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Australian/New Zealand Standard™

**Electrical installations— Selection of cables**

**Part 1.2: Cables for alternating voltages up to and including 0.6/1 kV—Typical New Zealand installation conditions**

**AS/NZS 3008.1.2:1998**

This Joint Australian/New Zealand Standard was prepared by Joint Technical Committee EL/1, Wiring Rules. It was approved on behalf of the Council of Standards Australia on 11 February 1998 and on behalf of the Council of Standards New Zealand on 12 February 1998. It was published on 5 May 1998.

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Australian Electrical and Electronic Manufacturers Association Canterbury Manufacturers Association, New Zealand Communications Electrical Plumbing Union, Australia

DAS Interiors Australia

Electrical Contractors Association, Qld

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*This Standard was issued in draft form for comment as DR 96408 (in part).*

Australian/New Zealand Standard™

**Electrical installations— Selection of cables**

**Part 1.2: Cables for alternating voltages up to and including 0.6/1 kV—Typical New Zealand installation conditions**

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## PREFACE

This Standard was prepared by the Joint Standards Australia/ Standards New Zealand Committee EL/1, Wiring Rules, to supersede AS 3008.1—1989, *Electrical installations— Selection of cables*, Part 1: *Cables for alternating voltages up to and including 0.6/1 kV*.

This Standard (Part 1.2) is applicable to New Zealand installation conditions where the nominal ambient air and soil temperatures are 30°C and 15°C, respectively. Part 1.1 is applicable to Australian installation conditions where the nominal air and soil temperatures are 40°C and 25°C, respectively. Each Part is a complete Standard and requires no reference to the other.

Part 2 will deal with cables for use with alternating voltages over 1 kV.

The objective of the Standard is to specify current-carrying capacity, voltage drop and short-circuit temperature rise of cables, to provide a method of selection for those types of electric cables and methods of installation which are in common use at working voltages up to and including 0.6/1 kV at 50 Hz a.c.

This Standard differs from the 1989 edition as follows:

1. Cables with a conductor operating temperature of 110°C have been added.
2. Aluminium sheathed MIMS cables have been deleted, tables for copper sheathed MIMS cables have been revised and their sheath operating temperature has been changed to 100°C.
3. Paper insulated cables have been deleted.
4. Voltage drop tables for tinned copper conductors have been deleted.
5. References have been added for aerial bundled cables.
6. Tables apply to New Zealand installation conditions.
7. Tables have been recalculated to IEC 287, *Electric cables— Calculation of the current rating* (all Parts), based on conductor, insulation and sheath dimensions in the relevant Australian/New Zealand Standards and New Zealand ambient temperatures, except as detailed in Clause 3.1.2. The current ratings for insulated aerial cables are generally based on IEC 287 and on methods proposed by Dr V.T. Morgan of the CSIRO. The work carried out by Dr V.T. Morgan was sponsored by ESAA and AEEMA.

In the preparation of this Standard, reference was made to IEC 287 and acknowledgment is made of the assistance received from that source.

Statements expressed in mandatory terms in notes to tables and figures are deemed to be requirements of this Standard.

The term ‘informative’ has been used in this Standard to define the application of the appendix to which it applies. An ‘informative’ appendix is only for information and guidance.

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## FOREWORD

This Standard gives the sustained or continuous constant current which is sufficient to produce the maximum permissible conductor temperature under specified ambient conditions. The time taken to reach this steady state temperature will vary depending on the type of cable and installation conditions. There will be many cable installations where, because of cable selection practices or demand patterns, the current is not sustained at the maximum specified in this Standard. Under these conditions care should be taken in the application of the correction factors included in Tables 22 to 26; it may be possible to derive other appropriate correction factors for these installations.

The contents of the Standard are a development of the limited provision of Appendix D to NZS 3000 and it is expected that AS/NZS 3000, currently under development, will have a modified and reduced Appendix and reference made to this Standard. For New Zealand the requirements of NZECP 28 apply and this will be updated to reflect changes in AS 3008.1, or will be withdrawn.

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## STANDARDS AUSTRALIA/ STANDARDS NEW ZEALAND

**Australian/ New Zealand Standard**

# Electrical installations— Selection of cables

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## Part 1.2: Cables for alternating voltages up to and including 0.6/1 kV— Typical New Zealand installation conditions

## S E C T I O N 1 S C O P E A N D G E N E R A L

### SCOPE AND APPLICATION

* + 1. **Scope** This Standard sets out a method for cable selection for those types of electrical cables and methods of installation which are in common use at working voltages up to and including 0.6/1 kV at 50 Hz a.c.

Three criteria are given for cable selection, as follows:

1. Current-carrying capacity.
2. Voltage drop.
3. Short-circuit temperature rise.

This Standard provides sustained current-carrying capacities and voltage drop values for those types of electrical cable and installation practices in common use in New Zealand. A significant amount of explanatory material is also provided on the application of rating factors which arise from the particular installation conditions of a single circuit or groups of circuits. Also, provided in Section 5 is information on cable selection based on short-circuit temperature limits.

NOTE: A number of worked examples on cable selection are included in Appendix A.

This Standard does not take into account the effects that may occur owing to temperature rise at the terminals of equipment and reference is necessary to NZS 3000 and the individual equipment Standards.

* + 1. **Application** This Standard is intended to apply to installations made or carried out after the date of publication, but it is recommended that it not be applied on a mandatory basis until 6 months after the date of publication. However, if work on an installation is commenced before publication of this edition, the inspecting authority may grant permission for the installation to be carried out in accordance with the superseded edition.
  1. **ALTERNATIVE SPECIFICATIONS** NZS 3000 gives current-carrying capacities for a limited number of cable installation conditions. These conditions are included in this Standard but, in some cases where recalculations have been performed, the tabulated values differ slightly between the Standards. Where this occurs the current-carrying capacity given in this Standard is considered to be more accurate, but either value is acceptable for the application of any appropriate requirements of NZS 3000, e.g. maximum current rating of a circuit-protective device.

Where the type of cable or method of installation is not specifically covered in the tables of this Standard, current-carrying capacities obtained from alternative specifications such as ERA Report 69-30 may be employed.

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ERA Report 69-30, particularly Part III, gives information on the following areas which are not covered by this Standard:

1. The d.c. current-carrying capacities of two single-core cables and one two-core cable.
2. The current-carrying capacity of armoured single-core cables.
3. Group rating factors for underground cables laid in tier formation.

Current-carrying capacities may also be determined by calculation using IEC 287 and appropriate cable data.

The subject of assigning a current-carrying capacity to a cyclically or intermittently loaded cable is not covered in this Standard as it normally relates to HV cable installation. However, reference may be made to ERA Report F/T 186 for information on the determination of such cable ratings by calculation.

### REFERENCED AND RELATED DOCUMENTS

* + 1. **Referenced documents** The following documents are referred to in this Standard: STANDARDS

AS

1125 Conductors in insulated electric cables and flexible cords

NZS

3000 Electrical installations— Buildings, structures and premises (known as the NZS Wiring Rules)

NZECP

28 New Zealand electrical code of practice for selection and installation of cables

IEC

287 Electric cables— Calculation of the current rating (all Parts)

ERA REPORTS

69-30 Current rating standards for distribution cables

Part III: Sustained current ratings for PVC-insulated cables

Part V: Sustained current ratings for armoured cables with thermo-setting insulation

F/T

186 Methods for the calculation of cyclic rating factors and emergency loading for cables laid direct in the ground or in ducts

* + 1. **Related documents** Attention is drawn to the following related documents: AS

1531 Conductors— Bare overhead— Aluminium and aluminium alloy

1746 Conductors— Bare overhead— Hard-drawn copper

3147 Approval and test specification — Electric cables — Thermoplastic insulated— For working voltages up to and including 0.6/1 kV

3158 Approval and test specification— Electric cables— Glass fibre insulated— For working voltages up to and including 0.6/1 kV

3178 Approval and test specification — Electric cables— Silicone rubber insulated— For working voltages up to and including 0.6/1 kV

3560 Electric cables— XLPE insulated— Aerial bundled— For working voltages up to and including 0.6/1 kV

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AS/NZS

3116 Approval and test specification— Electric cables— Elastomer insulated— For working voltages up to and including 0.6/1 kV

3155 Approval and test specification— Electric cables— Neutral screened— For working voltages of 0.6/1 kV

3187 Approval and test specification— Mineral-insulated metal-sheathed cables 3191 Approval and test specification— Electric flexible cords

3198 Approval and test specification— Electric cables— XLPE insulated— For working voltages up to and including 0.6/1 kV

IEC

724 Guide to the short-circuit temperature limits of electric cables with a rated voltage not exceeding 0.6/1.0 kV

* 1. **DEFINITIONS** For the purpose of this Standard, the definitions in NZS 3000, NZECP 28 and those below apply.
     1. **Ambient temperature**—the temperature of the medium in the immediate neighbourhood of the installed cable—

1. including any increase in temperature due to materials or equipment to which the cables are connected, or are to be connected; but
2. excluding any increase in temperature which may be due to the heat arising from the cables at that point.
   * 1. **Continuous loading** — a continuous constant current (100% load factor) just sufficient to produce asymptotically the maximum conductor temperature, the surrounding ambient conditions being assumed constant.
     2. **Ladder support**—a support in which the impedance of air flow around the cable is not greater than 10%, i.e. supporting metalwork under the cable occupies less than 10% of the plan area.
     3. **Perforated tray**—a tray having not less than 30% of its surface area removed by the perforation.
     4. **Route length**—the distance measured along a run of wiring from the origin of the circuit to the point of consideration, e.g. the distance measured between a switchboard and a motor.

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S E C T I O N 2 C A B L E S E L E C T I O N P R O C E D U R E

* 1. **GENERAL** The cable selection procedures set out in this Section detail the guidelines to be followed to determine the minimum size of cable required to satisfy a particular installation condition.
  2. **SELECTION PROCESS** The following three main factors influence the selection of a particular cable to satisfy the circuit requirements:

1. *Current-carrying capacity*—dependent upon the method of installation and the presence of external influences, such as thermal insulation, which restrict the operating temperature of the cable.
2. *Voltage drop*—dependent upon the impedance of the cable, the magnitude of the load current and the load power factor.
3. *Short-circuit temperature limit*—dependent upon energy produced during the short-circuit condition.

The minimum cable size will be the smallest cable that satisfies the three requirements. However, with experience it will become apparent that the different nature of installations will determine which of the requirements predominate. In general, the current-carrying capacity requirement will be the most demanding in the relatively shorter route lengths of domestic premises and the like where factors such as semi-enclosed rewirable fuse protection, cable grouping, and thermal insulation occur. On the other hand the voltage drop limitation is usually the deciding factor for longer route lengths which are not subject to the factors mentioned above. The need to increase cable size to meet the short-circuit temperature rise requirements will only occur in special situations for the voltage ratings of the cables covered by this Standard.

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* 1. **DETERMINATION OF MINIMUM CABLE SIZE BASED ON CURRENT- CARRYING CAPACITY CONSIDERATIONS** To satisfy the current-carrying capacity requirements of a circuit it is necessary to take into account a number of factors, as follows:

1. Determine the current requirements of the circuit.

NOTES:

* 1. NZS 3000 makes requirements concerning the relationship between the current required by the load connected to the circuit, the type and current rating of the overcurrent protective device, and the current-carrying capacity of the cable. Such factors will invariably determine the minimum current requirements for the application of this Standard.
  2. Where rewirable fuses form the circuit-protection, NZS 3000 makes provision for a derating factor to be applied to the current-carrying capacity of cable determined from this Standard. This derating factor is necessary because of the desire to limit the maximum permissible temperature rise under overload conditions.

1. Determine the method of cable installation to be used, as follows:
2. For a single circuit, determine if the method of installation requires the application of a derating factor selected from Tables 22, 23 or 24. Where applicable, divide the value of current determined in Step (a) by the derating factor so determined.

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1. For a group of circuits, determine if the method of installation requires the application of a derating factor selected from Tables 22 to 26. Where applicable, divide the value of current determined by Step (a) by the derating factor so determined.

NOTE: Tables 2(1), 2(2), 2(3) and 2(4) provide a guide to the installation methods and derating factors applicable to the common elastomer or thermoplastic-insulated cables.

1. Determine the environmental conditions in the vicinity of the cable installation. Where applicable, divide the value of current determined in Step (b) by—
2. the ambient air or soil temperature rating factor selected from Tables 27(1) and 27(2);
3. the depth of laying rating factor selected from Tables 28(1) and 28(2); and
4. the soil thermal resistivity rating factor selected from Table 29.
5. The resulting value of current represents the minimum current-carrying capacity required of the circuit. Reference is then made to the tables of current-carrying capacity for the different cable types, i.e. Tables 3 to 21. Taking into account the method of installation employed, the smallest conductor size which has a tabulated current-carrying capacity equal to or in excess of this predetermined minimum value will be considered to be the minimum cable size satisfying the current-carrying capacity requirement.
   1. **DETERMINATION OF MINIMUM CABLE SIZE BASED ON VOLTAGE DROP CONSIDERATIONS** To satisfy the voltage drop limitations of a circuit, it is necessary to take into account the current required by the load and the route length of the circuit, as follows:

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1. Determine the current (*I*) requirements of the circuit.
2. Determine the route length (*L*) of the circuit.
3. Determine the maximum voltage drop (*V*d) permitted on the circuit run.

NOTE: NZS 3000 generally limits the fall in voltage from the point of supply to any point of an installation to 5% of the nominal voltage at the consumers’ terminals.

1. Determine the voltage drop (*V*c) in millivolts per ampere metre (mV/A.m) using Equation 4.2(1) and the values of *I*, *L* and *V*d determined in Steps (a), (b) and (c).
2. Refer to the tables of voltage drop (mV/A.m) for the different cable types, i.e. Tables 40 to 50. Taking into account the method of installation, maximum conductor operating temperature and load power factor, the smallest conductor size which has a tabulated voltage drop (mV/A.m) value nearest to, but not exceeding, the value determined in Step (d) will be considered to be the minimum cable size satisfying the voltage drop limitation.

This simplified method gives an approximate but conservative solution assuming maximum cable operating temperatures and the most onerous relationship between load and cable power factors. A more accurate assessment can be made of the actual voltage drop (*V*d) using the appropriate equation of Clause 4.5, the cable reactance determined from Tables 30 to 33, the cable a.c. resistance determined from Tables 34 to 39 using the

approximate conductor operating temperature assessed from Equation 4.4(1), and the load power factor.

NOTES:

1. If the value of voltage drop assessed using the appropriate equation of Clause 4.5 is significantly lower than the equivalent value determined using the simplified method suggested in Steps (a) to (e), consideration should be given to the calculation of voltage drop for the next smaller cable size.

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1. Because of the need to make an initial set of assumptions relating to cable size, the calculation method of Clause 4.5 will normally only be of use to check the accuracy of the simplified method or to check the voltage drop on an existing or known cable installation.
   1. **DETERMINATION OF MINIMUM CABLE SIZE BASED ON THE SHORT-CIRCUIT TEMPERATURE CONSIDERATIONS** To satisfy the short-circuit temperature limit it is necessary to take into account the energy producing the temperature rise (*I*2*t*) and the initial and final temperatures, as follows:
2. Determine the maximum duration and value of the prospective short-circuit current.
3. Determine the initial and final conductor temperatures and select an appropriate value of the constant (*K*) from Table 51.
4. Calculate the minimum cross-sectional area of the cable using Equation 5.3(1). This cable size represents the minimum size required to satisfy the short-circuit temperature rise requirements.

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S E C T I O N 3 C U R R E N T - C A R R Y I N G C A P A C I T Y

### RATINGS

* + 1. **General** The provisions of this Section apply to the selection of conductor sizes with regard to current-carrying capacity.

