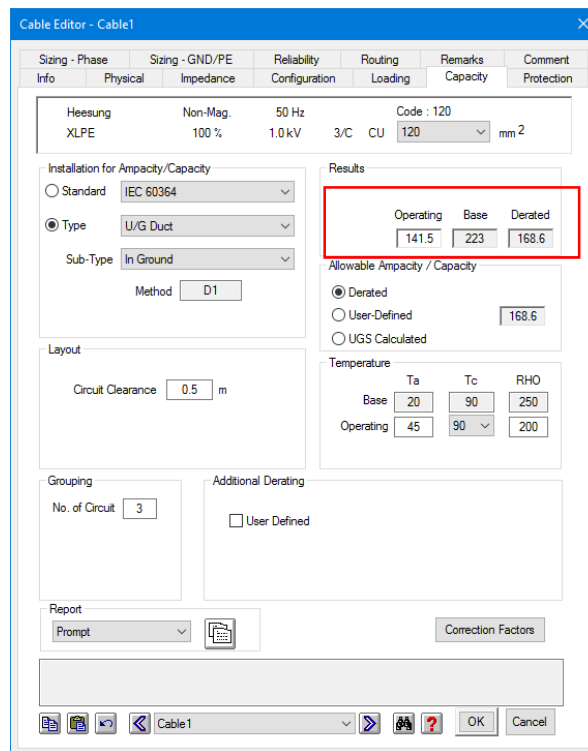
- General:** Heesung, Non-Mag., 50 Hz, Code: 120, XLPE, 100 %, 1.0 kV, 3/C, CU, 120 mm².
- Installation for Ampacity/Capacity:**
 - Standard: IEC 60364
 - Type: U/G Duct
 - Sub-Type: In Ground
 - Method: D1
- Layout:** Circuit Clearance: 0.5 m
- Grouping:** No. of Circuit: 3
- Additional Derating:** User Defined (unchecked)
- Results:**

	Operating	Base	Derated
	141.5	223	168.6
- Allowable Ampacity / Capacity:**
 - Derated (selected)
 - User-Defined: 168.6
 - UGS Calculated
- Temperature:**

	Ta	Tc	RHO
Base	20	90	250
Operating	45	90	200

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

Cable Sizing



Cable Editor - Cable1

Sizing - Phase	Sizing - GND/PE	Reliability	Routing	Remarks	Comment
Info	Physical	Impedance	Configuration	Loading	Capacity
Heesung XLPE	Non-Mag. 100 %	50 Hz 1.0 kV	3/C CU	Code : 120 120	mm ²

Installation for Ampacity/Capacity

☐ Standard IEC 60364

☒ Type U/G Duct

Sub-Type In Ground

Method D1

Layout

Circuit Clearance 0.5 m

Grouping

No. of Circuit 3

Additional Derating

☐ User Defined

Report

Prompt

Correction Factors

Results

Operating	Base	Derated
141.5	223	168.6

Allowable Ampacity / Capacity

☒ Derated

☐ User-Defined 168.6

☐ UGS Calculated

Temperature

	Ta	Tc	RHO
Base	20	90	250
Operating	45	90	200

OK Cancel

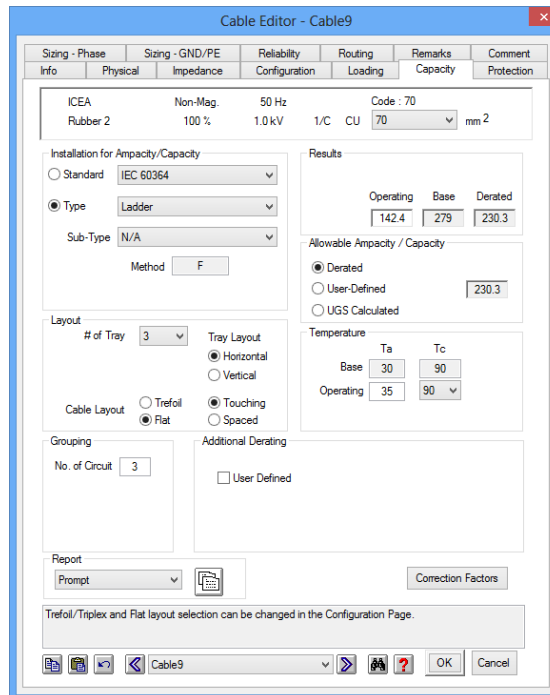
10. Follow same procedure for Single core LV cable ampacity calculation. Based on installation conditions and cable details as shown below by creating a new system for single core cable.

