

NOTE 1: The illustrations are not intended to depict actual product or installation practices but are indicative of the method described.

NOTE 2: The installation and reference methods stated are in line with IEC. However, not all methods have a corresponding rating for all cable types.

INSTALLATION METHOD

Table 1: Installation Method

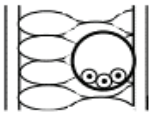
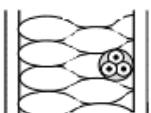
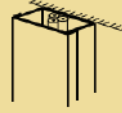
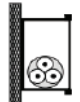
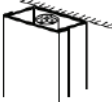
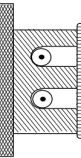
No	Examples	Description	Reference Method to be used to determine current-carrying capacity
1	 Room	Non-sheathed cables in conduit in a thermally insulated wall with an inner skin having a thermal conductance of not less than 10 W/m²k	A
2	 Room	Multicore cable in conduit in a thermally insulated wall with an inner skin having a thermal conductance of not less than 10 W/m²K	A
3	 Room	Multicore cable direct in a thermally insulated wall with an inner skin having a thermal conductance of not less than 10 W/m²k	A
4		Non-sheathed cables in conduit on a wooden or masonry wall or spaced less than 0.3 x conduit diameter from it ^c	B
5		Multicore cable in conduit on a wooden or masonry wall or spaced less than 0.3 x conduit diameter from it ^c	B
6		Non-sheathed cables in cable trunking on a wooden or masonry wall	B
7		6 - run horizontally ^b 7 - run vertically ^{b, c}	

Table 1 (Con't): Installation Method

No	Examples	Description	Reference Method to be used to determine current-carrying capacity
8		Multicore cable in cable trunking on a wooden or masonry wall	B*
9		8 - run horizontally ^b 9 - run vertically ^{b, c}	
10		Non-sheathed cables in suspended cable trunking ^b	B
11		Multicore cable in suspended cable trunking ^b	B
12		Non-sheathed cables run in mouldings ^{c, e}	A

- b** Values given for Installation Method B in Appendix 4 (in IEE Wiring Regulations 18th Edition) are for a single circuit. Where there is more than one circuit in the trunking the group rating factor given in Table 2.6 is applicable, irrespective of the presence of an internal barrier or partition.
- c** Care is needed where the cable runs vertically and ventilation is restricted. The ambient temperature at the top of the vertical section can be much higher.
- e** The thermal resistivity of the enclosure is assumed to be poor because of the material of construction and possible air spaces. Where the construction is thermally equivalent to Installation Methods 6 or 7, Reference Method B may be used.
- * Still under consideration in IEC.



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APPENDIX A INSTALLATION METHODS OF CABLES

Table 1 (Con't): Installation Method

No	Examples	Description	Reference Method to be used to determine current-carrying capacity
20		Single-core or multicore cables: Fixed on (clipped direct), or spaced less than 0.3 x cable diameter from a wooden or masonry wall ^c	C
21		Single-core or multicore cables: Fixed directly under wooden or masonry ceiling	C (Higher than standard ambient temperatures may occur with this installation method)
22		Single-core or multicore cables: Spaced from a ceiling	E, F or G* (Higher than standard ambient temperatures may occur with this installation method)
30		Single-core or multicore cables: On unperforated tray run horizontally or vertically ^{c, h}	C with item 2 of Table 2.6
31		Single-core or multicore cables: On perforated tray run horizontally or vertically ^{c, h}	E or F

c Care is needed where the cable runs vertically and ventilation is restricted. The ambient temperature at the top of the vertical section can be much higher.

f The thermal resistivity of the enclosure is assumed to be poor because of the material of construction and possible air spaces. Where the construction is thermally equivalent to Installation Methods 6, 7, 8 or 9. Reference Method B may be used.

g The factor in Table 2.6 may also be used.

h D_e = the external diameter of a multicore cable:
 - 2.2 x the cable diameter when three single-core cables are bound in trefoil, or
 - 3 x the cable diameter when three single-core cables are laid in flat formation.

* Still under consideration in IEC.