Clauses 3.2 to 3.5 stipulate conductor and cable requirements and installation conditions in order that the subsequent tables of current-carrying capacity may be applied.

Tables 2(1) to 2(4) give guidance to the appropriate table of current-carrying capacity for different installation methods for the common types of cable insulant covered by Tables 3 to 14. A specific installation condition is defined and illustrated and alternative installation conditions deemed to have the same current-carrying capacity are also given. Attention is drawn to tables of rated current-carrying capacity where the standard installation conditions of Clause 3.4 are varied.

Tables 3 to 21 give the current-carrying capacities for the variety of different cable types described in Clause 3.3.

* + 1. **Basis** The values for current ratings given in Tables 3 to 14 have been calculated using the method described in IEC 287 except for 75°C and 90°C rated cables enclosed in conduit in air or partially surrounded by thermal insulation.

NOTE: The parameters for calculating current ratings in PVC conduits in IEC 287 are still under consideration and considerable disparity was noted between values calculated using available parameters and those previously published in the 1989 edition as well as other International Standards.

It has therefore been decided in these cases to leave the values previously assigned in the 1989 edition even though in some cases these appear to be higher than would normally be justified. The ratings, however, for all other cables have been compared with international data and confirm the validity of using the IEC 287 method.

When IEC 287 is suitably amended then it is proposed to undertake a revision of this Standard to correct these anomalies.

Furthermore it should be noted that the current ratings for 110°C rated cables enclosed in conduit in air assume the use of metallic conduit. If non-metallic conduits are used then these ratings are not applicable.

### TYPES OF CONDUCTORS

* + 1. **Conductor material** The current-carrying capacities are based on conductors of high-conductivity copper and aluminium in sizes, strandings and resistances complying with AS 1125.
    2. **Insulation material operating temperatures** The sustained current-carrying capacities are based on the ‘normal use’ temperatures specified in Column 2 of Table 1. Where the ‘maximum permissible’ temperature in Column 3 of Table 1 is greater than the ‘normal use’ temperature, the ‘maximum permissible’ temperature may only be used under the conditions described in Note 2 to Table 1 for thermoplastic cables and in Note 3 to Table 1 for MIMS cables.

NOTE: Where cables are consistently operating substantially below the limiting temperature of Table 1, the heat losses (*I*2*R*) and voltage drop (*IZ*) will also be reduced. These features could be relevant in determining the optimum economic design of a circuit.

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### TYPES OF CABLE

* + 1. **Sheathed and unsheathed thermoplastic, elastomer and XLPE cables**
       1. *General* The current-carrying capacity of sheathed and unsheathed thermoplastic, elastomer or XLPE insulated cables shall be determined from Tables 3 to 14.
       2. *Method of installation* The current-carrying capacity of a given cable depends on the method of installation. Tables 2(1) to 2(4) provide a schedule of the installation methods applicable to sheathed and unsheathed elastomer or thermoplastic cables whose current-carrying capacities are given in Tables 3 to 14. Tables 2(1) to 2(4) also draw attention to the different methods of installation which may be assigned the same current-carrying capacity and refers to tables of derating factors applicable where one circuit is run in close proximity to another circuit or circuits.

### Flexible cords and cables

* + - 1. *Used for fixed wiring* The determination of current-carrying capacity of flexible cords and cables used for fixed wiring shall be as follows:

1. *Not subject to flexing* The current-carrying capacity of flexible cords and cables used as fixed wiring which are not subject to flexing in normal use shall be determined from values for other cables of the corresponding insulant type as given in Tables 3 to 14.

NOTE: The appropriate rating factors applicable to Tables 3 to 14 are applicable when the current-carrying capacity of flexible cords and cables is determined in accordance with Item (a).

1. *Subject to flexing* The current-carrying capacity of flexible cables and cords used as fixed wiring but which are subject to flexing in normal use, shall be determined from Tables 15 or 16.

### TABLE 1

**LIMITING TEMPERATURES FOR INSULATED CABLES**

|  |  |  |
| --- | --- | --- |
| 1 | 2 | 3 |
| **Type of cable insulation** | **Operating temperatures of conductors, °C (see Note 1)** | |
| **Normal use** | **Maximum permissible** |
| Thermoplastic (see Note 2) |  |  |
| V-75 and HFI-75-TP | 75 | 75 |
| V-90 and HFI-90-TP | 75 | 90 |
| V-90HT | 75 | 105 |
| Elastomer |  |  |
| R-EP-90, R-CPE-90, R-HF-90 and R-CSP-90 | 90 | 90 |
| R-HF-110 and R-E-110 | 110 | 110 |
| Cross-linked polyethylene (XLPE) |  |  |
| X-90 and X-HF-90 | 90 | 90 |
| X-HF-110 | 110 | 110 |
| Mineral-insulated | 100 (sheath) | 250 (sheath) |
| Copper sheathed (MIMS) (see Note 3) |  |  |
| High temperature (see Note 4) |  |  |
| R-S-150 elastomer | 150 | 150 |
| Type 150 fibrous or polymeric | 150 | 150 |
| Type 200 fibrous or polymeric | 200 | 200 |

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NOTES:

1. The temperature limits specified in Table 1 relate to the sustained current-carrying capacity and do not represent the maximum permissible temperatures permitted under short-circuit conditions. A guide to the acceptable short-circuit temperature limits is given in Section 5.
2. The current-carrying capacities for thermoplastic cables, including flexible cords used as fixed wiring, insulated with V-90 and V-90HT PVC compounds have been based on a conductor operating temperature of 75°C because of the likelihood of thermal deformation of these cable types in the temperature range 90 to 105°C. Cables may be operated in that temperature range when incorporated as equipment wiring and not exposed to mechanical damage, e.g. in certain types of luminaires and heating appliances. Cables totally surrounded by thermal insulation may be considered not exposed to mechanical damage.
3. The current-carrying capacities for MIMS cables are based on an operating temperature of 100°C for the external surface of either bare metal-sheathed cables or served cables. Higher continuous operating temperatures are permissible for bare metal-sheathed cables, particularly stainless steel sheathed cables, dependent upon factors such as the following:
   1. The suitability of the cable terminations and mountings.
   2. The location of the cable away from combustible materials.
   3. The location of the cable away from areas where there is a reasonable chance of persons touching the exposed surface.
   4. Other environmental and external influences.
4. The current-carrying capacities given in Table 17 for cables insulated with high temperature elastomer, polymeric or fibrous materials are based on cables operating at temperatures of 150°C in an ambient temperature of 30°C and where the hot cable surfaces are acceptable. However, the cables are generally installed in areas of high ambient temperature, such as equipment wiring, and it will be necessary to apply an appropriate temperature correction factor from Table 27.

The current-carrying capacities for fibrous and polymeric (PTFE) type cables and cords suitable for operation at 200°C are not given in this Standard. As an alternative to the use of the relatively conservative values given in Table 17, advice may be sought from cable manufacturers.

1. Cables with an operating temperature of 110°C should only be connected to equipment suitable for this temperature. Consideration should also be given to the voltage drop at this operating temperature.
   * + 1. *Other than fixed wiring* The determination of current-carrying capacity of flexible cords and cables used for other than fixed wiring shall be as follows:

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1. *General* Except as provided in Item (b), the current-carrying capacity of flexible cords and cables not used as fixed wiring shall be determined from Tables 15 and 16.
2. *Connection of appliances* Where a flexible cord is—
   1. used for the connection of an appliance to the fixed wiring by means of a plug and socket; and
   2. the appliance comes within the scope of associated Standards;

the current-carrying capacity shall be determined from the appropriate Standard.

* + 1. **Mineral-insulated metal-sheathed (MIMS) cables** The current-carrying capacity of bare or served copper MIMS cables shall be determined from Tables 18 and 19.

NOTE: Current-carrying capacities are not given in this Standard for polyethylene served or other forms of MIMS cable used for heating purposes, such as trace heating, tank heating or floor warming.

* + 1. **Aerial cables** The current-carrying capacity of aerial cables shall be determined from Tables 20 and 21. See Clause 3.3.5 for the determination of the current-carrying capacity of neutral-screened aerial cables.
    2. **Neutral-screened cables** The current-carrying capacity of neutral-screened cables shall be determined from Tables 9 to 14, as appropriate to the number of cable cores and method of installation. However, the current-carrying capacity of neutral-screened aerial cables shall be determined as follows:

1. For two-core neutral-screened cable . . . . . . . . . . . . Columns 8 to 10 of Table

20 or Table 21, as appropriate.

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1. For three- or four-core neutral-screened cable . . . . . Columns 11 to 13 of Table

20 or Table 21, as appropriate.

* + 1. **High temperature elastomer, polymeric or fibrous cables and flexible cords** The current-carrying capacity of R-S-150 elastomer insulated cables, Type 150 heat-resisting fibrous insulated cables and Type 150 PTFE insulated flexible cords shall be determined from Table 17.
    2. **Other cable types** This Standard provides current-carrying capacities for types of cables that are considered to be in common use. For cables not included in this Standard, cable manufacturers should be consulted for recommendations on the current-carrying capacity and acceptable methods of installation.

### 3.4 INSTALLATION CONDITIONS

**3.4.1 General** The current-carrying capacity of a cable is dependent on the method of installation to maintain the temperature of the cable within its operating limits. Different methods of installation vary the rate at which the heat generated by the current flow is dissipated to the surrounding medium.

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Specific conditions of installation are laid down in Clauses 3.4.2 to 3.4.5 for cables installed with or without wiring enclosures in air, in the ground or embedded in building materials. These conditions have been used to derive the current-carrying capacities tabulated in Section 3. Where a number of installation conditions exist along a cable run or variations to the specific conditions occur, reference shall be made to Clauses 3.4.6 and

3.5 respectively.

* + 1. **Cables installed in air** For cables installed in free air, the current-carrying capacities shall be based on the following conditions of installation and operation:

1. *Ambient temperature* An ambient air temperature of 30°C.
2. *Unenclosed cables* Cables installed as follows:
   1. Directly in air and, except for flexible cables as mentioned in Note 2 to Table 1 and aerial cables, not exposed to direct sunlight and where they are—
      1. lying on a horizontal surface;
      2. lying across ceiling joists;
      3. supported on perforated or unperforated cable trays, ladders, hangers or racks;
      4. clipped at intervals to a vertical or horizontal surface, such as a wall or beneath a ceiling;
      5. suspended from a catenary wire;
      6. lying in the bottom of open trunking; or
      7. in an enclosure such as a switchboard.
   2. Directly embedded beneath the surface of plaster, cement render or masonry.

NOTE: Table 2(1) contains a reference to the appropriate current-carrying capacity table for cables installed unenclosed in air.

1. *Enclosed cables* Cables installed as follows:
   1. In metallic or non-metallic wiring enclosure in—
      1. free air;
      2. a ventilated or enclosed trench;

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* + 1. a concrete slab on or above the surface of the ground; or
    2. a concrete, plaster, cement rendered or masonry wall.
  1. In closed trunking.
  2. In an enclosed trench with removable covers.
  3. Directly buried in concrete.

NOTES:

1. Table 2(2) contains a reference to the appropriate current-carrying capacity table for enclosed cables installed in air.
2. Where an otherwise unenclosed cable run includes short lengths of wiring enclosure which do not restrict the free circulation of air, the current-carrying capacity for unenclosed conditions may be assigned to the cable run provided that the following are complied with:
   1. The total above-ground sections do not exceed half the length of the cable run or 6 m, whichever is the shorter dimension.
   2. The wiring enclosure is not surrounded by thermal insulation.
   3. The wiring enclosure is of adequate size to permit free air circulation to dissipate any heat arising from the enclosed cables. This would be satisfied if the wiring enclosure—
      1. has a bore area not less than twice the total cross-sectional area of the enclosed live cables;
      2. is arranged in a substantially vertical direction; and
      3. has an open upper end or other means which will not restrict the escape of hot air to the surroundings.
3. Selection of wiring enclosure material needs to take into account the highest sheath temperature of the cable.
   * 1. **Cables installed in thermal insulation** For cables installed in thermal insulation the current-carrying capacities shall be based on the following conditions of installation and operation:
4. *Ambient temperature* An ambient temperature of the air surrounding the thermal insulation of 30°C.
5. *Unenclosed cables* Cables installed without further enclosure—
   1. lying on a horizontal surface;
   2. lying across ceiling joists;
   3. supported on perforated or unperforated cable trays, ladders, hangers or racks;
   4. clipped at intervals to a vertical or horizontal surface such as a wall or ceiling joist; or
   5. lying in the bottom of open trunking.

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1. *Enclosed cables* Cables installed in—
   1. metallic or non-metallic wiring enclosure; or
   2. closed trunking or ducts.
2. *Bulk thermal insulation* Bulk thermal insulation installed as follows:
   1. *Materials* Building materials installed to provide a thermal insulation including—
      1. fibreglass or rockwool batts;
      2. cellulose fibre, paper, cork, seagrass or similar organic materials which are normally installed in a loose-fill form; or

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* + 1. expanded synthetic foams such as polystyrene ureaformaldehyde or polyurethane which may be installed by pumping or injection as a wet foam.

NOTE: Reflective foil laminates are not considered to be bulk thermal insulation.

* 1. *Completely surrounded installation* An installation method where bulk thermal insulation surrounds, and is in contact with, unenclosed or enclosed cables.

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* 1. *Partially surrounded installation* An installation method where bulk thermal insulation is prevented from completely surrounding unenclosed or enclosed cable, such as where an unenclosed or enclosed cable is clipped to a structural member or is lying on a ceiling.

NOTE: Table 2(2) contains a reference to the appropriate current-carrying capacity table for cables installed in thermal insulation.

* + 1. **Cables buried direct in the ground** For cables buried direct in the ground, the current-carrying capacities shall be based on the following conditions of installation and operation:

1. *Ambient temperature* An ambient soil temperature of 15°C.
2. *Depth of laying* A depth of laying of 0.5 m measured from the ground surface to the centre of a cable, or to the centre of a trefoil group of cables.
3. *Thermal resistivity of soil* A soil thermal resistivity of 1.2°C.m/W.
4. *Spacing of cables* Cables are spaced as follows:
   1. *Single-core cables* Either—
      1. three single-core cables laid touching throughout in trefoil formation; or
      2. two or three single-core cables laid touching in flat formation.
   2. *Multicore cables* Multicore cables laid singly.

NOTE: Table 2(3) contains a reference to the appropriate current-carrying capacity table for cables buried direct in the ground.

* + 1. **Cables installed in underground wiring enclosures** For cables installed in underground wiring enclosures, the current-carrying capacities shall be based on the following conditions of installation and operation:

1. *Ambient temperature* An ambient soil temperature of 15°C.
2. *Depth of laying* A depth of laying of 0.5 m measured from the ground surface to the centre of a wiring enclosure, or to the centre of a trefoil group of wiring enclosures.
3. *Thermal resistivity of soil* A soil thermal resistivity of 1.2°C.m/W.
4. *Spacing of wiring enclosures* Wiring enclosures shall be spaced as follows:
   1. Single-core cables in separate wiring enclosures with—
      1. two ducts side by side touching; or
      2. three ducts in trefoil, or in flat formation touching.
   2. Single-core cables as a circuit in a single wiring enclosure.
   3. Multicore cable in a single wiring enclosure.

NOTE: Table 2(4) contains a reference to the appropriate current-carrying capacity table for cables installed in underground wiring enclosures.

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* + 1. **Variation of installation conditions along cable run** In situations where one method of installation is used for part of a cable run and other methods for the remainder, the current-carrying capacity of the cable run shall be limited to the lowest value of current determined for each method of installation employed, unless precautions are taken which avoid cable overheating.