Single Core cable details:

Cable selected: 1 kV, CU, Rubber, 1/C, non mag. 70 mm², length 200 m, unarmored and Non-magnetic

Library Quick Pick - Cable									
	Unit	Freq	Type	kV	% Class	#/C	Insul	Source	Install
1	Metric	50	CU	1.0	100	1/C	Rubber 2	ICEA	Mag.
2	Metric	50	CU	1.0	100	1/C	Rubber 2	ICEA	Non-Mag.

Cable Sizing



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

Three Core Cable

Cable selected: 1 kV, 3/C, CU, XLPE, Non-Mag, 120 mm², 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
 = $223 \times 0.8 \times 1.05 \times 0.9$
 = **168.56 A**

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

Single Core cable

Cable selected: 1 kV, CU, Rubber, 1/C, non mag. 70 mm², 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
 = $279 \times 0.96 \times 0.86$
 = **230.34 A**

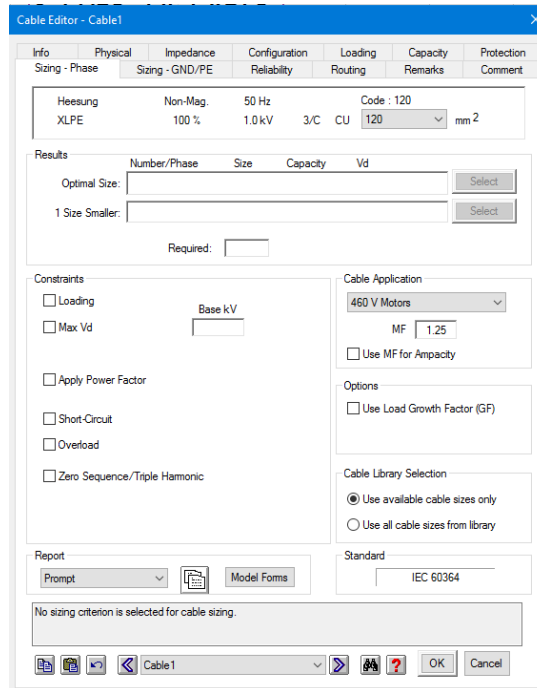
12. Similarly, de-rated cable ampacity for 3 core and 1 core cable with different types of installation method such as U/G Duct, A/G Trays (perforated) etc. can be carried out.

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



Cable Editor - Cable1

Info Physical Impedance Configuration Loading Capacity Protection
Sizing - Phase Sizing - GND/PE Reliability Routing Remarks Comment

Heesung Non-Mag. 50 Hz Code : 120
XLPE 100 % 1.0 kV 3/C CU 120 mm²

Results

Number/Phase	Size	Capacity	Vd
Optimal Size:	120		
1 Size Smaller:	120		

Required:

Constraints

☒ Loading Base kV
☐ Max Vd
☐ Apply Power Factor
☐ Short-Circuit
☐ Overload
☐ Zero Sequence/Trip Harmonic

Cable Application
460 V Motors
MF 1.25
☐ Use MF for Ampacity

Options
☐ Use Load Growth Factor (GF)

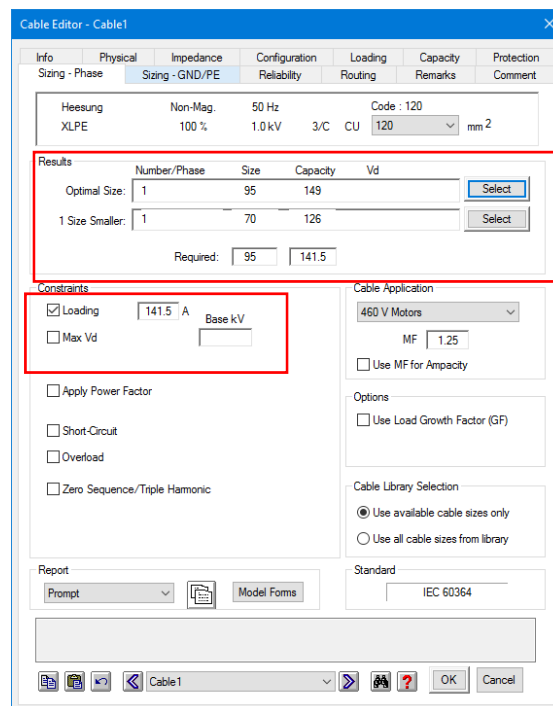
Cable Library Selection
☒ Use available cable sizes only
☐ Use all cable sizes from library

Report
Prompt Model Forms

No sizing criterion is selected for cable sizing.