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APPENDIX A INSTALLATION METHODS OF CABLES

Table 1 (Con't): Installation Method

No	Examples	Description	Reference Method to be used to determine current-carrying capacity
32		Single-core or multicore cables: On brackets or on a wire mesh tray run horizontally or vertically ^{c, h}	E or F
33		Single-core or multicore cables: Spaced more than 0.3 x the cable diameter from a wall	E, F or G ^g
34		Single-core or multicore cables: On a ladder ^c	E or F
35		Single-core or multicore cable suspended from or incorporating a support wire or harness	E or F
36		Bare or non-sheathed cables on insulators	G
40		Single-core or multicore cables: In a building void ^{c, h, i}	Where $1.5 D_e \leq V < 20 D_e$ Use B
41		Non-sheathed cables: - In conduit - In a building void - In masonry having a thermal resistivity not greater than 2 K.m/W ^{c, i, j}	Where $1.5 D_e \leq V$ Use B
42		Single-core or multicore cables: - In conduit - In a building void - In masonry having a thermal resistivity not greater than 2 K.m/W ^{c, j}	Where $1.5 D_e \leq V$ Use B



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APPENDIX A INSTALLATION METHODS OF CABLES

Table 1 (Con't): Installation Method

No	Examples	Description	Reference Method to be used to determine current-carrying capacity
43		Non-sheathed cables: - In cable ducting - In a building void - In masonry having a thermal resistivity not greater than 2 K.m/W ^{c, i, j}	Where $1.5 D_e \leq V$ Use B
44		Single-core or multicore cables: - In cable ducting - In a building void - In masonry having a thermal resistivity not greater than 2 K.m/W ^{c, i, j}	Where $1.5 D_e \leq V$ Use B
45		Non-sheathed cables: - In cable ducting - In masonry having a thermal resistivity not greater than 2 K.m/W ^{c, h, i}	Where $1.5 D_e \leq V < 50 D_e$ Use B
46		Single-core or multicore cables: - In cable ducting - In masonry having a thermal resistivity not greater than 2 K.m/W ^{c, h, i}	Where $1.5 D_e \leq V \leq 50 D_e$ Use B
47		Single-core or multicore cables: - In a ceiling void - In a suspended door ^{h, i}	Where $1.5 D_e \leq V \leq 50 D_e$ Use B

c Care is needed where the cable runs vertically and ventilation is restricted. The ambient temperature at the top of the vertical section can be much higher.

g The factor in Table 2.6 may also be used.

h D_e = the external diameter of a multicore cable:
- 2.2 x the cable diameter when three single-core cables are bound in trefoil, or
- 3 x the cable diameter when three single-core cables are laid in flat formation.

i V = the smaller dimension or diameter of a masonry duct or void, or the vertical depth of a rectangular duct, floor or ceiling void or channel.

j D_e = the external diameter of conduit or vertical depth of cable ducting.



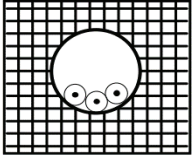
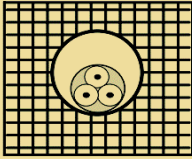
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APPENDIX A INSTALLATION METHODS OF CABLES

Table 1 (Con't): Installation Method

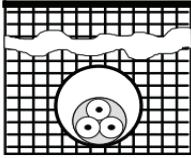
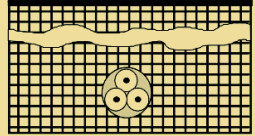
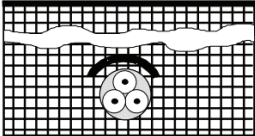
No	Examples	Description	Reference Method to be used to determine current-carrying capacity
50		Non-sheathed cables in flush cable trunking in the floor	B
51		Multicore cable in flush cable trunking in the floor	B
52		Non-sheathed cables in flush trunking ^c	B
53		Multicore cable in flush trunking ^c	
54		Non-sheathed cables or single-core cables in conduit in an unventilated cable channel run horizontally or vertically ^{c, i, k, m}	Where $1.5 D_e \leq V$ Use B
55		Non-sheathed cables in conduit in an open or ventilated cable channel in the floor ^{l, m}	B
56		Sheathed single-core or multicore cable in an open or ventilated cable channel run horizontally or vertically ^m	B
57		Single-core or multicore cable direct in masonry having a thermal resistivity not greater than 2 K.m/W - without added mechanical protection ^{n, o}	C
58		Single-core or multicore cable direct in masonry having a thermal resistivity not greater than 2 K.m/W - with added mechanical protection ^{n, o} (eg. capping)	C