NOTES:

* + - 1. An example of appropriate precautions is where long runs of cable buried direct in the ground are enclosed in wiring enclosures when passing beneath roadways and the like. The use of selected backfill materials over the enclosed cables can improve the conduction of heat away from the cables and as a consequence higher current-carrying capacities, in the order of that for buried direct cables, can be sustained by the short lengths of enclosed cables.
      2. Note 2 to Clause 3.4.2(c) describes a situation where a short length of suitably arranged enclosure may be disregarded for the assignment of a current-carrying capacity to an otherwise unenclosed cable run in air.
      3. Attention is drawn to the connection of equipment to an underground cable run by means of short lengths of enclosed or unenclosed cables in air. The current-carrying capacity assigned to the underground portion of the cable run may be assigned to the above-ground portion where the prevailing installation conditions maintain the final operating temperature of the cable within the limits given in Table 1.

### EXTERNAL INFLUENCES ON CABLES

* + 1. **Application of rating factors** The current-carrying capacity of a cable will be affected by the presence of certain external influences as detailed in Clauses 3.5.2 to

3.5.8. Under such conditions the current-carrying capacity given in Tables 3 to 21 shall be corrected by the application of an appropriate rating factor or factors obtained from Tables 22 to 28.

### Effect of grouping of cables

* + - 1. *General* The current-carrying capacities given in Tables 3 to 21 relate to single circuits.

Where a number of circuits are installed in the same group in free air, on a surface, buried direct in the ground or within the same sheath or wiring enclosure, in such a way that they are not independently cooled by the ambient air or the ground, the appropriate derating factor shall be as given in Tables 22 to 26.

Specific guidance on the use of Tables 22 to 26 is given in Clauses 3.5.2.3 to 3.5.2.7 and Table 2.

NOTES:

* + - * 1. The derating factors have been calculated on the basis of sustained operation of all cables within the group. In most instances the loading on all cables in the group will not occur simultaneously and as a result actual factors may vary from those in Tables 22 to 26. Actual values would need to be calculated according to loading.
        2. Where cables of different temperature rating are grouped, they should be rated at the rating appropriate to the lowest temperature cable, unless adequate spacing is provided in accordance with Figure 1.
      1. *Installation conditions which avoid derating* The derating factors of Tables 22 to 26 are not applicable to the following conditions of grouped cables:

1. *MIMS cables* MIMS cables without serving unless other types of cables are installed in close proximity or within the same wiring enclosure. The higher operating temperature achieved by grouping will not affect the mineral insulation of the unserved cable. However, care must be taken that the cable environment and means of support can withstand the higher temperatures.

NOTE: See Note 3 to Table 1.

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1. *Limited length of grouping* Groups of cables such as at a switchboard entry, provided that the length of wiring enclosure does not exceed—
   1. for conductor sizes smaller than 300 mm2 for aluminium and

smaller than 150 mm2 for copper . . . . . . . . . . . . . . . . . . . . . . . . . . . 1 m;

* 1. for conductor sizes of 300 mm2 or larger for aluminium and

150 mm2 or larger for copper . . . . . . . . . . . . . . . . . . . . . . . . . . . . 3 m; or

* 1. half the length of the cable; whichever is the shorter dimension.

1. *Groups of circuits in free air* Groups of circuits installed unenclosed under the conditions and circuit arrangements depicted in Figure 1.
2. *Cables operating below current-carrying capacity* Cables which, as a result of the conditions of operation of the installation or cable selection practices, are operating at less than 35% of its current-carrying capacity (see Figure 1, Note 3).
   * + 1. *Cables run horizontally* For cables installed horizontally the following shall apply:
3. *Unenclosed on cable tray, ladder support, rack hanger or cleat* Where a single-core or multicore cable is installed horizontally in close proximity to a cable or cables of another circuit and—
   1. it is on perforated or unperforated trays, ladder supports, racks, hangers or cleats; and
   2. it is either—
      1. touching the other cable or cables; or
      2. in terms of its spacing from the other cable or cables, less than that specified in Clause 3.5.2.2(c) and Figure 1;

the appropriate derating factor shall be as given in Table 23 or Table 24.

1. *Enclosed, fixed to a surface, or bunched in free air* Where a single-core or multicore cable is installed horizontally in close proximity to a cable or cables of another circuit—
   1. within a wiring enclosure;
   2. on a surface, wall, floor or ceiling, spaced or touching;
   3. bunched in free air; or
   4. suspended from a catenary;

the appropriate derating factor shall be as given in Table 22.

* + - 1. *Cables run vertically* Where a cable is installed vertically, the appropriate current-carrying capacities and derating factors shall be—

1. obtained from Tables 22 to 24 as for cables run horizontally; and
2. if a barrier is not provided at intervals of 3.5 m or less to prevent the vertical flow of air along the cable, determined in accordance with Clause 3.5.3 using the highest ambient air temperature up the cable run.
   * + 1. *Cables buried direct in the ground* Where a single-core or multicore cable is buried directly in the ground and is separated by not less than 2 m from a cable or cables of another circuit carrying substantial currents, no derating factor need be applied. Where the circuits are separated by less than 2 m, the appropriate derating factor shall be obtained from Table 25 except for installation methods not covered in this Standard, for which alternative specifications are recommended in Clause 1.2.

NOTE: The derating factors have been determined from the hottest cable in the group and assume that all cables are of the same thermal grade of insulation.

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* + - 1. *Cables in wiring enclosures* For cables in enclosures the following shall apply:

1. *Underground wiring enclosures* Where a single-core or multicore cable is installed in an underground wiring enclosure and is separated by not less than 2 m from a cable or cables of another enclosed circuit carrying substantial currents, no derating factor need be applied. Where the enclosed circuits are separated by less than 2 m, the appropriate derating factor shall be as given in Table 26 or, for installation methods not covered in this Standard, alternative specifications as recommended in Clause 1.2.
2. *Other enclosures* Where cables are installed in an enclosure such as a switchboard, the current-carrying capacity shall be determined from the unenclosed in air conditions in Tables 3 to 8 with due regard being given to the derating factors when circuits are bunched.

NOTE: The selection of the derating factor should be based on the number of circuits that would be loaded; for example, where nine circuits are bunched but only six are loaded at any one time, a derating factor of 0.57 from Table 22 would be applicable.

* + - 1. *Conductors connected in parallel or passing more than once within a group or enclosure* In applying the derating factors of Tables 22 to 26 where—

1. a group of conductors forming a circuit passes more than once through the same wiring enclosure, group of cables or group of enclosures; or
2. groups of conductors are connected in parallel;

each separate group of conductors shall be regarded as a separate circuit.

In parallel circuits of single core cables, electrically asymmetric arrangements give rise to unequal load sharing and consequently the heating effects in some cables can be substantially greater than in a single circuit.

NOTE: See Appendix B for recommended circuit configurations for the installation of single-core cables in parallel.

* + 1. **Effect of ambient temperature** The current-carrying capacities given in the tables of this Standard are based on a consistent ambient air temperature of 30°C and an ambient soil temperature of 15°C. Where other ambient temperatures apply, the appropriate rating factors shall be as given in Table 27.

NOTES:

* + - 1. In Australia the conditions of installation specify an ambient temperature of 40°C and a soil temperature of 25°C. A complete set of current rating tables, calculated for Australian conditions is given in AS/NZS 3008.1.1.
      2. Particular consideration should be given to the existence of higher ambient air temperatures in confined roof spaces, boiler rooms, cable tunnels, vertical shafts and the like. Similarly, lower ambient temperatures may apply for cables installed in concrete slabs on or above the surface of the ground.
      3. In practice the ambient air temperature may be measured by one of the following simple methods:
         1. *Before installation of cables* Measurement may be made by temperature sensors placed in free air as close as practicable to the position at which the cables are to be installed.
         2. *After installation of cables* Measurement may be made by temperature sensors placed in free air in the vicinity of the cables in such a position that readings are not influenced by heat arising from the cables. Where the measurements are made while the cables are loaded, e.g. as may be required by Clause 3.5.2.4 for vertical cable runs, the sensors should be placed approximately 500 mm, or 10 times the overall diameter of the cable, from the cables in a horizontal plane, or 150 mm below the cables.

If at the cable position, the ambient temperature, including any increase of temperature due to heat arising from equipment to which the cables are connected, does not exceed 30°C except for infrequent combinations of weather and load currents, then the current-carrying capacities given in the tables apply without correction.

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* + 1. **Effect of depth of laying** The current-carrying capacities given in the tables of this Standard are based on a depth of laying of 0.5 m as specified in Clauses 3.4.4 and

3.4.5. Where other depths of laying apply, the appropriate rating factors shall be as given in Table 28.

NOTE: The rating factors are based on the assumption that the effective thermal resistivity of the ground is constant from a depth of 0.5 m to 3 m. Above and below these respective limits it is considered that a reduction in effective thermal resistivity occurs due to the composition and moisture content of the soil.

* + 1. **Effect of thermal resistivity of soil** The current-carrying capacities given in the tables of this Standard are based on a soil thermal resistivity of 1.2°C.m/W.

Soil thermal resistivity varies greatly with soil composition, moisture retention qualities and seasonal weather patterns as well as the variation in load carried by the cable. Higher current-carrying capacities are obtained in clay or peat soils which may have resistivities as low as 0.8°C.m/W. Similarly, values as high as 2.5°C.m/W may be associated with well drained sands for constantly loaded cables. The value of 1.2°C.m/W has been selected as an average figure on the basis of soil types and assumes maximum thermal resistivity at times of maximum load.

If possible the actual value should be measured along the cable route as it can greatly affect the current-carrying capacity of the cable. Where values for soil resistivities other than 1.2°C.m/W apply, the appropriate rating factors may be obtained from Table 29.

NOTE: Where the soil is known to be of poor quality and has a thermal resistivity greater than 1.2°C.m/W throughout much of the year, consideration should be given to the use of a selected or stabilized backfill material around the cables or wiring enclosures.

Such backfill should completely surround the cable with a minimum thickness of 200 mm and could be used in lieu of the bedding required in NZS 3000.

The following two types of material have a worst-case or dried-out thermal resistivity in the order of 1.2°C.m/W:

1. *Cement-bound sand* A mixture of sand bound with cement in the ratio of 14:1 by volume, with water added to enable adequate compaction to be achieved.
2. *Gravel/sand* A mixture of a selected sand having a dried-out thermal resistivity of not greater than 2.7°C.m/W, with an equal quantity of 10 mm coarse aggregate.
   * 1. **Effect of varying loads** The current-carrying capacities given in the tables of this Standard and the derating factors given in Clauses 3.5.2 to 3.5.5 are based on continuous loading on all conductors. Where it can be shown that intermittent load variations will occur or that all conductors cannot be loaded simultaneously, appropriate uprating factors may be applied.

In many installations, groups of cables comprise a mixture of loaded and unloaded cables at any one time and the designer may justify the use of alternative derating factors to those specified in Tables 22 to 26, if the connected loads have a known diversity. If the diversity is unknown or unobtainable by experiment, the design may have to be based on worst-case analysis of the possible load combinations at any one time. Some information on the diversity of certain loads may be obtained from the determination of maximum demand in NZS 3000.

* + 1. **Effect of thermal insulation** Current-carrying capacities are given in Tables 3 to

14 of this Standard for unenclosed or enclosed cables surrounded by bulk thermal insulating materials which affect the rate of heat dissipation from the cables.

The rate of heat dissipation varies with the type and thickness of material used; a comparative measure of the performance of different materials is known as the R-factor.

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The current-carrying capacity values in the tables are based upon typical installation conditions and a range of different materials as described in Clause 3.4.3. Where different materials or installation conditions are used such that the rate of heat dissipation is adversely or favourably affected, lower or higher current-carrying capacities may be obtained respectively.

NOTES:

1. Where a length of cable not exceeding 150 mm passes through bulk thermal insulation, e.g. for the connection of a lighting point, the cable need not be considered as being surrounded by thermal insulation.
2. A cable is considered to be affected by thermal insulation if it is embedded in, or surrounded by, insulating material. Cables lying on top of suitably rigid material do not in general come into this consideration.
   * 1. **Effect of direct sunlight** Current-carrying capacities are given in Tables 15, 20 and 21 for flexible cables and aerial cables exposed to direct sunlight. For other types of cable installed in locations exposed to direct solar radiation it will be necessary to make some provision for the effects of the increased heating. This may be achieved by one of the following means:
3. Provision of a shield, screen or enclosure which allows for the natural ventilation of the cable.
4. Reduction of the current-carrying capacity of the cable by an appropriate amount in accordance with the higher air temperature. As a rule-of-thumb alternative to any recommendation from a cable manufacturer, a correction factor obtained from Table 27(1) for a temperature 20°C higher than the ambient air temperature may be applied.

NOTE: For further information on the effects of ultraviolet radiation it is recommended that the cable manufacturer be consulted.

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|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Method of installation** | **Horizontal spacings** | | | | **Vertical spacings** |
| Cables suspended from a |  |  |  |  |  |
| catenary wire where air |  |  |  |  |
| circulation is unrestricted |  |  |  |  |
| or spaced from surfaces |  |  |  |  |
| and supported on ladders, |  |  |  |  |
| racks, hangers or cleats |  |  |  |  |
| where the impedance of |  |  |  |  |
| the air flow around the |  |  |  |  |
| cable is not greater than |  |  |  |  |
| 10% |  |  |  |  |
| Cables spaced from surfaces and supported on perforated or unperforated cable trays where air circulation is partially restricted |  | | | |  |
| Cables fixed directly to a wall, floor, ceiling or similar surface where air circulation is restricted |  | | | |  |

* 1. Single-core cables



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|  |  |  |
| --- | --- | --- |
| **Method of installation** | **Horizontal spacings** | **Vertical spacings** |
| Cables suspended from a catenary wire where air circulation is unrestricted or spaced from surfaces and supported on ladders, racks, hangers or cleats where the impedance of the air flow around the cable is not greater than 10% |  |  |
| Cables spaced from surfaces and supported on perforated or unperforated cable trays where air circulation is partially restricted |  |  |
| Cables fixed directly to a wall, floor, ceiling or similar surface where air circulation is restricted |  |  |

* 1. Multicore cables



FIGURE 1 MINIMUM CABLE SPACINGS IN AIR TO AVOID DERATING

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NOTES TO FIGURE 1:

1. *D* equals cable outside diameter or, in the case of a flat multicore cable, the maximum dimension of the cable.
2. For simplicity, the illustrations depict balanced multiphase circuits. Where a neutral conductor is required to be substantially loaded it shall be placed adjacent to the associated active conductors and the clearance measured as appropriate (see Note 3 for lightly loaded or unloaded conductors).
3. The illustrations are intended to depict clearances required between cables operating at or near their sustained current-carrying capacity. Where the loading of any cable is less than 35% of such sustained capacity it may be disregarded from the cable arrangements as its contribution to the mutual heating of the group will be small. Such cables, which would include earthing conductors, lightly loaded neutrals and unloaded control wiring, may be placed adjacent to, or between, groups of associated loaded conductors.
4. Where the cables concerned are not of the same size, the spacing will be based on the largest cable diameter in the adjacent groups.
5. The spacings are essentially minimum requirements to avoid derating and care should be taken, particularly with smaller spacings, to avoid installation methods which would reduce these clearances. No restriction is placed on the number of circuits that may be arranged horizontally with the spacings given; however, care should be taken if more than three circuits are arranged vertically and full cable utilization is required.
6. Where the spacings are not achieved, smaller spacings and derating factors are laid down in the following tables:
   1. For circuits installed directly on walls, floors or ceilings . . . . . . . . . . . . . . . . . . . . . . . . Table 22.
   2. For circuits installed on trays, ladder supports, racks, hangers or cleats . . . . . . . . Tables 23 and 24.
7. Proportionally smaller spacings would be acceptable where the cables in the group are not loaded to the full current-carrying capacity. In such cases appropriate rating factors may be obtained from ERA Report 69-30.