OK Cancel

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



Cable Editor - Cable1

Info Physical Impedance Configuration Loading Capacity Protection
Sizing - Phase Sizing - GND/PE Reliability Routing Remarks Comment

Heesung Non-Mag. 50 Hz Code : 120
XLPE 100 % 1.0 kV 3/C CU 120 mm²

Results

Number/Phase	Size	Capacity	Vd
Optimal Size:	95	149	
1 Size Smaller:	70	126	

Required: 95 141.5

Constraints

☒ Loading 141.5 A Base kV
☐ Max Vd
☐ Apply Power Factor
☐ Short-Circuit
☐ Overload
☐ Zero Sequence/Trip Harmonic

Cable Application
460 V Motors
MF 1.25
☐ Use MF for Ampacity

Options
☐ Use Load Growth Factor (GF)

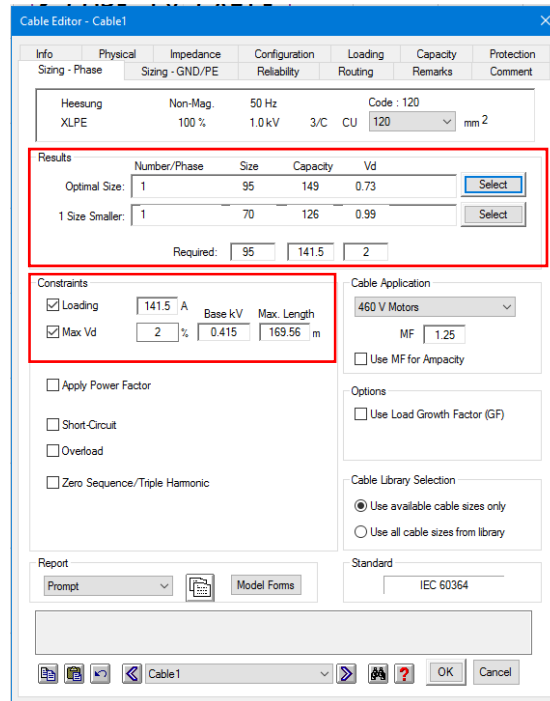
Cable Library Selection
☒ Use available cable sizes only
☐ Use all cable sizes from library

Report
Prompt Model Forms

OK Cancel

Cable Sizing

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



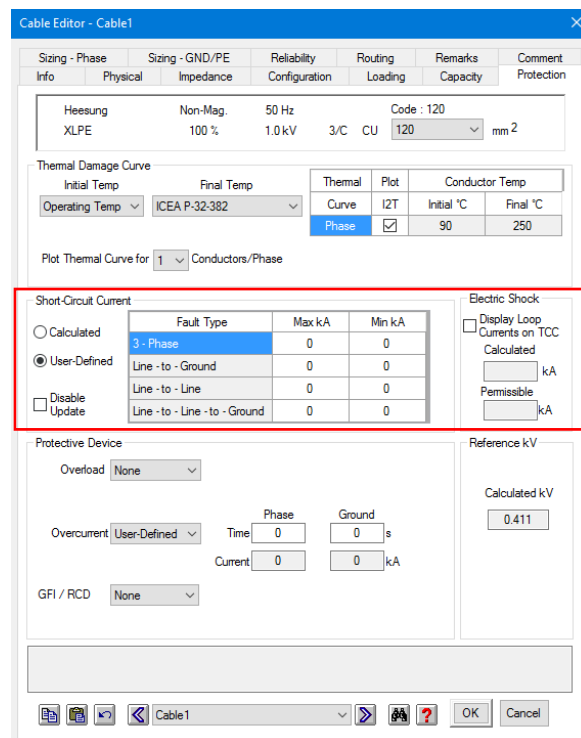
The screenshot shows the 'Cable Editor - Cable1' dialog box. The 'Results' section is highlighted with a red box, showing the following data:

Results	Number/Phase	Size	Capacity	Vd
Optimal Size:	1	95	149	0.73
1 Size Smaller:	1	70	126	0.99

The 'Constraints' section is also highlighted with a red box, showing the following settings:

- ☒ Loading: 141.5 A
- ☒ Max Vd: 2 %
- Base kV: 0.415
- Max. Length: 169.56 m

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.