Table 1 (Con't): Installation Method

No	Examples	Description	Reference Method to be used to determine current-carrying capacity
59		Non-sheathed cables or single-core cables in conduit in masonry having a thermal resistivity not greater than 2 K.m/W °	B
60		Multicore cables in conduit in masonry having a thermal resistivity not greater than 2 K.m/W °	B

- c** Care is needed where the cable runs vertically and ventilation is restricted. The ambient temperature at the top of the vertical section can be much higher.
- k** De = external diameter of conduit.
- i** V = the smaller dimension or diameter of a masonry duct or void, or the vertical depth of a rectangular duct, floor or ceiling void or channel. The depth of the channel is more important than the width.
- l** For multicore cable installed as Method 55, use current-carrying capacity for Reference Method B.
- m** It is recommended that these Installation Methods are used only in areas where access is restricted to authorized persons so that the reduction in current-carrying capacity and the fire hazard due to the accumulation of debris can be prevented.
- n** For cables having conductors not greater than 16 mm², the current-carrying capacity may be higher.
- o** Thermal resistivity of masonry is not greater than 2 K.m/W. The term masonry is taken to include brickwork, concrete, plaster and the like (excludes thermally insulating materials).

Table 1 (Con't): Installation Method

No	Examples	Description	Reference Method to be used to determine current-carrying capacity
70		Multicore armoured cable in conduit or in cable ducting in the ground	D For multicore armoured cable only
72		Sheathed, armoured or multicore cables direct in the ground: - without added mechanical protection (see note)	D
73		Sheathed, armoured or multicore cables direct in the ground: with added mechanical protection (e.g. cable covers) (see note)	D

NOTE: The inclusion of directly buried cables is satisfactory where the soil thermal resistivity is of the order of 2.5 K.m/W. For lower soil resistivities, the current-carrying capacity for directly buried cables is appreciably higher than for cables in ducts.

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APPENDIX B RATING FACTORS

The current-carrying capacities in this work standard are based upon the following reference ambient temperatures:

- i) For non-sheathed and sheathed cables in air, irrespective of the installation method: 30°C
- ii) For buried cables, either directly in the soil or in ducts in the ground: 20°C

When the ambient temperature in the intended location of the non-sheathed or sheathed cables differs from the reference ambient temperature, please refer to the appropriate rating factors as below table (Table 2.1 and 2.2).

Table 2.1
Rating factors for ambient air temperatures other than 30°C to be applied to the current-carrying capacities for the cables in free air.

Ambient Air Temperature (°C)	PVC	XLPE
25	1.03	1.02
30	1.00	1.00
35	0.94	0.96
40	0.87	0.91
45	0.79	0.87
50	0.71	0.82
55	0.61	0.76
60	0.50	0.71
65	-	0.65
70	-	0.58
75	-	0.50
80	-	0.41
85	-	-
90	-	-
95	-	-

Table 2.2
Rating factors for ambient ground temperatures other than 20°C to be applied to the current-carrying capacities for the cables capacities for cables buried to ground.

Ambient Ground Temperature (°C)	PVC	XLPE
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



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APPENDIX B RATING FACTORS

Table 2.3:
Rating factors for cables buried direct in the ground or in an underground conduit system to BS EN 50086-2-4 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	Rating factor for cables in buried ducts	Rating factor for direct buried cables
0.50	1.28	1.88
0.80	1.20	1.62
1.00	1.18	1.50
1.20	1.13	1.40
1.50	1.10	1.28
2.00	1.05	1.12
2.50	1.00	1.00
3.00	0.96	0.90

Note:

- The rating factors given have been averaged over the range of conductor sizes and types of installation included in the relevant table in this appendix. The overall accuracy of rating factors is within $\pm 5\%$.
- The rating factors are applicable to cables drawn into buried ducts. For cables laid direct in the ground, the rating factors for thermal resistivities less than 2.5 K.m/W will be higher. Where more precise values, are required they may be calculated by methods given BS 7769 (BS IEC 60287).
- The rating factors are applicable to ducts buried at depths of up to 0.8m.