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### TABLE 2(1)

**SCHEDULE OF INSTALLATION METHODS FOR CABLES DEEMED TO HAVE THE SAME CURRENT-CARRYING CAPACITY AND CROSS-REFERENCES**

**TO APPLICABLE DERATING TABLES— UNENCLOSED IN AIR**

1 2 3 4 5 6



**Item No.**

**Cable details (see Note 2)**

**Reference drawing (see Note 3)**

**Current-carrying capacity table reference**

**Methods of installation for cables deemed to have the same current-carrying capacity (See Notes 4, 5 & 6)**

Cables with minimum cable separations in air as shown for horizontal and vertical

**Derating table for more than one circuit**

1 Two single- core cables

Tables 3 and 4

Columns 2 and 3

mounting and installed —

1. spaced from a wall or vertical surface;
2. supported on ladders, racks, perforated

trays, cleats or hangers; 23

or

2

Three single- core cables

3

4 Two single- core cables

5

Three single- core cables

6

1. Two single-

core cables

1. Three single- core cables

Tables 6 and 7

Columns 2 and 3

Tables 3 and 4

(see Note 5)

Columns 4 and 5

Tables 6 and 7

(see Note 5)

Columns 4 and 5

Tables 3 and 4

(see Note 4)

Columns 6 and 7

Tables 6 and 7

(see Note 4)

Columns 6 and 7

1. suspended from a catenary wire. 22

Cables with minimum cable spacings in air as shown and installed —

1. spaced from a wall or vertical surface;
2. supported on ladders, racks, perforated or unperforated trays, cleats or hangers;
3. in a switchboard or similar enclosure; 23

or

1. suspended from a catenary wire. 22

Cables of the one circuit touching and installed —

1. clipped direct to a wall, floor, ceiling or similar surface;
2. in a ventilated trench or open trunking; 22
3. buried directly in a plaster or render on a wall; or
4. in a switchboard or similar enclosure.
5. Two-core cables

Tables 9 and 10

(see Note 5)

Columns 2 and 3

Cables with minimum spacings in air as shown and installed —

1. spaced from a wall or vertical surface;
2. supported on ladders, racks, perforated or unperforated trays, cleats or hangers;
3. in a switchboard or similar enclosure; 24

or

1. Three-core cables

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11

Tables 12 and 13

(see Note 5)

Columns 2 and 3

1. suspended from a catenary or as a self- supported overhead cable.

22

(*continued*)

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**TABLE 2(1)** (*continued*)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 6 |
| **Item No.** | **Cable details (see Note 2)** | **Reference drawing (see Note 3)** | **Current-carrying capacity table reference** | **Methods of installation for cables deemed to have the same current-carrying capacity (See Notes 4, 5 & 6)** | **Derating table for more than one circuit** |
| 12 | Two-core cables |  | Tables 9 and 10  (see Note 4)  Columns 4 and 5 | Cables installed —   1. clipped direct to a wall, floor, ceiling or similar surface; 2. buried directly in concrete or masonry above the ground or in plaster or render on a wall; 3. in a ventilated trench or open trunking; or 4. in a switchboard or similar enclosure | 22 |
| 13 | Three-core cables |  | Tables 12 and 13  (see Note 4)  Columns 4 and 5 |

NOTES:

* 1. *D* equals cable outside diameter or, in the case of a flat multicore cable, the maximum dimension of the cable.
  2. Earthing conductors, lightly loaded neutral conductors of three-phase circuits and conductors subject only to momentary loading, such as control wiring, shall not be counted in the number of cable cores.
  3. See column headings of Tables 3 to 14.
  4. See Table 22 for the derating factor applicable to a single circuit fixed to the underside of a ceiling or similar horizontal surface.
  5. See Tables 23 and 24 for the derating factors applicable to a single circuit fixed to perforated or unperforated trays.
  6. See NZS 3000 for the restricted installation conditions of certain types of cable, e.g. unarmoured cables in plaster or cement render on walls.

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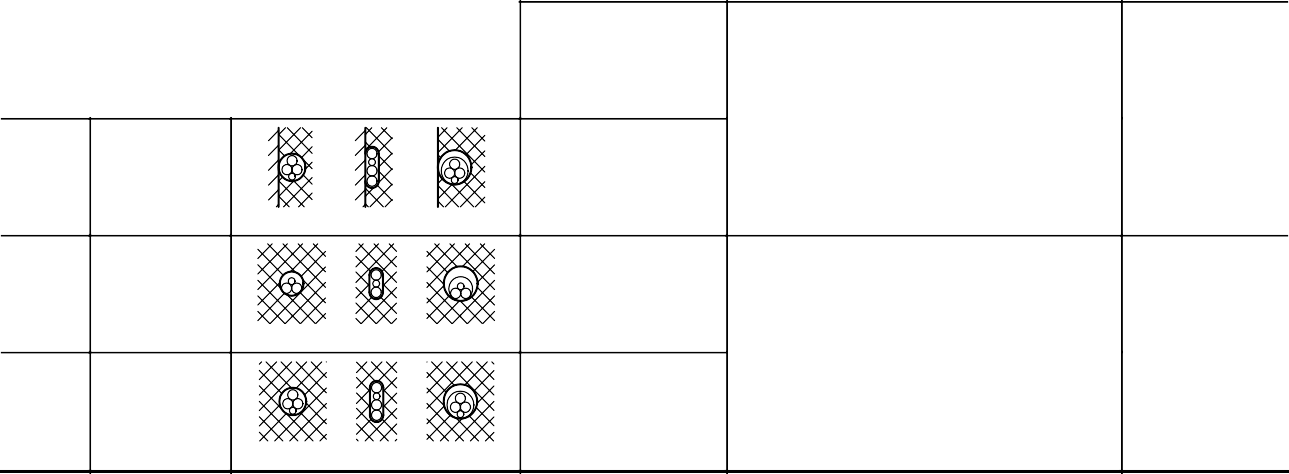
### TABLE 2(2)

**SCHEDULE OF INSTALLATION METHODS FOR CABLES DEEMED TO HAVE THE SAME CURRENT-CARRYING CAPACITY AND CROSS-REFERENCES TO**

**APPLICABLE DERATING TABLES— ENCLOSED**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 6 |
| **Item No.** | **Cable details**  **(see Note 1)** | **Reference drawing (see Note 2)** | **Current-carrying capacity table reference** | **Methods of installation for cables deemed to have the same current- carrying capacity (See Note 3)** | **Derating table for more than one circuit** |
| 1 | Two single- core cables |  | Tables 3 and 4  Columns 8 and 9 | Cables in wiring enclosures installed in —   1. air; 2. plaster, cement render, masonry or concrete in a wall or floor; 3. a concrete slab on or above the surface of the ground; or 4. a ventilated trench. Cables installed in — 5. a wiring enclosure on a wall; or 6. an enclosed trench with a removable cover. | 22 |
| 2 | Three single- core cables |  | Tables 6 and 7  Columns 8 and 9 |
| 3 | Two single- core cables |  | Tables 3 and 4  Columns 10 and 11 | Cables enclosed or unenclosed —   1. partially surrounded by thermal insulation material; or 2. in an enclosed trench. | 22 |
| 4 | Three single- core cables |  | Tables 6 and 7  Columns 10 and 11 |
| 5 | Two single- core cables |  | Tables 3 and 4  Columns 12 and 13 | Unenclosed cables completely surrounded by thermal insulation | 22 |
| 6 | Three single- core cables |  | Tables 6 and 7  Columns 12 and 13 |
| 7 | Two-core cables |  | Table 9  Columns 6 to 9  Table 10  Columns 6 and 7 | Cables in wiring enclosures installed in —   1. air; 2. plaster, cement render, masonry or concrete in a wall or floor; 3. a concrete slab on or above the surface of the ground; or 4. a ventilated trench. Cables installed in — 5. closed trunking, or wiring enclosures on a wall; or 6. an enclosed trench with a removable cover. | 22 |
| 8 | Three-core cables |  | Table 12  Columns 6 to 9  Table 13  Columns 6 and 7 |
| 9 | Two-core cables | Table 9 Enclosed or unenclosed cables partially Columns 10 and 11 surrounded by thermal insulation.  Table 10  Columns 8 and 9  22 | | | |

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10 Three-core cables

11 Two-core cables

Three-core cables

Table 12

Columns 10 and 11

Table 13

Columns 8 and 9

Table 9

Columns 12 and 13

Table 10

Columns 10 and 11

Table 12

Columns 12 and 13

Table 13

Columns 10 and 11

Enclosed or unenclosed cables completely surrounded by thermal insulation

22

12

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NOTES TO TABLE 2(2):

1. Earthing conductors, lightly loaded neutral conductors of three-phase circuits and conductors subject only to momentary loading, such as control wiring, shall not be counted in the number of cable cores.
2. See column headings of Tables 3 to 14.
3. See NZS 3000 for the restricted installation conditions of certain types of cables, e.g. insulated or insulated and sheathed cables in metallic and non-metallic conduits.

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### TABLE 2(3)

**SCHEDULE OF INSTALLATION METHODS FOR CABLES DEEMED TO HAVE THE**

**SAME CURRENT-CARRYING CAPACITY AND CROSS-REFERENCES TO APPLICABLE DERATING TABLES— BURIED DIRECT IN THE GROUND**



|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 6 |
| **Item No.** | **Cable details**  **(see Note 1)** | **Reference drawing (see Note 2)** | **Current-carrying capacity table reference** | **Methods of installation for cables deemed to have the same current- carrying capacity (see Note 3)** | **Derating table for more than one circuit** |
| 1 | Two single- core cables |  | Tables 3 and 4  Columns 14 and 15 | Cables with a minimum depth of laying of —   1. 0.3 m under continuous concrete paved areas; or 2. 0.5 m in other locations. | 25(1) |
| 2 | Three single-core cables |  | Tables 6 and 7  Columns 14 and 15 |
| 3 | Two-core cables |  | Table 9  Columns 14 and 15  Table 10  Columns 12 and 13 | 25(2) |
| 4 | Three-core cables |  | Table 12  Columns 14 and 15  Table 13  Columns 12 and 13 |

NOTES:

1. Earthing conductors, lightly loaded neutral conductors of three-phase circuits and conductors subject only to momentary loading, such as control wiring, shall not be counted in the number of cable cores.
2. See column headings of Tables 3 to 14.
3. See Tables 27 and 28 for rating factors applicable to different ambient soil temperatures and depths of laying.

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### TABLE 2(4)

**SCHEDULE OF INSTALLATION METHODS FOR CABLES DEEMED TO HAVE THE**

**SAME CURRENT-CARRYING CAPACITY AND CROSS-REFERENCES TO APPLICABLE DERATING TABLES— ENCLOSED IN UNDERGROUND PIPES AND DUCTS**



|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 6 |
| **Item No.** | **Cable details**  **(see Note 1)** | **Reference drawing (see Note 2)** | **Current-carrying capacity table reference** | **Methods of installation for cables deemed to have the same current- carrying capacity (see Note 3)** | **Derating table for more than one circuit** |
| 1 | Two single- core cables |  | Tables 3 and 4  Columns 16 and 17 | Cables in a single enclosure laid —   1. directly under continuous concrete paved areas; or 2. minimum 0.5 m in other locations. | 26(2) |
| 2 | Three single-core cables |  | Tables 6 and 7  Columns 16 and 17 |
| 3 | One two- core cable |  | Table 9  Columns 16 and 17  Table 10  Columns 14 and 15 |
| 4 | One three- core cable |  | Table 12  Columns 16 and 17  Table 13  Columns 14 and 16 |
| 5 | Single-core cables |  | Tables 3 and 4  Columns 18 and 19 | Two enclosures laid —   1. directly under continuous concrete paved areas; or 2. minimum 0.5 m in other locations. | 26(1) |
| 6 |  | Tables 6 and 7  Columns 18 and 19 | Three enclosures laid —   1. directly under continuous concrete paved areas; or 2. minimum 0.5 m in other locations. |

NOTES:



1. Earthing conductors, lightly loaded neutral conductors of three-phase circuits and conductors subject only to momentary loading, such as control wiring, shall not be counted in the number of cable cores.
2. See column headings of Tables 3 to 14.
3. See Tables 27 and 28 for rating factors applicable to different ambient soil temperatures and depths of laying.

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### TABLE 3

**CURRENT-CARRYING CAPACITIES OF TWO SINGLE-CORE 0.6/1 kV SHEATHED AND UNSHEATHED NON-ARMOURED CABLES WITH**

### V-75, V-90,V-90HT, HFI-75-TP OR HFI-90-TP INSULATION (See Note 1)



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|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|  | **Current-carrying capacity, A** | | | | | | | | | | | | | | | | | |
|  | **Unenclosed** | | | | | | **Enclosed** | | | | | | **Buried direct** | | **Underground non-metallic wiring enclosure** | | | |
|  | **Spaced** | | **Spaced from** | | **Touching** | | **Non-metallic** | | **In** | | **Completely** | |  | |  | |  | |
|  |  | | **surface** | |  | | **wiring** | | **non-metallic** | | **surrounded** | |
|  |  | |  | |  | | **enclosure in** | | **wiring** | | **by thermal** | |
|  |  | |  | |  | | **air** | | **enclosure or** | | **insulation** | |
|  |  | |  | |  | |  | | **unenclosed** | |  | |
| **Con- ductor size** |  | |  | |  | |  | | **partially surrounded by thermal insulation** | |  | |
| **mm2** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** |
| 1 | 18 | — | 18 | — | 15 | — | 15 | 11 | 11 | 9 | 7 | — | 26 | — | 20 | — | 23 | — |
| 1.5 | 24 | — | 24 | — | 18 | — | 18 | 14 | 15 | 11 | 9 | — | 34 | — | 26 | — | 30 | — |
| 2.5 | 34 | — | 33 | — | 26 | — | 25 | 19 | 21 | 16 | 14 | — | 47 | — | 36 | — | 41 | — |
| 4 | 46 | — | 44 | — | 35 | — | 34 | 26 | 27 | 22 | 18 | — | 62 | — | 46 | — | 53 | — |
| 6 | 58 | — | 56 | — | 46 | — | 43 | 34 | 35 | 29 | 23 | — | 78 | — | 58 | — | 66 | — |
| 10 | 79 | — | 76 | — | 62 | — | 60 | 47 | 48 | 39 | 31 | — | 103 | — | 78 | — | 87 | — |
| 16 | 105 | 81 | 101 | 78 | 82 | 63 | 81 | 63 | 65 | 51 | 41 | 32 | 132 | 105 | 100 | 77 | 110 | 86 |
| 25 | 143 | 109 | 137 | 105 | 111 | 86 | 111 | 86 | 90 | 71 | 55 | 42 | 176 | 138 | 132 | 101 | 149 |  |
| 35 | 177 | 137 | 165 | 131 | 137 | 106 | 131 | 103 | 105 | 82 | 67 | 52 | 209 | 160 | 160 | 121 | 176 | 110 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 138 |
| 50 | 211 | 165 | 200 | 160 | 165 | 131 | 160 | 125 | 125 | 99 | — | — | 248 | 193 | 187 | 149 | 209 | 160 |
| 70 | 274 | 211 | 257 | 200 | 211 | 165 | 200 | 160 | 160 | 125 | — | — | 303 | 237 | 231 | 182 | 259 | 198 |
| 95 | 336 | 262 | 314 | 245 | 262 | 205 | 239 | 188 | 188 | 148 | — | — | 363 | 281 | 286 | 220 | 314 | 242 |
| 120 | 393 | 308 | 365 | 285 | 302 | 239 | 285 | 222 | 222 | 177 | — | — | 418 | 325 | 325 | 253 | 352 | 275 |
| 150 | 450 | 348 | 416 | 325 | 353 | 274 | 319 | 257 | 257 | 200 | — | — | 468 | 363 | 369 | 286 | 396 | 314 |
| 185 | 524 | 405 | 485 | 376 | 410 | 319 | 371 | 291 | 291 | 228 | — | — | 528 | 413 | 418 | 330 | 457 | 358 |
| 240 | 627 | 485 | 581 | 450 | 490 | 382 | 439 | 348 | 342 | 268 | — | — | 616 | 479 | 495 | 385 | 528 | 418 |
| 300 | 730 | 564 | 661 | 519 | 564 | 439 | — | — | — | — | — | — | 693 | 539 | 561 | 440 | 616 | 473 |
| 400 | 844 | 661 | 775 | 604 | 661 | 519 | — | — | — | — | — | — | 781 | 616 | 649 | 512 | 693 | 550 |
| 500 | 992 | 775 | 889 | 707 | 764 | 604 | — | — | — | — | — | — | 880 | 704 | 737 | 583 | 803 | 627 |
| 630 | 1151 | 912 | 1026 | 832 | 878 | 718 | — | — | — | — | — | — | 990 | 814 | 847 | 682 | 913 | 726 |