The screenshot shows the 'Cable Editor - Cable1' dialog box. The 'Short-Circuit Current' section is highlighted with a red box, showing the following data:

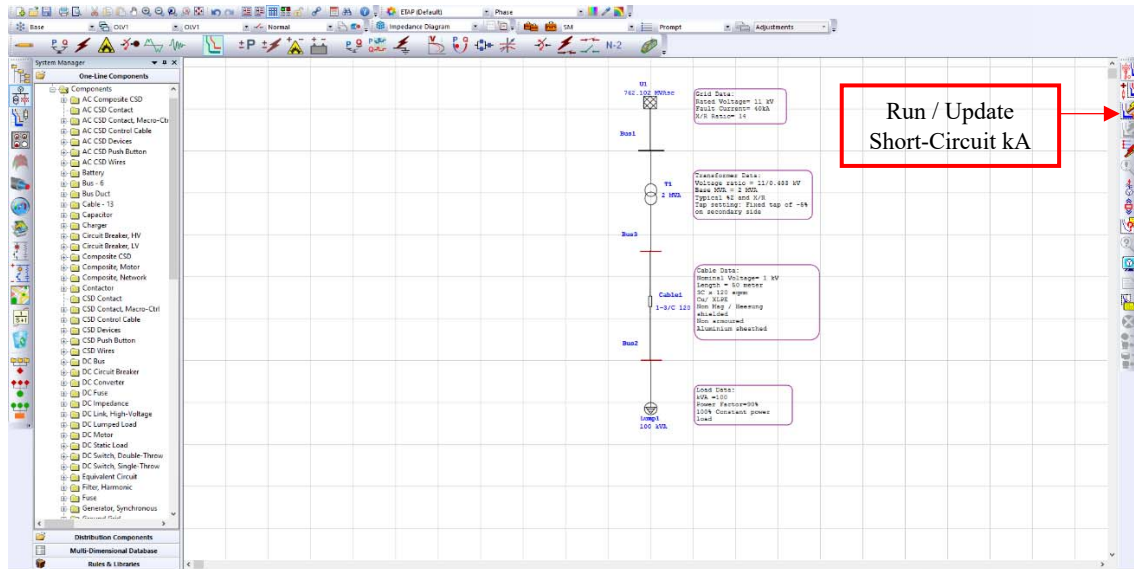
Short-Circuit Current	Fault Type	Max kA	Min kA
<input checked="" type="radio"/> User-Defined	3 - Phase	0	0
	Line - to - Ground	0	0
	Line - to - Line	0	0
	Line - to - Line - to - Ground	0	0

The 'Protective Device' section is also highlighted with a red box, showing the following settings:

- Overload: None
- Overcurrent: User-Defined
- Time: 0 s
- Current: 0 kA
- GFI / RCD: None

Cable Sizing

- 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.



- 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 Editor - Cable1

Sizing - Phase	Sizing - GND/PE	Reliability	Routing	Remarks	Comment
Heesung	Non-Mag.	50 Hz	Code : 120		
XLPE	100 %	1.0 kV	3/C CU	120	mm ²

Thermal Damage Curve

Initial Temp	Final Temp	Thermal	Plot	Conductor Temp
Operating Temp	ICEA P-32-382	Curve	I ² T	Initial °C
		Phase	✓	Final °C

Plot Thermal Curve for 1 Conductors/Phase

Short-Circuit Current

Fault Type	Max kA	Min kA
3 - Phase	48.1	0
Line - to - Ground	48.54	0
Line - to - Line	41.65	0
Line - to - Line - to - Ground	49	0