Table 2.4: Rating factors for depths of laying other than 0.7m for direct buried cables and cables in buried ducts

Depth of Laying (m)	Buried Direct	In Buried Ducts
0.5	1.03	1.02
0.7	1.00	1.00
1.0	0.97	0.98
1.3	0.95	0.96
1.5	0.94	0.95
1.8	0.93	0.94
2.0	0.92	0.93
2.5	0.90	0.92
3.0	0.89	0.91



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APPENDIX B RATING FACTORS

Table 2.5: Rating factors for cables having more than 4 loaded cores

Number of loaded cores	Rating factor	Number of loaded cores	Rating factor
5	0.72	24	0.42
6	0.67	27	0.4
7	0.63	30	0.39
10	0.56	37	0.36
12	0.53	44	0.34
14	0.51	46	0.33
19	0.45	48	0.33

NOTE 1: The current-carrying capacity for a cable in the size range 1.5 to 4mm², having more than 4 loaded cores, is obtained by multiplying the current-carrying capacity of a 2-core, having the same insulation type, by the factor selected from this table. The current-carrying capacity for the 2-core cable is that for the installation condition to be used for the multicore cable.

NOTE 2: If, due to known operating conditions, a core is expected to carry not more than 30% of its current-carrying capacity in the multicore cable it may be ignored for the purpose of determining the number of cores in the cable.

NOTE 3: If, due to known operating conditions, a core is expected to carry not more than 30% of its rating, after applying the rating factor for the total number of current-carrying cores, it may be ignored for the purpose of obtaining the rating factor for the number of loaded cores.
For example, the current-carrying capacity of a cable having N loaded cores would normally be obtained by multiplying the current-carrying capacity of a 2-core, having the same insulation type, by the factor selected from this table for N cores. That is $I_{zlc} = I_{t2c} \times C_{gN}$ where:

I_{zlc} is the current-carrying capacity of the multicore cable after applying the rating factor for the total number of current-carrying cores

I_{t2c} is the tabulated current-carrying capacity of a 2-core cable, having the same insulation type as the multi-core cable

C_{gN} is the rating factor from Table 2.5 for the total number of current-carrying cores

However, if M cores in the cable carry loads which are not greater than $0.3 \times I_{t2c} \times C_{gN}$, the current-carrying capacity can be obtained by using the rating factor corresponding to (N-M) cores.

The "not greater than $0.3 \times I_{t2c} \times C_{gN}$ " calculation should be applied before the adjacent multicore cable grouping factor, if applicable, from Table 2.6. The 30% rule should not be further applied to any adjacent cable grouping factor calculations.

I_{zlc} should be greater than or equal to I_n or I_b as appropriate, divided by the relevant rating factor(s) C, that is $I_{zlc} \geq I_n$ or I_b/C .



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APPENDIX B RATING FACTORS

Table 2.6: Rating factors for one circuit or one multicore cable or for a group of circuits, or a group of multicore cables, to be used with current-carrying capacities of Table A1.1 to Table B4.2.

Item	Arrangement (Cable Touching)	Number of circuits or multi-core cables												To be used with current- carrying capacities, Reference
		1	2	3	4	5	6	7	8	9	12	16	20	
1	Bunched in air, on a surface, embedded or enclosed	1	0.80	0.70	0.65	0.60	0.57	0.54	0.52	0.50	0.45	0.41	0.38	Methods A to F
2	Single layer multicore on wall or floor	1	0.85	0.79	0.75	0.73	0.72	0.72	0.71	0.70	0.70	0.70	0.70	Method C
3	Single layer multicore on a perforated horizontal or vertical tray cable system	1	0.88	0.82	0.77	0.75	0.73	0.73	0.72	0.72	0.72	0.72	0.72	Methods E and F
4	Single layer multicore on cable ladder system or cleats, etc	1	0.87	0.82	0.80	0.8	0.79	0.79	0.78	0.78	0.78	0.78	0.78	Methods E and F

Note:

1. These factors are applicable to uniform groups of cables, equally loaded.

2. Where horizontal clearances between adjacent cables exceeds twice their overall diameter, no rating factor need be applied.

3. The same factors are applied to: - groups of two or three single-core cables:
- multicore cables.

4. If a system consists of both two- and three-core cables, the total number of cables is taken as the number of circuits, and the corresponding factor is applied to the tables for two loaded conductors for the two-core cables, and to the Tables for three loaded conductors for the three-core cables.

5. If a group consists of n single-core cables it may either be considered as n/2 circuits of two loaded conductors or n/3 circuits of three loaded conductors.