NOTES:

1. Refer to Note 2 of Table 1 for information regarding the use of V-90 and V-90HT insulated cables.
2. Refer to Tables 2(1), 2(2), 2(3) and 2(4) for cable configurations deemed to have the same current-carrying capacities as those illustrated.
3. Derating factors may apply as follows:
   1. The current-carrying capacities apply to single circuits; for grouped cable circuits see Clause 3.5.2 and Tables 22, 23, 25 and 26 for appropriate derating factors.
   2. For a single circuit fixed to the underside of a ceiling or similar horizontal surface, see Table 22 for the derating factor to be applied to the current-carrying capacities given in Columns 6 and 7.
   3. For a single circuit fixed to perforated or unperforated cable tray, see Table 23 for the derating factor to be applied to the current-carrying capacities given in Columns 4 and 5.
   4. For ambient temperature and depth of laying factors, see Tables 27 and 28.
4. To calculate the single-phase voltage drop of these configurations, multiply the appropriate three-phase voltage drop value in Table 40 or Table 43 by 1.155.
5. These ratings are based on 30°C ambient air temperature and 15°C ambient soil temperature. For other conditions, see Clause 3.5.3.

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### TABLE 4

**CURRENT-CARRYING CAPACITIES OF TWO SINGLE-CORE 0.6/1 kV SHEATHED AND UNSHEATHED NON-ARMOURED CABLES WITH**

**X-90, X-HF-90, R-EP-90, R-CPE-90, R-HF-90 OR R-CSP-90 INSULATION**



|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|  | **Current-carrying capacity, A** | | | | | | | | | | | | | | | | | |
|  | **Unenclosed** | | | | | | **Enclosed** | | | | | | **Buried direct** | | **Underground non-metallic wiring enclosure** | | | |
|  | **Spaced** | | **Spaced from** | | **Touching** | | **Non-metallic** | | **In non-** | | **Completely** | |  | |  | |  | |
|  |  | | **surface** | |  | | **wiring** | | **metallic** | | **surround-** | |
|  |  | |  | |  | | **enclosure in** | | **wiring** | | **ed by** | |
|  |  | |  | |  | | **air** | | **enclosure or** | | **thermal** | |
|  |  | |  | |  | |  | | **unenclosed** | | **insulation** | |
| **Con- ductor size** |  | |  | |  | |  | | **partially surrounded by thermal insulation** | |  | |
| **mm2** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** |
| 1 | 22 | — | 22 | — | 18 | — | 18 | 13 | 15 | 12 | 9 | — | 30 | — | 22 | — | 26 | — |
| 1.5 | 29 | — | 28 | — | 22 | — | 22 | 18 | 19 | 14 | 11 | — | 39 | — | 29 | — | 33 | — |
| 2.5 | 40 | — | 40 | — | 31 | — | 31 | 24 | 26 | 21 | 15 | — | 54 | — | 40 | — | 45 | — |
| 4 | 53 | — | 52 | — | 41 | — | 41 | 33 | 35 | 28 | 21 | — | 68 | — | 51 | — | 59 | — |
| 6 | 67 | — | 66 | — | 52 | — | 52 | 43 | 44 | 35 | 26 | — | 86 | — | 64 | — | 73 | — |
| 10 | 92 | — | 90 | — | 72 | — | 72 | 59 | 62 | 48 | 35 | — | 112 | — | 86 | — | 96 | — |
| 16 | 121 | 96 | 121 | 92 | 95 | 74 | 95 | 74 | 81 | 64 | 47 | 36 | 150 | 112 | 112 | 86 | 123 | 95 |
| 25 | 165 | 127 | 160 | 121 | 127 | 100 | 127 | 100 | 110 | 89 | 64 | 50 | 193 | 150 | 144 | 112 | 161 | 123 |
| 35 | 204 | 160 | 193 | 149 | 160 | 121 | 160 | 121 | 132 | 103 | 79 | 62 | 230 | 177 | 171 | 134 | 193 | 150 |
| 50 | 253 | 193 | 237 | 182 | 193 | 149 | 193 | 149 | 160 | 127 | — | — | 273 | 214 | 209 | 161 | 230 | 177 |
| 70 | 319 | 248 | 303 | 231 | 248 | 193 | 242 | 193 | 198 | 154 | — | — | 337 | 262 | 257 | 198 | 284 | 219 |
| 95 | 396 | 308 | 374 | 286 | 308 | 237 | 286 | 237 | 237 | 187 | — | — | 401 | 310 | 310 | 241 | 337 | 262 |
| 120 | 462 | 363 | 435 | 336 | 358 | 281 | 341 | 281 | 281 | 220 | — | — | 455 | 353 | 358 | 278 | 391 | 305 |
| 150 | 534 | 413 | 495 | 385 | 413 | 319 | 385 | 319 | 314 | 253 | — | — | 514 | 396 | 401 | 310 | 439 | 342 |
| 185 | 627 | 484 | 572 | 446 | 479 | 374 | 440 | 374 | 363 | 286 | — | — | 578 | 455 | 465 | 358 | 503 | 391 |
| 240 | 748 | 583 | 682 | 534 | 572 | 451 | 523 | 440 | 429 | 341 | — | — | 674 | 524 | 546 | 428 | 589 | 455 |
| 300 | 869 | 671 | 792 | 616 | 671 | 523 | — | — | — | — | — | — | 760 | 599 | 621 | 482 | 674 | 524 |
| 400 | 1012 | 792 | 924 | 726 | 781 | 616 | — | — | — | — | — | — | 867 | 685 | 717 | 567 | 770 | 599 |
| 500 | 1188 | 935 | 1067 | 847 | 902 | 726 | — | — | — | — | — | — | 974 | 781 | 813 | 653 | 877 | 696 |
| 630 | 1386 | 1100 | 1221 | 990 | 1045 | 847 | — | — | — | — | — | — | 1102 | 888 | 952 | 770 | 1017 | 803 |

NOTES:

1. Refer to Tables 2(1), 2(2), 2(3) and 2(4) for cable configurations deemed to have the same current-carrying capacities as those illustrated.
2. Derating factors may apply as follows:
   1. The current-carrying capacities apply to single circuits; for grouped cable circuits see Clause 3.5.2 and Tables 22, 23, 25 and 26 for appropriate derating factors.

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* 1. For a single circuit fixed to the underside of a ceiling or similar horizontal surface, see Table 22 for the derating factor to be applied to the current-carrying capacities given in Columns 6 and 7.
  2. For a single circuit fixed to perforated or unperforated cable tray, see Table 23 for the derating factor to be applied to the current-carrying capacities given in Columns 4 and 5.
  3. For ambient temperature and depth of laying factors, see Tables 27 and 28.

1. To calculate the single-phase voltage drop of these configurations, multiply the appropriate three-phase voltage drop value in Table 40 or Table 43 by 1.155.
2. These ratings are based on 30°C ambient air temperature and 15°C ambient soil temperature. For other conditions, see Clause 3.5.3.

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### TABLE 5

**CURRENT-CARRYING CAPACITIES OF TWO SINGLE-CORE 0.6/1 kV SHEATHED AND UNSHEATHED NON-ARMOURED CABLES WITH**

**R-HF-110, R-E-110 OR X-HF-110 INSULATION**



|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|  | **Current-carrying capacity, A** | | | | | | | | |
|  | **Unenclosed** | | | **Enclosed** | | | **Buried direct** | **Underground non-metallic wiring enclosure** | |
|  | **Spaced** | **Spaced from** | **Touching** | **Metallic** | **In metallic** | **Completely** |  |  |  |
|  |  | **surface** |  | **wiring** | **wiring** | **surrounded** |
|  |  |  |  | **enclosure in** | **enclosure or** | **by thermal** |
|  |  |  |  | **air** | **unenclosed** | **insulation** |
|  |  |  |  |  | **partially** |  |
| **Con- ductor size** |  |  |  |  | **surrounded by thermal insulation** |  |
| **mm2** | **Cu** | **Cu** | **Cu** | **Cu** | **Cu** | **Cu** | **Cu** | **Cu** | **Cu** |
| 1 | 27 | 26 | 21 | 21 | 17 | 11 | 33 | 25 | 29 |
| 1.5 | 34 | 33 | 27 | 27 | 21 | 14 | 41 | 32 | 36 |
| 2.5 | 48 | 47 | 39 | 37 | 30 | 19 | 58 | 45 | 50 |
| 4 | 63 | 62 | 50 | 49 | 40 | 25 | 75 | 58 | 65 |
| 6 | 80 | 78 | 63 | 62 | 49 | 32 | 94 | 72 | 81 |
| 10 | 112 | 106 | 87 | 83 | 66 | 43 | 127 | 95 | 106 |
| 16 | 144 | 139 | 112 | 112 | 89 | 57 | 164 | 127 | 138 |
| 25 | 198 | 187 | 155 | 144 | 118 | 77 | 212 | 159 | 180 |
| 35 | 241 | 230 | 187 | 177 | 139 | 94 | 254 | 196 | 212 |
| 50 | 294 | 278 | 230 | 219 | 177 | — | 297 | 233 | 254 |
| 70 | 375 | 353 | 289 | 273 | 219 | — | 366 | 286 | 313 |
| 95 | 465 | 433 | 364 | 342 | 273 | — | 440 | 350 | 382 |
| 120 | 546 | 503 | 423 | 396 | 316 | — | 504 | 398 | 435 |
| 150 | 621 | 578 | 487 | 460 | 369 | — | 562 | 456 | 488 |
| 185 | 717 | 663 | 567 | 530 | 423 | — | 636 | 519 | 562 |
| 240 | 867 | 792 | 674 | 631 | 508 | — | 742 | 615 | 647 |
| 300 | 995 | 920 | 781 | — | — | — | 837 | 710 | 753 |
| 400 | 1166 | 1070 | 910 | — | — | — | 954 | 806 | 859 |
| 500 | 1370 | 1231 | 1059 | — | — | — | 1081 | 922 | 996 |
| 630 | 1605 | 1423 | 1231 | — | — | — | 1219 | 1071 | 1134 |

NOTES:

1. Refer to Tables 2(1), 2(2), 2(3) and 2(4) for cable configurations deemed to have the same current-carrying capacities as those illustrated.
2. Derating factors may apply as follows:
   1. The current-carrying capacities apply to single circuits, for grouped cable circuits see Clause 3.5.2 and Tables 22, 23, 25 and 26 for appropriate derating factors.
   2. For a single circuit fixed to the underside of a ceiling or similar horizontal surface, see Table 22 for the derating factor to be applied to the current-carrying capacities given in Column 4.
   3. For a single circuit fixed to perforated or unperforated cable tray, see Table 23 for the derating factor to be applied to the current-carrying capacities given in Column 3.
   4. For ambient temperature and depth of laying factors, see Tables 27 and 28.
3. To calculate the single-phase voltage drop of these configurations, multiply the appropriate three-phase voltage drop value in Table 40 or Table 43 by 1.155.
4. These ratings are based on 30°C ambient air temperature and 15°C ambient soil temperature. For other conditions, see Clause 3.5.3.

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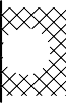
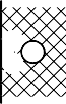
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### TABLE 6

### CURRENT-CARRYING CAPACITIES OF THREE SINGLE-CORE 0.6/1 kV SHEATHED AND UNSHEATHED NON-ARMOURED CABLES WITH

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**V-75, V-90, V-90HT, HFI-75-TP OR HFI-90-TP INSULATION (See Note 1)**



|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|  | **Current-carrying capacity, A** | | | | | | | | | | | | | | | | | |
|  | **Unenclosed** | | | | | | **Enclosed** | | | | | | **Buried direct** | | **Underground non-metallic wiring enclosure** | | | |
|  | **Spaced** | | **Spaced from** | | **Touching** | | **Non-metallic** | | **In** | | **Completely** | |  | |  | |  | |
|  |  | | **surface** | |  | | **wiring** | | **non-metallic** | | **surrounded** | |
|  |  | |  | |  | | **enclosure in** | | **wiring** | | **by thermal** | |
|  |  | |  | |  | | **air** | | **enclosure or** | | **insulation** | |
|  |  | |  | |  | |  | | **unenclosed** | |  | |
| **Con- ductor size** |  | |  | |  | |  | | **partially surrounded by thermal insulation** | |  | |
| **mm2** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** |
| 1 | 18 | — | 16 | — | 15 | — | 13 | 10 | 11 | 9 | 7 | — | 23 | — | 18 | — | 21 | — |
| 1.5 | 23 | — | 19 | — | 18 | — | 16 | 13 | 14 | 10 | 9 | — | 30 | — | 22 | — | 28 | — |
| 2.5 | 33 | — | 29 | — | 26 | — | 23 | 18 | 19 | 15 | 14 | — | 41 | — | 31 | — | 37 | — |
| 4 | 43 | — | 38 | — | 35 | — | 30 | 23 | 26 | 21 | 18 | — | 54 | — | 41 | — | 48 | — |
| 6 | 56 | — | 48 | — | 46 | — | 39 | 30 | 33 | 25 | 23 | — | 67 | — | 51 | — | 59 | — |
| 10 | 76 | — | 66 | — | 62 | — | 54 | 41 | 44 | 34 | 31 | — | 89 | — | 67 | — | 79 | — |
| 16 | 101 | 78 | 88 | 67 | 82 | 63 | 71 | 55 | 59 | 46 | 41 | 32 | 116 | 89 | 88 | 67 | 101 | 78 |
| 25 | 137 | 106 | 120 | 91 | 111 | 86 | 99 | 78 | 82 | 64 | 55 | 42 | 149 | 116 | 116 | 88 | 132 | 101 |
| 35 | 171 | 131 | 143 | 113 | 137 | 106 | 114 | 90 | 96 | 74 | 67 | 52 | 176 | 138 | 138 | 107 | 160 | 121 |
| 50 | 205 | 160 | 177 | 137 | 165 | 131 | 143 | 108 | 114 | 90 | — | — | 209 | 160 | 165 | 127 | 187 | 143 |
| 70 | 262 | 205 | 222 | 177 | 211 | 165 | 177 | 137 | 143 | 113 | — | — | 259 | 198 | 204 | 160 | 231 | 182 |
| 95 | 325 | 257 | 279 | 217 | 262 | 205 | 205 | 165 | 171 | 137 | — | — | 308 | 237 | 248 | 193 | 281 | 215 |
| 120 | 382 | 296 | 325 | 257 | 302 | 239 | 251 | 194 | 200 | 160 | — | — | 347 | 270 | 286 | 220 | 319 | 248 |
| 150 | 439 | 342 | 376 | 291 | 353 | 274 | 285 | 222 | 228 | 182 | — | — | 391 | 303 | 319 | 253 | 352 | 281 |
| 185 | 507 | 393 | 439 | 342 | 405 | 319 | 325 | 251 | 262 | 205 | — | — | 440 | 341 | 369 | 286 | 407 | 319 |
| 240 | 616 | 473 | 519 | 405 | 485 | 376 | 388 | 302 | 308 | 245 | — | — | 512 | 402 | 429 | 336 | 473 | 369 |
| 300 | 707 | 553 | 604 | 473 | 559 | 439 | 445 | 348 | 353 | 285 | — | — | 572 | 451 | 495 | 385 | 545 | 424 |
| 400 | 832 | 650 | 695 | 553 | 650 | 519 | 519 | 405 | 410 | 331 | — | — | 649 | 517 | 561 | 446 | 616 | 484 |
| 500 | 969 | 752 | 809 | 650 | 752 | 604 | 604 | 467 | 473 | 382 | — | — | 737 | 594 | 649 | 512 | 715 | 561 |
| 630 | 1129 | 901 | 935 | 764 | 866 | 718 | 707 | 547 | 553 | 445 | — | — | 825 | 682 | 726 | 594 | 803 | 638 |