Protective Device

Overload: None

Overcurrent: User-Defined

Phase	Ground
Time: 0.3	0.3 s
Current: 48.54	49 kA

GFI / RCD: None

Electric Shock

Display Loop Currents on TCC: Calculated

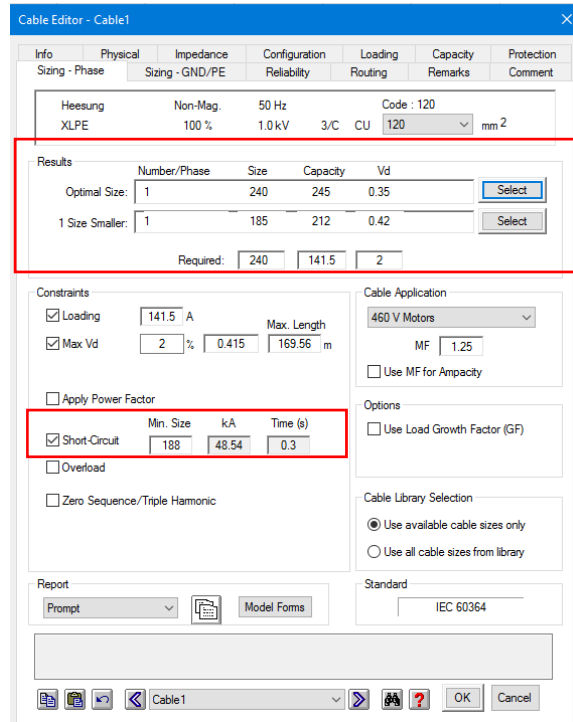
Reference kV

Calculated kV: 0.411

OK Cancel

Cable Sizing

- 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.



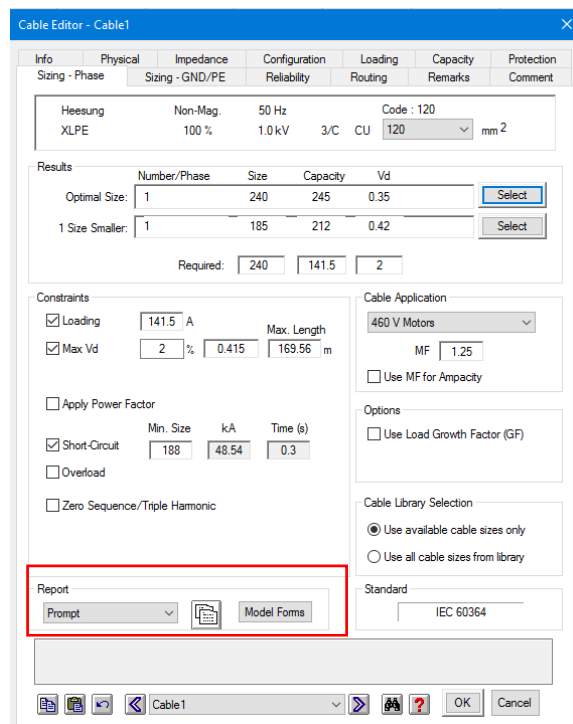
Info	Physical	Impedance	Configuration	Loading	Capacity	Protection
Sizing - Phase	Sizing - GND/PE	Reliability	Routing	Remarks	Comment	
Heesung XLPE	Non-Mag. 100 %	50 Hz 1.0 kV	3/C CU	Code : 120 120	mm ²	

Results	Number/Phase	Size	Capacity	Vd	
Optimal Size:	1	240	245	0.35	Select
1 Size Smaller:	1	185	212	0.42	Select

Required: 240 141.5 2

Constraints	Min. Size	kA	Time (s)
<input checked="" type="checkbox"/> Short-Circuit	188	48.54	0.3

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



Info	Physical	Impedance	Configuration	Loading	Capacity	Protection
Sizing - Phase	Sizing - GND/PE	Reliability	Routing	Remarks	Comment	
Heesung XLPE	Non-Mag. 100 %	50 Hz 1.0 kV	3/C CU	Code : 120 120	mm ²	

Results	Number/Phase	Size	Capacity	Vd	
Optimal Size:	1	240	245	0.35	Select
1 Size Smaller:	1	185	212	0.42	Select