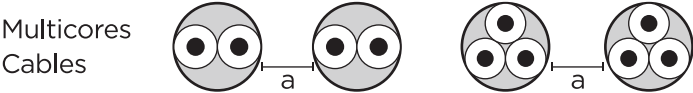
6. The rating factors given have been averaged over the range of conductor sizes and types of installation included in Table A1.1 to B4.2 the overall accuracy of tabulated values is within 5%.

7. For some installations and for other methods not provided for in the above table, it may be appropriate to use factors calculated for specific uses, see for example Table 2.9 and 2.10.

8. When Cables having differing conductor operating temperature are grouped together, the current rating is to be based upon the lowest operating temperature of any cable in the group.

9. If, due to known operating conditions, a cable is expected to carry not more than 30% of its grouped rating, it may be ignored for the purpose of obtaining the rating factor for the rest of the group. For example, a group of N loaded cables would normally required a group rating factor of C_g applied to the tabulated It. However, if M cables in the group carry loads which are not greater than $0.3 C_g I_t$ amperes the other cables can be sized using the group rating factor corresponding to (N-M) cables.

Table 2.7: Rating factors for more than one circuit, cables buried directly in the ground - Reference Method D (Multicore Cables)



Number of cables or circuits	Clearance between cables (a)				
	Nil (Cables Touching)	1 Cable Diameter	0.125m	0.25m	0.5m
2	0.75	0.80	0.85	0.90	0.90
3	0.65	0.70	0.75	0.80	0.85
4	0.60	0.60	0.70	0.75	0.80
5	0.55	0.55	0.65	0.70	0.80
6	0.50	0.55	0.60	0.70	0.80

Note:

1. Values given apply to an installation depth of 0.7m and a soil thermal resisitivity of 2.5K.m/W. These are average values for the range of cable sizes and types quoted for Table A1.1 to B4.2. The process of averaging, together with rounding off, can result in some cases in errors of up to ± 10%. (Where more precise values are required they may be calculated by methods given in BS 7769 (BS IEC 60287)).

2. In case of a thermal resistivity lower than 2.5 K.m/W the rating factors can, in general, be increased and can be calculated by the methods given in BS 7769 (BS IEC60287).

Table 2.8: Rating factors for more than one circuit, single cables in ducts buried in the ground - Reference Method D (Multicore cables in single-way ducts)



Number of ducts	Clearance between ducts (a)			
	Nil (Ducts Touching)	0.25m	0.5m	1m
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

Note:

1. Values given apply to an installation depth of 0.7m and a soil thermal resisitivity of 2.5K.m/W. These are average values for the range of cable sizes and types quoted for Table A1.1 to B4.2. The process of averaging, together with rounding off, can result in some cases in errors of up to ± 10%. (Where more precise values are required they may be calculated by methods given in BS 7769 (BS IEC 60287)).

2. In case of a thermal resistivity lower than 2.5 K.m/W the rating factors can, in general, be increased and can be calculated by the methods given in BS 7769 (BS IEC60287).



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APPENDIX B

RATING FACTORS

Table 2.9: Rating factors for groups of more than one multicore cable, to be applied to reference current-carrying capacities for multicore cables in free air - Reference Method E in Tables A1.1 to B4.2.

Installation Method in Table 1			Number of Trays or Ladders	Number of Cables per Tray of Ladder					
				1	2	3	4	6	9
Perforated Cable Tray Systems (Note 3)	31		1	See item 3 of Table 2.6					
			2	1.00	0.87	0.80	0.77	0.73	0.68
			3	1.00	0.86	0.79	0.76	0.71	0.66
			6	1.00	0.84	0.77	0.73	0.68	0.64
			1	1.00	1.00	0.98	0.95	0.91	-
			2	1.00	0.99	0.96	0.92	0.87	-
			3	1.00	0.98	0.95	0.91	0.85	-
			1	See item 3 of Table 2.6					
			2	1.00	0.88	0.81	0.76	0.71	0.70
Vertical Perforated Cable Tray Systems (Note 4)	31		1	1.00	0.91	0.89	0.88	0.87	-
			2	1.00	0.91	0.88	0.87	0.85	-
Underperforated Cable Tray Systems	30		1	0.97	0.84	0.78	0.75	0.71	0.68
			2	0.97	0.83	0.76	0.72	0.68	0.63
			3	0.97	0.82	0.75	0.71	0.66	0.61
			6	0.97	0.81	0.73	0.69	0.63	0.58



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APPENDIX B

RATING FACTORS

Table 2.9 (Con't): Rating factors for groups of more than one multicore cable, to be applied to reference current-carrying capacities for multicore cables in free air - Reference Method E in Tables A1.1 to B4.2.