NOTES:

1. Refer to Note 2 of Table 1 for information regarding the use of V-90 and V-90HT insulated cables.
2. Refer to Tables 2(1), 2(2), 2(3) and 2(4) for cable configurations deemed to have the same current-carrying capacities as those illustrated.
3. Derating factors may apply as follows:
   1. The current-carrying capacities apply to single circuits; for grouped cable circuits see Clause 3.5.2 and Tables 22, 23, 25 and 26 for appropriate derating factors.
   2. For a single circuit fixed to the underside of a ceiling or similar horizontal surface, see Table 22 for the derating factor to be applied to the current-carrying capacities given in Columns 6 and 7.
   3. For a single circuit fixed to perforated or unperforated cable tray, see Table 23 for the derating factor to be applied to the current-carrying capacities given in Columns 4 and 5.
   4. For ambient temperature and depth of laying factors, see Tables 27 and 28.
4. To calculate the single-phase voltage drop of these configurations, multiply the appropriate three-phase voltage drop value in Table 40 or Table 43 by 1.155.
5. These ratings are based on 30°C ambient air temperature and 15°C ambient soil temperature. For other conditions, see Clause 3.5.3.

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### TABLE 7

**CURRENT-CARRYING CAPACITIES OF THREE SINGLE-CORE 0.6/1 kV SHEATHED AND UNSHEATHED NON-ARMOURED CABLES WITH**

**X-90, X-HF-90, R-EP-90, R-CPE-90, R-HF-90 OR R-CSP-90 INSULATION**



|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|  | **Current-carrying capacity, A** | | | | | | | | | | | | | | | | | |
|  | **Unenclosed non-metallic wiring enclosure** | | | | | | **Enclosed** | | | | | | **Buried direct** | | **Underground non-metallic wiring enclosure** | | | |
|  | **Spaced** | | **Spaced from** | | **Touching** | | **Non-metallic** | | **In** | | **Completely** | |  | |  | |  | |
|  |  | | **surface** | |  | | **wiring** | | **non-metallic** | | **surrounded** | |
|  |  | |  | |  | | **enclosure in** | | **wiring** | | **by thermal** | |
|  |  | |  | |  | | **air** | | **enclosure or** | | **insulation** | |
|  |  | |  | |  | |  | | **unenclosed** | |  | |
| **Con- ductor size** |  | |  | |  | |  | | **partially surrounded by thermal insulation** | |  | |
| **mm2** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** |
| 1 | 21 | — | 18 | — | 18 | — | 15 | 12 | 11 | 10 | 9 | — | 26 | — | 19 | — | 24 | — |
| 1.5 | 28 | — | 23 | — | 22 | — | 20 | 15 | 13 | 13 | 11 | — | 33 | — | 25 | — | 30 | — |
| 2.5 | 39 | — | 33 | — | 31 | — | 28 | 21 | 19 | 18 | 15 | — | 45 | — | 34 | — | 42 | — |
| 4 | 51 | — | 44 | — | 41 | — | 36 | 29 | 31 | 24 | 21 | — | 59 | — | 44 | — | 54 | — |
| 6 | 65 | — | 55 | — | 52 | — | 46 | 37 | 40 | 32 | 26 | — | 73 | — | 56 | — | 66 | — |
| 10 | 89 | — | 76 | — | 72 | — | 64 | 53 | 55 | 44 | 35 | — | 97 | — | 74 | — | 87 | — |
| 16 | 121 | 92 | 101 | 78 | 95 | 74 | 86 | 70 | 73 | 58 | 47 | 36 | 123 | 97 | 95 | 74 | 112 | 86 |
| 25 | 160 | 127 | 138 | 107 | 127 | 100 | 121 | 99 | 101 | 80 | 64 | 50 | 161 | 123 | 123 | 96 | 144 | 112 |
| 35 | 198 | 154 | 171 | 132 | 160 | 121 | 138 | 116 | 116 | 94 | 79 | 62 | 193 | 150 | 150 | 118 | 171 | 134 |
| 50 | 242 | 187 | 209 | 160 | 193 | 149 | 171 | 138 | 143 | 110 | — | — | 230 | 177 | 182 | 139 | 209 | 161 |
| 70 | 308 | 242 | 264 | 204 | 248 | 193 | 209 | 176 | 176 | 143 | — | — | 278 | 219 | 225 | 177 | 251 | 198 |
| 95 | 385 | 297 | 330 | 253 | 308 | 237 | 253 | 215 | 215 | 171 | — | — | 337 | 262 | 268 | 209 | 300 | 235 |
| 120 | 451 | 352 | 385 | 297 | 358 | 281 | 297 | 253 | 248 | 198 | — | — | 380 | 294 | 310 | 241 | 348 | 273 |
| 150 | 517 | 402 | 446 | 347 | 413 | 319 | 341 | 286 | 281 | 226 | — | — | 428 | 332 | 353 | 273 | 391 | 300 |
| 185 | 605 | 468 | 517 | 402 | 479 | 374 | 391 | 330 | 325 | 259 | — | — | 482 | 375 | 401 | 310 | 449 | 348 |
| 240 | 726 | 561 | 616 | 484 | 572 | 446 | 462 | 396 | 385 | 303 | — | — | 556 | 439 | 471 | 369 | 519 | 407 |
| 300 | 847 | 660 | 715 | 561 | 660 | 517 | 534 | 457 | 440 | 352 | — | — | 631 | 498 | 546 | 428 | 599 | 465 |
| 400 | 990 | 770 | 836 | 660 | 770 | 616 | 616 | 534 | 512 | 407 | — | — | 717 | 567 | 621 | 487 | 685 | 535 |
| 500 | 1155 | 913 | 957 | 770 | 891 | 715 | 715 | 616 | 594 | 468 | — | — | 803 | 642 | 717 | 578 | 770 | 610 |
| 630 | 1353 | 1078 | 1111 | 902 | 1034 | 847 | 836 | 726 | 693 | 550 | — | — | 899 | 738 | 813 | 663 | 888 | 706 |

NOTES:

1. Refer to Tables 2(1), 2(2), 2(3) and 2(4) for cable configurations deemed to have the same current-carrying capacities as those illustrated.
2. Derating factors may apply as follows:
   1. The current-carrying capacities apply to single circuits; for grouped cable circuits see Clause 3.5.2 and Tables 22, 23, 25 and 26 for appropriate derating factors.
   2. For a single circuit fixed to the underside of a ceiling or similar horizontal surface, see Table 22 for the derating factor to be applied to the current-carrying capacities given in Columns 6 and 7.
   3. For a single circuit fixed to perforated or unperforated cable tray, see Table 23 for the derating factor to be applied to the current-carrying capacities given in Columns 4 and 5.
   4. For ambient temperature and depth of laying factors, see Tables 27 and 28.
3. To determine the three-phase voltage drop of these configurations, refer to the appropriate value in Table 40, Table 41, Table 43 or Table 44.
4. These ratings are based on 30°C ambient air temperature and 15°C ambient soil temperature. For other conditions, see Clause 3.5.3.

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### TABLE 8

**CURRENT-CARRYING CAPACITIES OF THREE SINGLE-CORE 0.6/1 kV SHEATHED AND UNSHEATHED NON-ARMOURED CABLES WITH**

**R-HF-110, R-E-110 OR X-HF-110 INSULATION**



|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|  | **Current-carrying capacity, A** | | | | | | | | |
|  | **Unenclosed** | | | **Enclosed** | | | **Buried direct** | **Underground non- metallic wiring enclosure** | |
|  | **Spaced** | **Spaced** | **Touching** | **Metallic** | **In metallic** | **Completely** |  |  |  |
|  |  | **from** |  | **wiring** | **wiring** | **surrounded** |
|  |  | **surface** |  | **enclosure** | **enclosure or** | **by thermal** |
|  |  |  |  | **in air** | **unenclosed** | **insulation** |
|  |  |  |  |  | **partially** |  |
|  |  |  |  |  | **surrounded by** |  |
| **Con- ductor** |  |  |  |  | **thermal insulation** |  |
| **size** |  |  |  |  |  |  |
| **mm2** | **Cu** | **Cu** | **Cu** | **Cu** | **Cu** | **Cu** | **Cu** | **Cu** | **Cu** |
| 1 | 26 | 22 | 21 | 18 | 15 | 11 | 29 | 22 | 27 |
| 1.5 | 33 | 29 | 27 | 24 | 19 | 14 | 36 | 28 | 33 |
| 2.5 | 46 | 41 | 39 | 34 | 27 | 19 | 50 | 39 | 46 |
| 4 | 61 | 54 | 50 | 44 | 35 | 25 | 65 | 50 | 58 |
| 6 | 78 | 67 | 63 | 55 | 44 | 32 | 81 | 63 | 73 |
| 10 | 106 | 92 | 87 | 76 | 61 | 43 | 106 | 84 | 95 |
| 16 | 139 | 123 | 112 | 100 | 79 | 57 | 138 | 106 | 127 |
| 25 | 187 | 166 | 155 | 134 | 107 | 77 | 180 | 143 | 159 |
| 35 | 235 | 203 | 187 | 161 | 128 | 94 | 212 | 170 | 191 |
| 50 | 284 | 246 | 230 | 193 | 155 | — | 249 | 201 | 228 |
| 70 | 364 | 310 | 289 | 251 | 198 | — | 307 | 249 | 281 |
| 95 | 449 | 391 | 364 | 305 | 246 | — | 371 | 302 | 339 |
| 120 | 524 | 449 | 423 | 358 | 289 | — | 419 | 350 | 387 |
| 150 | 610 | 519 | 487 | 407 | 326 | — | 472 | 392 | 429 |
| 185 | 706 | 599 | 567 | 482 | 385 | — | 530 | 456 | 498 |
| 240 | 845 | 717 | 674 | 589 | 471 | — | 615 | 541 | 572 |
| 300 | 974 | 835 | 781 | 674 | 535 | — | 700 | 615 | 668 |
| 400 | 1145 | 974 | 910 | 770 | 610 | — | 795 | 700 | 753 |
| 500 | 1338 | 1124 | 1049 | 920 | 738 | — | 890 | 816 | 880 |
| 630 | 1562 | 1305 | 1209 | 1049 | 845 | — | 1007 | 912 | 986 |

NOTES:

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1. Refer to Tables 2(1), 2(2), 2(3) and 2(4) for cable configurations deemed to have the same current-carrying capacities as those illustrated.
2. Derating factors may apply as follows:
   1. The current-carrying capacities apply to single circuits; for grouped cable circuits see Clause 3.5.2 and Tables 22, 23, 25 and 26 for appropriate derating factors.
   2. For a single circuit fixed to the underside of a ceiling or similar horizontal surface, see Table 22 for the derating factor to be applied to the current-carrying capacities given in Column 4.
   3. For a single circuit fixed to perforated or unperforated cable tray, see Table 23 for the derating factor to be applied to the current- carrying capacities given in Column 3.
   4. For ambient temperature and depth of laying factors, see Tables 27 and 28.
3. To determine the three-phase voltage drop of these configurations, refer to the appropriate value in Table 40, Table 41, Table 43 or Table 44.
4. These ratings are based on 30°C ambient air temperature and 15°C ambient soil temperature. For other conditions, see Clause 3.5.3.

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### TABLE 9

**CURRENT-CARRYING CAPACITIES OF TWO-CORE 0.6/1 kV INSULATED AND SHEATHED (INCLUDING NEUTRAL SCREENED) CABLES WITH OR**

### WITHOUT EARTH CONDUCTOR, ARMOURED OR NON-ARMOURED CABLES WITH V-75, V-90, HFI-75-TP OR HFI-90-TP INSULATION (See Note 1)



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|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|  | **Current-carrying capacity, A** | | | | | | | | | | | | | | | |
|  | **Unenclosed** | | | | **Enclosed** | | | | | | | | **Buried direct** | | **Underground non-metallic wiring enclosure** | |
|  | **Spaced** | | **Touching** | | **Non-metallic** | | **Non-metallic** | | **In non-metallic** | | **Completely** | |  | |  | |
|  |  | |  | | **wiring** | | **wiring enclosure** | | **wiring** | | **surrounded by** | |
|  |  | |  | | **enclosure in** | | **in air — flat** | | **enclosure or** | | **thermal** | |
|  |  | |  | | **air — round** | | **cable** | | **unenclosed** | | **insulation** | |
|  |  | |  | | **cable** | |  | | **partially** | |  | |
| **Con- ductor size** |  | |  | |  | |  | | **surrounded by thermal insulation** | |  | |
| **mm2** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** |
| 1 | 17 | — | 16 | — | 13 | 10 | 15 | 11 | 11 | 9 | 8 | — | 24 | — | 19 | — |
| 1.5 | 22 | — | 21 | — | 16 | 13 | 19 | 15 | 15 | 11 | 10 | — | 31 | — | 24 | — |
| 2.5 | 31 | — | 30 | — | 23 | 17 | 25 | 19 | 21 | 16 | 15 | — | 44 | — | 34 | — |
| 4 | 42 | — | 39 | — | 30 | 23 | 33 | 25 | 27 | 22 | 19 | — | 57 | — | 44 | — |
| 6 | 52 | — | 50 | — | 39 | 30 | 42 | 32 | 35 | 27 | 25 | — | 72 | — | 56 | — |
| 10 | 73 | — | 68 | — | 54 | 41 | 57 | 43 | 49 | 38 | 34 | — | 96 | — | 75 | — |
| 16 | 97 | 75 | 91 | 71 | 72 | 55 | 75 | 57 | 65 | 50 | 46 | 35 | 127 | 97 | 97 | 75 |
| 25 | 131 | 100 | 120 | 95 | 100 | 76 | 101 | 76 | 90 | 71 | 60 | 47 | 160 | 127 | 127 | 98 |
| 35 | 160 | 125 | 148 | 114 | 120 | 89 | 120 | 89 | 105 | 82 | 74 | 58 | 198 | 154 | 154 | 121 |
| 50 | 194 | 148 | 182 | 143 | 143 | 107 | 143 | 107 | 125 | 99 | — | — | 231 | 182 | 182 | 143 |
| 70 | 245 | 188 | 228 | 177 | 177 | 137 | — | — | 160 | 125 | — | — | 286 | 220 | 226 | 176 |
| 95 | 302 | 234 | 285 | 217 | 217 | 165 | — | — | 188 | 148 | — | — | 341 | 264 | 275 | 215 |
| 120 | 348 | 274 | 331 | 257 | 257 | 194 | — | — | 222 | 177 | — | — | 391 | 303 | 319 | 248 |
| 150 | 399 | 308 | 376 | 291 | 291 | 217 | — | — | 251 | 200 | — | — | 440 | 341 | 358 | 275 |
| 185 | 462 | 359 | 428 | 336 | 336 | 251 | — | — | 291 | 228 | — | — | 495 | 385 | 407 | 319 |
| 240 | 542 | 428 | 507 | 399 | 393 | 296 | — | — | 342 | 274 | — | — | 572 | 446 | 473 | 369 |
| 300 | 627 | 490 | 581 | 456 | 456 | 342 | — | — | 393 | 314 | — | — | 649 | 506 | 545 | 429 |
| 400 | 718 | 570 | 673 | 530 | 530 | 399 | — | — | 462 | 365 | — | — | 726 | 583 | 616 | 490 |
| 500 | 821 | 661 | 764 | 616 | 707 | 564 | — | — | 564 | 450 | — | — | 814 | 660 | 715 | 572 |