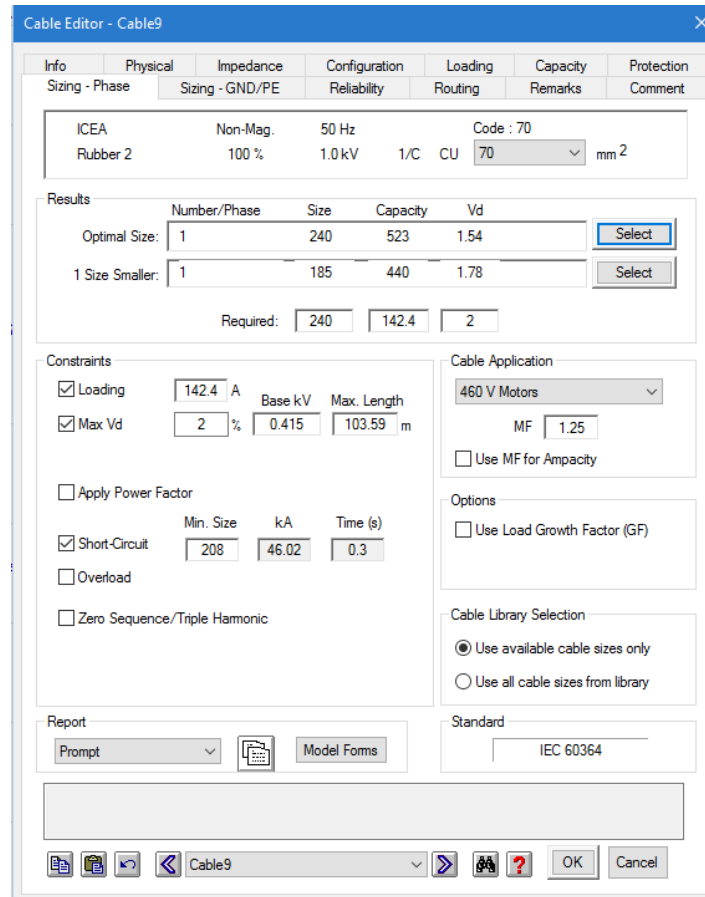
Required: 240 141.5 2

Constraints	Min. Size	kA	Time (s)
<input checked="" type="checkbox"/> Short-Circuit	188	48.54	0.3

Report	Model Forms
Prompt	

Cable Sizing

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



Cable Editor - Cable9

Info	Physical	Impedance	Configuration	Loading	Capacity	Protection
Sizing - Phase	Sizing - GND/PE	Reliability	Routing	Remarks	Comment	
ICEA	Non-Mag.	50 Hz	Code : 70			
Rubber 2	100 %	1.0 kV	1/C CU	70	mm 2	

Results

	Number/Phase	Size	Capacity	Vd	
Optimal Size:	1	240	523	1.54	Select
1 Size Smaller:	1	185	440	1.78	Select

Required: 240 142.4 2

Constraints

☒ Loading 142.4 A Base kV Max. Length

☒ Max Vd 2 % 0.415 103.59 m

☐ Apply Power Factor

☒ Short-Circuit Min. Size kA Time (s)

☐ Overload 208 46.02 0.3

☐ Zero Sequence/Trip Harmonic

Cable Application

460 V Motors

MF 1.25

☐ Use MF for Ampacity

Options

☐ Use Load Growth Factor (GF)

Cable Library Selection

☒ Use available cable sizes only

☐ Use all cable sizes from library

Report

Prompt

Model Forms

Standard

IEC 60364

OK Cancel

Cable Sizing

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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 mm² 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.

Cable Sizing

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			
	PVC	XLPE and EPR	Mineral ^a	
			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

Cable Sizing

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

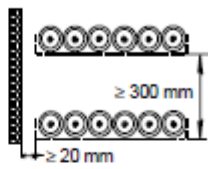
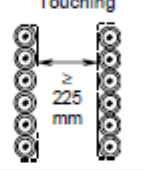
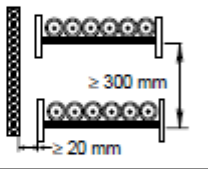
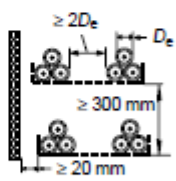
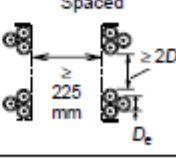
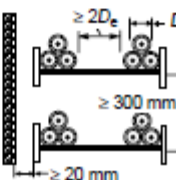
Thermal resistivity, K · m/W	0,5	0,7	1	1,5	2	2,5	3
Correction factor for cables in buried ducts	1,28	1,20	1,18	1,1	1,05	1	0,96
Correction factor for direct buried cables	1,88	1,62	1,5	1,28	1,12	1	0,90

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		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		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		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		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	