Installation Method in Table 1			Number of Trays or Ladders	Number of Cables per Tray of Ladder					
				1	2	3	4	6	9
Cable Ladder Systems, Cleats, Wire Mesh Tray, etc. (Note 3)	32 33 34		1	See item 4 of Table 2.6					
			2	1.00	0.86	0.80	0.78	0.76	0.73
			3	1.00	0.85	0.79	0.76	0.73	0.70
			6	1.00	0.84	0.77	0.73	0.68	0.64
			1	1.00	1.00	1.00	1.00	1.00	-
			2	1.00	0.99	0.98	0.97	0.96	-
			3	1.00	0.98	0.97	0.96	0.93	-
			1	See item 4 of Table 2.6					
			2	1.00	0.88	0.81	0.76	0.71	0.70

NOTE 1: Values given are averages for the cable types and range of conductor sizes considered in Tables A1.1 to B4.2. The spread of values is generally less than 5%.

NOTE 2: Factors apply to single layer groups of cables as shown above and do not apply when cables are installed in more than one layer touching each other. Values for such installations may be significantly lower and must be determined by an appropriate method.

NOTE 3: Values are given for vertical spacing between cable trays of 300mm and at least 20mm between cable trays and wall. For closer spacing the factors should be reduced.

NOTE 4: Values are given for horizontal spacing between cable trays of 225mm with cable trays mounted back-to-back. For closer spacing the factors should be reduced.



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APPENDIX B RATING FACTORS

Table 2.10: Rating 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 - Reference Method F in Tables A1.1 to B4.2

Installation Method in Table 1			Number of Trays or Ladders	Number of three-phase circuits per tray or ladder			Use as a multiplier to rating for
				1	2	3	
Perforated Cable Tray Systems (Note 3)	31		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	
Vertical Perforated Cable Tray Systems (Note 4)	31		1	0.96	0.86	-	Three cables in vertical formation
			2	0.95	0.84	-	
Cable Ladder Systems, Cleats, Wire Mesh Tray, etc. (Note 3)	32		1	1.00	0.97	0.96	Three cables in horizontal formation
	33		2	0.98	0.93	0.89	
	34		3	0.97	0.90	0.86	
Perforated Systems (Note 3)	31		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 Cable Tray Systems (Note 4)	31		1	1.00	0.91	0.89	
			2	1.00	0.90	0.86	



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APPENDIX B RATING FACTORS

Table 2.10 (Con't): Rating 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 - Reference Method F in Tables A1.1 to B4.2

Installation Method in Table 1			Number of Trays or Ladders	Number of three-phase circuits per tray or ladder			Use as a multiplier to rating for
				1	2	3	
Cable Ladder Systems, Cleats, Wire Mesh Tray, etc. (Note 3)	32		1	1.00	1.00	1.00	Three cables in trefoil formation
	33		2	0.97	0.95	0.93	
	34		3	0.96	0.94	0.90	

NOTE 1: Values given are averages for the cable types and range of conductor sizes considered in Tables A1.1 to B4.2. The spread of values is generally less than 5%.

NOTE 2: Factors apply to single layer groups of cables (or trefoil groups) as shown above and do not apply when cables are installed in more than one layer touching each other. Values for such installations may be significantly lower and must be determined by an appropriate method.

NOTE 3: Values are given for vertical spacing between cable trays of 300mm and at least 20mm between cable trays and wall. For closer spacing the factors should be reduced.

NOTE 4: Values are given for horizontal spacing between cable trays of 225mm with cable trays mounted back-to-back. For closer spacing the factors should be reduced.

NOTE 5: For circuits having more than one cable in parallel per phase, each three-phase set of conductors is to be considered as a circuit for the purpose of this table.



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APPENDIX C

SHORT CIRCUIT CURRENT RATINGS

Short-Circuit Current Ratings for Low Voltage Cables

"When the duration of short-circuit current is brief (0.1 seconds up to 5 seconds maximum), all of the heat produced is assumed to remain in the conductor, causing its temperature to rise." The heating process is assumed to be adiabatic, which means there is not heat loss to the surrounding. Up to maximum of 5 seconds, the equation can determine the permissible current, I (kA) to be allowed for a conductor (in mm²), before the temperature reaches a level that would damage the insulation.