NOTES:

1. Refer to Note 2 of Table 1 for information regarding the use of V-90 insulated cables.
2. Refer to Tables 2(1), 2(2), 2(3) and 2(4) for cable configurations deemed to have the same current-carrying capacities as those illustrated.
3. Derating factors may apply as follows:
   1. The current-carrying capacities apply to single circuits; for grouped cable circuits see Clause 3.5.2 and Tables 22, 23, 25 and 26 for appropriate derating factors.
   2. For a single circuit fixed to the underside of a ceiling or similar horizontal surface, see Table 22 for the derating factor to be applied to the current-carrying capacities given in Columns 4 and 5.
   3. For a single circuit fixed to unperforated cable tray, see Table 24 for the derating factor to be applied to the current- carrying capacities given in Columns 2 and 3.
   4. For ambient temperature and depth of laying factors, see Tables 27 and 28.
4. To calculate the single-phase voltage drop of these configurations, multiply the appropriate three-phase voltage drop value in Table 42 or Table 45 by 1.155.
5. These ratings are based on 30°C ambient air temperature and 15°C ambient soil temperature. For other conditions, see Clause 3.5.3.

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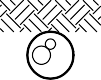
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### TABLE 10

**CURRENT-CARRYING CAPACITIES OF TWO-CORE 0.6/1 kV INSULATED AND SHEATHED (INCLUDING NEUTRAL SCREENED) CABLES WITH OR**

**WITHOUT EARTH CONDUCTOR, ARMOURED OR NON-ARMOURED CABLES WITH X-90, X-HF-90, R-EP-90, R-CPE-90,**

**R-HF-90 OR R-CSP-90 INSULATION**



|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|  | **Current-carrying capacity, A** | | | | | | | | | | | | | |
|  | **Unenclosed** | | | | **Enclosed** | | | | | | **Buried direct** | | **Underground non-metallic wiring enclosure** | |
|  | **Spaced** | | **Touching** | | **Non-metallic** | | **In non-metallic** | | **Completely** | |  | |  | |
|  |  | |  | | **wiring enclosure** | | **wiring enclosure** | | **surrounded by** | |
|  |  | |  | | **in air** | | **or unenclosed** | | **thermal** | |
|  |  | |  | |  | | **partially** | | **insulation** | |
|  |  | |  | |  | | **surrounded by** | |  | |
| **Con-** |  | |  | |  | | **thermal** | |  | |
| **ductor** |  | |  | |  | | **insulation** | |  | |
| **size** |  | |  | |  | |  | |  | |
| **mm2** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** |
| 1 | 20 | — | 19 | — | 14 | 11 | 15 | 12 | 10 | — | 28 | — | 21 | — |
| 1.5 | 26 | — | 24 | — | 19 | 14 | 19 | 15 | 12 | — | 35 | — | 27 | — |
| 2.5 | 37 | — | 34 | — | 26 | 20 | 26 | 20 | 18 | — | 49 | — | 37 | — |
| 4 | 50 | — | 46 | — | 36 | 26 | 35 | 28 | 23 | — | 64 | — | 49 | — |
| 6 | 63 | — | 58 | — | 46 | 35 | 45 | 35 | 30 | — | 80 | — | 61 | — |
| 10 | 86 | — | 80 | — | 65 | 48 | 62 | 48 | 40 | — | 107 | — | 82 | — |
| 16 | 116 | 89 | 107 | 83 | 87 | 66 | 81 | 64 | 54 | 42 | 139 | 107 | 107 | 83 |
| 25 | 154 | 121 | 143 | 110 | 121 | 92 | 116 | 89 | 73 | 56 | 182 | 139 | 139 | 107 |
| 35 | 193 | 149 | 176 | 138 | 143 | 109 | 132 | 103 | 89 | 69 | 219 | 171 | 171 | 128 |
| 50 | 231 | 182 | 215 | 171 | 176 | 132 | 160 | 127 | — | — | 262 | 203 | 203 | 155 |
| 70 | 297 | 231 | 275 | 215 | 220 | 171 | 198 | 154 | — | — | 321 | 251 | 251 | 193 |
| 95 | 363 | 281 | 341 | 264 | 264 | 204 | 237 | 187 | — | — | 385 | 300 | 305 | 235 |
| 120 | 424 | 330 | 396 | 308 | 314 | 242 | 281 | 220 | — | — | 439 | 342 | 348 | 273 |
| 150 | 484 | 374 | 451 | 352 | 358 | 275 | 314 | 253 | — | — | 492 | 380 | 401 | 310 |
| 185 | 561 | 435 | 523 | 407 | 413 | 319 | 363 | 292 | — | — | 556 | 433 | 455 | 353 |
| 240 | 660 | 517 | 616 | 484 | 490 | 385 | 429 | 341 | — | — | 642 | 503 | 535 | 417 |
| 300 | 759 | 594 | 704 | 561 | 572 | 446 | 495 | 391 | — | — | 728 | 567 | 610 | 482 |
| 400 | 880 | 704 | 825 | 649 | 660 | 523 | 572 | 457 | — | — | 824 | 653 | 696 | 556 |
| 500 | 1012 | 803 | 935 | 748 | 847 | 682 | 682 | 545 | — | — | 920 | 738 | 803 | 642 |

NOTES:

1. Refer to Tables 2(1), 2(2), 2(3) and 2(4) for cable configurations deemed to have the same current-carrying capacities as those illustrated.
2. Derating factors may apply as follows:
   1. The current-carrying capacities apply to single circuits; for grouped cable circuits see Clause 3.5.2 and Tables 22, 24, 25 and 26 for appropriate derating factors.
   2. For a single circuit fixed to the underside of a ceiling or similar horizontal surface, see Table 22 for the derating factor to be applied to the current-carrying capacities given in Columns 4 and 5.
   3. For a single circuit fixed to unperforated cable tray, see Table 24 for the derating factor to be applied to the current- carrying capacities given in Columns 2 and 3.
   4. For ambient temperature and depth of laying factors, see Tables 27 and 28.
3. To calculate the single-phase voltage drop of these configurations, multiply the appropriate three-phase voltage drop value in Table 42 or Table 45 by 1.155.
4. These ratings are based on 30°C ambient air temperature and 15°C ambient soil temperature. For other conditions, see Clause 3.5.3.

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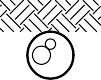
**AS/NZS 3008.1.2:1998** 42

### TABLE 11

**CURRENT-CARRYING CAPACITIES OF TWO-CORE 0.6/1 kV INSULATED AND SHEATHED (INCLUDING NEUTRAL SCREENED) CABLES WITH**

**OR WITHOUT EARTH CONDUCTOR, ARMOURED OR NON-ARMOURED CABLES WITH R-HF-110,**

### R-E-110 OR X-HF-110 INSULATION



--`,,,``,`,,``,,,,,`````,`,,`,,`-`-`,,`,,`,`,,`---

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| **Conductor size**  **mm2** | **Current-carrying capacity, A** | | | | | | |
| **Unenclosed** | | **Enclosed** | | | **Buried direct** | **Underground non- metallic wiring enclosure** |
| **Spaced** | **Touching** | **Metallic** | **In metallic wiring** | **Completely** |  |  |
|  |  | **wiring** | **enclosure unenclosed** | **surrounded by** |
|  |  | **enclosure in** | **partially surrounded** | **thermal** |
|  |  | **air** | **by thermal** | **insulation** |
|  |  |  | **insulation** |  |
| **Cu** | **Cu** | **Cu** | **Cu** | **Cu** | **Cu** | **Cu** |
| 1 | 25 | 24 | 20 | 16 | 12 | 31 | 24 |
| 1.5 | 31 | 30 | 26 | 20 | 15 | 39 | 31 |
| 2.5 | 44 | 42 | 35 | 29 | 20 | 54 | 42 |
| 4 | 59 | 55 | 48 | 39 | 28 | 71 | 55 |
| 6 | 74 | 70 | 60 | 48 | 35 | 89 | 69 |
| 10 | 102 | 95 | 81 | 64 | 48 | 117 | 92 |
| 16 | 134 | 128 | 107 | 87 | 63 | 154 | 122 |
| 25 | 182 | 171 | 144 | 112 | 85 | 201 | 159 |
| 35 | 219 | 209 | 177 | 144 | 104 | 239 | 191 |
| 50 | 268 | 251 | 214 | 171 | — | 286 | 228 |
| 70 | 337 | 321 | 273 | 219 | — | 350 | 281 |
| 95 | 417 | 391 | 332 | 268 | — | 419 | 339 |
| 120 | 487 | 455 | 396 | 316 | — | 477 | 392 |
| 150 | 556 | 519 | 444 | 358 | — | 541 | 445 |
| 185 | 642 | 599 | 519 | 417 | — | 604 | 509 |
| 240 | 760 | 706 | 631 | 503 | — | 700 | 604 |
| 300 | 867 | 813 | 717 | 578 | — | 795 | 678 |
| 400 | 1006 | 942 | 824 | 653 | — | 901 | 774 |
| 500 | 1145 | 1070 | 963 | 770 | — | 1018 | 901 |

NOTES:

1. Refer to Tables 2(1), 2(2), 2(3) and 2(4) for cable configurations deemed to have the same current-carrying capacities as those illustrated.
2. Derating factors may apply as follows:
   1. The current-carrying capacities apply to single circuits; for grouped cable circuits see Clause 3.5.2 and Tables 22, 24, 25 and 26 for appropriate derating factors.
   2. For a single circuit fixed to the underside of a ceiling or similar horizontal surface, see Table 22 for the derating factor to be applied to the current-carrying capacities given in Column 3.
   3. For a single circuit fixed to unperforated cable tray, see Table 24 for the derating factor to be applied to the current- carrying capacities given in Column 2.
   4. For ambient temperature and depth of laying factors, see Tables 27 and 28.
3. To calculate the single-phase voltage drop of these configurations, multiply the appropriate three-phase voltage drop value in Table 42 or Table 45 by 1.155.
4. These ratings are based on 30°C ambient air temperature and 15°C ambient soil temperature. For other conditions, see Clause 3.5.3.

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### TABLE 12

**CURRENT-CARRYING CAPACITIES OF THREE-CORE AND FOUR-CORE 0.6/1 kV INSULATED AND SHEATHED (INCLUDING NEUTRAL SCREENED) CABLES**

**WITH OR WITHOUT EARTH CONDUCTOR, ARMOURED OR NON-ARMOURED CABLES WITH V-75, V-90,**

**HFI-75-TP OR HFI-90-TP INSULATION (See Note 1)**



|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|  | **Current-carrying capacity, A** | | | | | | | | | | | | | | | |
|  | **Unenclosed** | | | | **Enclosed** | | | | | | | | **Buried direct** | | **Underground non-metallic wiring enclosure** | |
|  | **Spaced** | | **Touching** | | **Non-** | | **Non-metallic** | | **In non-metallic** | | **Completely** | |  | |  | |
|  |  | |  | | **metallic** | | **wiring** | | **wiring** | | **surrounded by** | |
|  |  | |  | | **wiring** | | **enclosures in** | | **enclosures or** | | **thermal** | |
|  |  | |  | | **enclosures** | | **air — flat cable** | | **unenclosed** | | **insulation** | |
|  |  | |  | | **in** | |  | | **partially** | |  | |
| **Con- ductor size** |  | |  | | **air — round cable** | |  | | **surrounded by thermal insulation** | |  | |
| **mm2** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** |
| 1 | 15 | — | 14 | — | 11 | 9 | 14 | 10 | 11 | 8 | 7 | — | 21 | — | 17 | — |
| 1.5 | 18 | — | 17 | — | 15 | 11 | 17 | 13 | 14 | 11 | 9 | — | 26 | — | 21 | — |
| 2.5 | 26 | — | 25 | — | 21 | 16 | 23 | 17 | 19 | 15 | 13 | — | 37 | — | 29 | — |
| 4 | 35 | — | 33 | — | 27 | 21 | 30 | 23 | 25 | 19 | 17 | — | 48 | — | 37 | — |
| 6 | 46 | — | 42 | — | 35 | 27 | 39 | 30 | 33 | 25 | 22 | — | 61 | — | 47 | — |
| 10 | 62 | — | 58 | — | 48 | 38 | 52 | 40 | 44 | 34 | 29 | — | 81 | — | 63 | — |
| 16 | 82 | 64 | 78 | 60 | 64 | 49 | 68 | 52 | 59 | 46 | 39 | 30 | 106 | 83 | 81 | 64 |
| 25 | 111 | 86 | 104 | 81 | 90 | 68 | 95 | 72 | 82 | 64 | 52 | 40 | 138 | 107 | 106 | 83 |
| 35 | 137 | 106 | 125 | 99 | 105 | 80 | 105 | 80 | 96 | 74 | 64 | 49 | 165 | 127 | 127 | 100 |
| 50 | 165 | 131 | 154 | 120 | 125 | 96 | 125 | 96 | 114 | 90 | — | — | 198 | 154 | 154 | 121 |
| 70 | 211 | 165 | 194 | 154 | 160 | 120 | — | — | 143 | 113 | — | — | 242 | 187 | 193 | 149 |
| 95 | 262 | 205 | 245 | 188 | 188 | 143 | — | — | 171 | 137 | — | — | 292 | 226 | 231 | 182 |
| 120 | 302 | 234 | 279 | 222 | 222 | 171 | — | — | 200 | 160 | — | — | 330 | 259 | 264 | 209 |
| 150 | 348 | 268 | 319 | 251 | 257 | 194 | — | — | 228 | 182 | — | — | 369 | 292 | 297 | 231 |
| 185 | 399 | 314 | 371 | 291 | 296 | 222 | — | — | 262 | 205 | — | — | 418 | 330 | 341 | 270 |
| 240 | 467 | 371 | 439 | 348 | 348 | 262 | — | — | 308 | 245 | — | — | 484 | 380 | 407 | 319 |
| 300 | 536 | 428 | 502 | 399 | — | — | — | — | — | — | — | — | 545 | 429 | 457 | 358 |
| 400 | 616 | 502 | 570 | 462 | — | — | — | — | — | — | — | — | 616 | 495 | 528 | 424 |
| 500 | 707 | 570 | 650 | 524 | — | — | — | — | — | — | — | — | 682 | 550 | 594 | 479 |

NOTES:

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1. Refer to Note 2 of Table 1 for information regarding the use of V-90 insulated cables.
2. Refer to Tables 2(1), 2(2), 2(3) and 2(4) for cable configurations deemed to have the same current-carrying capacities as those illustrated.
3. Derating factors may apply as follows:
   1. The current-carrying capacities apply to single circuits; for grouped cable circuits see Clause 3.5.2 and Tables 22, 24, 25 and 26 for appropriate derating factors.
   2. For a single circuit fixed to the underside of a ceiling or similar horizontal surface, see Table 22 for the derating factor to be applied to the current-carrying capacities given in Columns 4 and 5.
   3. For a single circuit fixed to unperforated cable tray, see Table 24 for the derating factor to be applied to the current- carrying capacities given in Columns 2 and 3.
   4. For ambient temperature and depth of laying factors, see Tables 27 and 28.
4. To determine the three-phase voltage drop of these configurations, refer to the appropriate value in Table 42 or Table 45.
5. These ratings are based on 30°C ambient air temperature and 15°C ambient soil temperature. For other conditions, see Clause 3.5.3.