Nominal Conductor Cross-Sectional Area	Short-Circuit Current Rating					
	Copper Conductor				Aluminium Conductor	
	PVC Insulation Initial Temp: 70°C Final Temp: 160°C (S ≤ 300mm ²) Final Temp: 140°C (S > 300mm ²)		XLPE Insulation Initial Temp: 90°C Final Temp: 250°C		XLPE Insulation Initial Temp: 90°C Final Temp: 250°C	
	1 second	3 seconds	1 second	3 seconds	1 second	3 seconds
mm ²	kA		kA		kA	
1.5	0.173	0.100	0.215	0.124	-	-
2.5	0.288	0.166	0.358	0.206	-	-
4	0.460	0.266	0.572	0.330	-	-
6	0.690	0.398	0.858	0.495	-	-
10	1.150	0.664	1.430	0.826	-	-
16	1.840	1.062	2.288	1.321	1.504	0.868
25	2.875	1.660	3.575	2.064	2.350	1.357
35	4.025	2.324	5.005	2.890	3.290	1.899
50	5.750	3.320	7.150	4.128	4.700	2.714
70	8.050	4.648	10.010	5.779	6.580	3.799
95	10.925	6.308	13.585	7.843	8.930	5.156
120	13.800	7.967	17.160	9.907	11.280	6.513
150	17.250	9.959	21.450	12.384	14.100	8.141
185	21.275	12.283	26.455	15.274	17.390	10.040
240	27.600	15.935	34.320	19.815	22.560	13.025
300	30.900	19.919	42.900	24.768	28.200	16.281
400	41.200	23.787	57.200	33.024	37.600	21.708
500	51.500	29.734	71.500	41.281	47.000	27.135
630	64.890	37.464	90.090	52.013	59.220	34.191
800	82.400	47.574	114.400	66.049	75.200	43.417
1000	103.000	59.467	143.000	82.561	94.000	54.271

The maximum permissible short-circuit current of cables up to 1kV with copper conductors could be calculated with the adiabatic temperature rise equation:

$$I \text{ (kA)} = \frac{s}{\sqrt{t}} \times K$$

where

I = Short-Circuit Rating (kA)
s = Nominal Cross-Sectional Area (mm²)
t = Duration of Short Circuit (s)

*the equation is suitable for durations up to 5 seconds, source: BS 7671, IEC 60364-5-54

K = Insulation Material Specific Constant

XLPE Insulated Cable (Copper)
K = 0.143

PVC Insulated Cable (Copper)
K = 0.115 (S ≤ 300mm²)
K = 0.103 (S > 300mm²)

XLPE Insulated Cable (Aluminium)
K = 0.094

Utama Cables has taken reasonable measures to ensure that the information and data represented in this catalogue is accurate and current. However, the manufacturer reserves the right to modify specification of any of the products at their discretion and without notice. The manufacturer can accept no responsibility as to the sustainability of any product for a particular use, or for any errors or omissions, unintentional or otherwise.



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APPENDIX D

MINIMUM BENDING RADIUS OF A CABLE

The minimum bending radius is based on the diameter of the cable and the type of cable. The following formula is used:

Minimum Bending Radius (mm) = Cable Overall Diameter (mm) x Multiplier Factor

Cable Type	Minimum Bend Radius as a Multiple of Overall Cable Diameter	
	Single Core	Multi Core
PVC Cables (Non Armoured)	6D	8D
PVC Cables (Armoured)	8D	8D
XLPE Cables (Non Armoured)	8D	8D
XLPE Cables (Armoured)	8D	8D

D = Cable Overall Diameter (mm)

Permissible maximum side wall pressure to the cable at bending point during installation is 500 kgf/m.

$$\text{Side Wall Pressure to Cable (kgf/m)} = \frac{T \text{ (kgf)}}{R \text{ (m)}}$$

Where T is Pulling Tension (kgf)
R is Bending Radius (m)

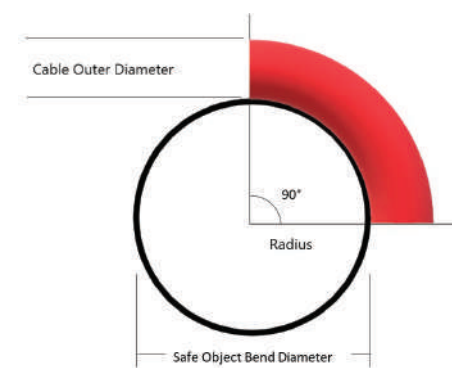


Fig 1: Min Bending Radius

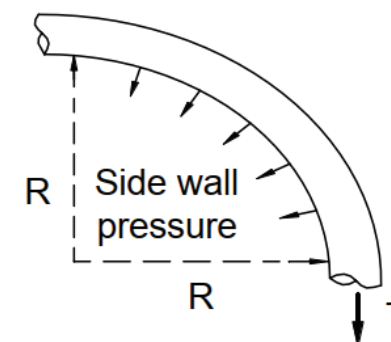


Fig 2: The Diagram of Side Wall Pressure

Permissible Maximum Side Wall Pressure To Cable

Pulling Tool	Type of Cables	Formula	Factor
Pulling eye	All types of cables	$P = \sigma \cdot A$	$\sigma = 70 \text{ N/mm}^2$ (Copper Conductor)
			$\sigma = 40 \text{ N/mm}^2$ (Aluminium Conductor)
Cable grip	Un-armoured Cables*	$P = \sigma \cdot A$	$\sigma = 50 \text{ N/mm}^2$ (Copper Conductor)
			$\sigma = 30 \text{ N/mm}^2$ (Aluminium Conductor)
	Armoured Cables**	$P = k \cdot D^2$	$k = 9 \text{ N/mm}^2$
	Lead Sheath Cables	$P = k \cdot D^2$	$k = 3 \text{ N/mm}^2$

* When pulling 3 single core cables simultaneously with a common pulling stocking, the same maximum pulling force applies, whereas the pulling force 3 laid-up single core cables is 3 times that of a single core and for 3 non-laid-up single core cables is 2 times that of a single core.

** Not applicable for high voltage cables.

P = Permissible maximum pulling force in N
A = Total cross-sectional area in mm² of all conductors (but not screen or concentric conductor)
D = Outside diameter of cable in mm
 σ = Permissible tensile stress of conductor in N/mm²
k = Empirically derived factor in N/mm²

Publications and construction of Utama Cables Low Voltage Cables are referred to the standards below:

IEC 60228:	Conductors of Insulated Cables
BS 6004:	Electric Cables – PVC Insulated, Non-Armoured Cables for Voltages Up to And Including 450/750 V, For Electric Power, Lighting and Internal Wiring
BS 6346:	Specification for 600/1000 V and 1900/3300 V Armoured Electric Cables Having PVC Insulation
BS EN 50288-7:	Multi-Element Metallic Cables Used in Analogue and Digital Communication and Control Part 7: Sectional Specification for Instrumentation and Control Cables
MS 2112-3:	Electric Cable and Wire – Polyvinyl Chloride (PVC) Insulated Cables of Rated Voltages Up to and Including 450/750 V Part 3: Non-Sheathed Cables for Fixed Wiring
MS 2112-4:	Electric Cable and Wire – Polyvinyl Chloride (PVC) Insulated Cables of Rated Voltages Up to and Including 450/750 V Part 4: Sheathed Cables for Fixed Wiring
MS 2100:	Electric Cable and Wire: 600/1000 V (U _m = 1200 V) Single Core PVC Insulated Cable – Non-Armoured
MS 2101:	Electric Cable and Wire: 600/1000 V (U _m = 1200 V) Single Core PVC Insulated Cable – Armoured
MS 2102:	Electric Cable and Wire: 600/1000 V (U _m = 1200 V) Multi Core PVC Insulated Cable – Non-Armoured
MS 2103:	Electric Cable and Wire: 600/1000 V (U _m = 1200 V) Multi Core PVC Insulated Cable – Armoured
MS 2107:	Electric Cable and Wire: 600/1000 V (U _m = 1200 V) Multi Core XLPE Insulated Cable – Armoured
IEC 60502-1:	Power Cables with Extruded Insulation and Their Accessories for Rated Voltage from 1kV (U _m = 1.2kV) up to 30kV (U _m = 36kV) Part 1: Cables for Rated Voltages of 1kV (U _m = 1.2kV) and 3kV (U _m = 3.6kV)
BS 7671:	Requirements for Electrical Installations, IET Wiring Regulations

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NOTES



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