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### TABLE 13

**CURRENT-CARRYING CAPACITIES OF THREE-CORE AND FOUR-CORE 0.6/1 kV INSULATED AND SHEATHED (INCLUDING NEUTRAL SCREENED) CABLES**

**WITH OR WITHOUT EARTH CONDUCTOR, ARMOURED OR NON-ARMOURED CABLES WITH X-90, X-HF-90,**

**R-EP-90, R-CPE-90, R-HF-90 OR R-CSP-90 INSULATION**



|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|  | **Current-carrying capacity, A** | | | | | | | | | | | | | |
|  | **Unenclosed** | | | | **Enclosed** | | | | | | **Buried direct** | | **Underground non-metallic wiring enclosure** | |
|  | **Spaced** | | **Touching** | | **Non-metallic** | | **In non-metallic** | | **Completely** | |  | |  | |
|  |  | |  | | **wiring enclosure** | | **wiring enclosure** | | **surrounded by** | |
|  |  | |  | | **in air** | | **or unenclosed** | | **thermal** | |
|  |  | |  | |  | | **partially** | | **insulation** | |
|  |  | |  | |  | | **surrounded by** | |  | |
| **Con-** |  | |  | |  | | **thermal** | |  | |
| **ductor** |  | |  | |  | | **insulation** | |  | |
| **size** |  | |  | |  | |  | |  | |
| **mm2** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** | **Cu** | **Al** |
| 1 | 18 | — | 15 | — | 13 | 10 | 13 | 11 | 8 | — | 24 | — | 18 | — |
| 1.5 | 22 | — | 21 | — | 18 | 13 | 18 | 14 | 10 | — | 30 | — | 22 | — |
| 2.5 | 31 | — | 29 | — | 24 | 19 | 23 | 19 | 14 | — | 42 | — | 32 | — |
| 4 | 42 | — | 39 | — | 32 | 24 | 31 | 25 | 20 | — | 55 | — | 41 | — |
| 6 | 53 | — | 50 | — | 42 | 32 | 40 | 32 | 24 | — | 67 | — | 51 | — |
| 10 | 73 | — | 68 | — | 58 | 44 | 55 | 44 | 34 | — | 91 | — | 68 | — |
| 16 | 97 | 75 | 91 | 70 | 77 | 59 | 73 | 58 | 45 | 35 | 118 | 91 | 89 | 70 |
| 25 | 132 | 102 | 121 | 95 | 108 | 84 | 101 | 80 | 62 | 47 | 155 | 118 | 118 | 91 |
| 35 | 160 | 127 | 149 | 116 | 127 | 98 | 116 | 94 | 76 | 58 | 182 | 144 | 144 | 112 |
| 50 | 198 | 154 | 187 | 143 | 154 | 121 | 143 | 110 | — | — | 219 | 171 | 171 | 134 |
| 70 | 253 | 198 | 237 | 182 | 193 | 149 | 176 | 143 | — | — | 268 | 209 | 214 | 166 |
| 95 | 314 | 242 | 292 | 226 | 231 | 182 | 215 | 171 | — | — | 321 | 251 | 257 | 198 |
| 120 | 363 | 281 | 336 | 264 | 275 | 215 | 248 | 198 | — | — | 369 | 284 | 294 | 230 |
| 150 | 413 | 325 | 385 | 297 | 308 | 242 | 281 | 226 | — | — | 412 | 321 | 332 | 257 |
| 185 | 479 | 374 | 446 | 347 | 358 | 281 | 325 | 259 | — | — | 465 | 364 | 380 | 300 |
| 240 | 572 | 446 | 528 | 413 | 424 | 336 | 385 | 303 | — | — | 535 | 423 | 449 | 353 |
| 300 | 649 | 512 | 605 | 473 | — | — | — | — | — | — | 610 | 476 | 508 | 401 |
| 400 | 748 | 605 | 693 | 550 | — | — | — | — | — | — | 685 | 546 | 578 | 460 |
| 500 | 858 | 693 | 792 | 638 | — | — | — | — | — | — | 760 | 621 | 663 | 535 |

NOTES:

1. Refer to Tables 2(1), 2(2), 2(3) and 2(4) for cable configurations deemed to have the same current-carrying capacities as those illustrated.
2. Derating factors may apply as follows:
   1. The current-carrying capacities apply to single circuits; for grouped cable circuits see Clause 3.5.2 and Tables 22, 24, 25 and 26 for appropriate derating factors.
   2. For a single circuit fixed to the underside of a ceiling or similar horizontal surface, see Table 22 for the derating factor to be applied to the current-carrying capacities given in Columns 4 and 5.
   3. For a single circuit fixed to unperforated cable tray, see Table 24 for the derating factor to be applied to the current- carrying capacities given in Columns 2 and 3.
   4. For ambient temperature and depth of laying factors, see Tables 27 and 28.
3. To determine the three-phase voltage drop of these configurations, refer to the appropriate value in Table 42 or Table 45.
4. These ratings are based on 30°C ambient air temperature and 15°C ambient soil temperature. For other conditions, see Clause 3.5.3.

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### TABLE 14

**CURRENT-CARRYING CAPACITIES OF THREE-CORE AND FOUR-CORE 0.6/1 kV INSULATED AND SHEATHED (INCLUDING NEUTRAL**

**SCREENED) CABLES WITH OR WITHOUT EARTH CONDUCTOR, ARMOURED OR NON-ARMOURED CABLES WITH R-HF-110,**

### R-E-110 OR X-HF-110 INSULATION



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|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| **Conductor size**  **mm2** | **Current-carrying capacity, A** | | | | | | |
| **Unenclosed** | | **Enclosed** | | | **Buried direct** | **Underground non-metallic wiring enclosure** |
| **Spaced** | **Touching** | **Metallic** | **In metallic wiring** | **Completely** |  |  |
|  |  | **wiring** | **enclosure** | **surrounded by** |
|  |  | **enclosure in** | **unenclosed partially** | **thermal insulation** |
|  |  | **air** | **surrounded by** |  |
|  |  |  | **thermal insulation** |  |
| **Cu** | **Cu** | **Cu** | **Cu** | **Cu** | **Cu** | **Cu** |
| 1 | 21 | 19 | 17 | 14 | 10 | 27 | 20 |
| 1.5 | 27 | 26 | 21 | 17 | 13 | 33 | 25 |
| 2.5 | 37 | 35 | 31 | 25 | 18 | 47 | 36 |
| 4 | 50 | 47 | 41 | 32 | 24 | 59 | 47 |
| 6 | 63 | 60 | 50 | 41 | 30 | 75 | 58 |
| 10 | 87 | 81 | 68 | 55 | 41 | 100 | 77 |
| 16 | 112 | 107 | 92 | 73 | 54 | 127 | 101 |
| 25 | 155 | 144 | 123 | 100 | 72 | 170 | 133 |
| 35 | 187 | 177 | 150 | 118 | 89 | 201 | 159 |
| 50 | 230 | 214 | 187 | 150 | — | 239 | 191 |
| 70 | 289 | 273 | 230 | 187 | — | 292 | 239 |
| 95 | 358 | 337 | 289 | 230 | — | 355 | 292 |
| 120 | 417 | 391 | 332 | 268 | — | 403 | 329 |
| 150 | 476 | 444 | 385 | 310 | — | 451 | 376 |
| 185 | 546 | 514 | 439 | 353 | — | 509 | 424 |
| 240 | 653 | 610 | 535 | 428 | — | 594 | 504 |
| 300 | 749 | 696 | — | — | — | 668 | 572 |
| 400 | 867 | 803 | — | — | — | 753 | 668 |
| 500 | 995 | 920 | — | — | — | 848 | 753 |

NOTES:

1. Refer to Tables 2(1), 2(2), 2(3) and 2(4) for cable configurations deemed to have the same current-carrying capacities as those illustrated.
2. Derating factors may apply as follows:
   1. The current-carrying capacities apply to single circuits; for grouped cable circuits see Clause 3.5.2 and Tables 22, 24, 25 and 26 for appropriate derating factors.
   2. For a single circuit fixed to the underside of a ceiling or similar horizontal surface, see Table 22 for the derating factor to be applied to the current-carrying capacities given in Column 3.
   3. For a single circuit fixed to unperforated cable tray, see Table 24 for the derating factor to be applied to the current- carrying capacities given in Column 2.
   4. For ambient temperature and depth of laying factors, see Tables 27 and 28.
3. To determine the three-phase voltage drop of these configurations, refer to the appropriate value in Table 42 or Table 45.
4. These ratings are based on 30°C ambient air temperature and 15°C ambient soil temperature.For other conditions, see Clause 3.5.3.

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### TABLE 15

**CURRENT-CARRYING CAPACITIES OF 0.6/1 kV FLEXIBLE CABLES**



|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| **Conductor size**  **mm2** | **Current-carrying capacity, A** | | | | | | | |
| **Single- and two-core** | | | | **Three- and four-core (see Note 3)** | | | |
| **Protected from sun** | | **Exposed to sun** | | **Protected from sun** | | **Exposed to sun** | |
| **V75, V90** | **R-EP-90 R-CSP-90** | **V75, V90** | **R-EP-90 R-CSP-90** | **V75, V90** | **R-EP-90 R-CSP-90** | **V75, V90** | **R-EP-90 R-CSP-90** |
| 6 | 50 | 59 | 39 | 47 | 43 | 51 | 33 | 41 |
| 10 | 68 | 81 | 52 | 64 | 59 | 69 | 44 | 55 |
| 16 | 92 | 109 | 68 | 85 | 80 | 94 | 58 | 73 |
| 25 | 125 | 149 | 91 | 116 | 108 | 127 | 78 | 97 |
| 35 | 154 | 182 | 108 | 138 | 131 | 154 | 92 | 116 |
| 50 | 182 | 215 | 125 | 160 | 160 | 182 | 109 | 138 |
| 70 | 234 | 275 | 160 | 204 | 200 | 237 | 137 | 171 |
| 95 | 274 | 319 | 182 | 231 | 234 | 275 | 160 | 198 |
| 120 | 319 | 374 | 211 | 270 | 274 | 319 | 182 | 231 |
| 150 | 365 | 429 | 245 | 308 | 319 | 369 | 211 | 264 |
| 185 | 410 | 484 | 274 | 347 | 359 | 418 | 234 | 297 |
| 240\* | 485 | 561 | 314 | 402 | 422 | 490 | 268 | 341 |
| 300\* | 559 | 660 | 359 | 462 | 485 | 561 | 308 | 396 |
| 400\* | 673 | 792 | 428 | 550 | 581 | 682 | 371 | 468 |
| 500† | 752 | 880 | 473 | 616 | — | — | — | — |

\* Single-core, two-core and three-core only.

† Single-core, only.

NOTES:

1. The number of wires and the nominal diameter of each wire is given in AS 1125. The ratings apply to conductors having a large number of smaller wires than specified in AS 1125.
2. Where layers of flexible cable are accommodated on a cylindrical-type cable drum or reel, multiply the values in Columns 2 to 9 by the appropriate factor, as follows:

*Number of layers:* 1 2 3 4

*Derating factor:* 0.85 0.65 0.45 0.35

Where a spiral layer of flexible cable is accommodated on a radial-type cable drum, multiply the values in Columns 2 to 9 by a factor of 0.85 for ventilated drums and 0.75 for unventilated drums.

1. The current-carrying capacities may also be applied to flat cables with three or four loaded conductors.
2. To determine the three-phase voltage drop of these configurations, refer to the appropriate value in Table 46 or Table 47. To determine the single-phase voltage drop, multiply the three-phase value by 1.155.
3. These ratings are based on 30°C ambient air temperature. For other conditions, see Clause 3.5.3.

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### TABLE 16

**CURRENT-CARRYING CAPACITIES OF FLEXIBLE CORDS**

|  |  |
| --- | --- |
| 1 | 2 |
| **Conductor size mm2** | **Current-carrying capacity A** |
| 0.5 | 3 (see Note 3) |
| 0.75 | 7.5 |
| 1.0 | 10 |
| 1.5 | 16 |
| 2.5 | 20 |
| 4.0 | 25 |

NOTES:

* 1. The minimum number of wires in each conductor is given in AS 1125. The current-carrying capacity also applies to conductors having a larger number of smaller wires.
  2. Where a flexible cord is wound on a drum, multiply current-carrying capacity by the appropriate factor, as follows:

*Number of layers:* 1 2 3 4

*Derating factor:* 0.76 0.58 0.47 0.40

* 1. Flexible cords having tinsel conductors with a nominal cross-sectional area of 0.5 mm2 have a current-carrying capacity of 0.5 A.
  2. The current-carrying capacity is based on a cable maximum conductor operating temperature of 60°C in order to limit the surface temperatures for the expected use of such cables. See Clause 3.3.2.1 where flexible cords are used as fixed wiring and higher temperatures are permitted.
  3. To determine the three-phase voltage drop, refer to the appropriate value in Table 48 or Table 49. To determine the single-phase voltage drop, multiply the three-phase value by 1.155.
  4. These ratings are based on 25°C ambient air temperature.

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### TABLE 17

**CURRENT-CARRYING CAPACITIES OF CABLES AND FLEXIBLE CORDS WITH R-S-150, TYPE 150 FIBROUS OR 150 TYPE PTFE INSULATION**



|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 |
| **Conductor size**  **mm2** | **Current-carrying capacity, A** | | | |
| **Two single-core or one two-core** | | **Three or four single-core or three or four core** | |
| **Unenclosed in air** | **Enclosed in air** | **Unenclosed in air** | **Enclosed in air** |
| 0.5 | 20 | 16 | 16 | 14 |
| 0.75 | 25 | 21 | 21 | 17 |
| 1.0 | 29 | 24 | 25 | 20 |
| 1.5 | 38 | 29 | 32 | 25 |
| 2.5 | 52 | 40 | 45 | 33 |
| 4 | 70 | 52 | 60 | 44 |
| 6 | 90 | 70 | 77 | 57 |
| 10 | 125 | 94 | 109 | 79 |
| 16 | 172 | 124 | 146 | 103 |
| 25 | 224 | 166 | 192 | 140 |
| 35 | 276 | 202 | 239 | 170 |

NOTES:

1. The values are based on a conductor maximum operating temperature of 150°C and an ambient air temperature of 30°C. Where cables are to be operated at this temperature, care must be taken to avoid inadvertent contact with the hot surface of the cable and associated supports and terminations, and also to avoid subjecting the cable to mechanical stresses. Where cables are not operated in an ambient air temperature of 30°C, reference must be made to the appropriate rating factors in Table 27.1.
2. As a conservative alternative to cable manufacturers’ recommendations, the values given in this Table may also be applied to fibrous or PTFE insulated cables designed for a maximum operating temperature of 200°C.
3. No values are given in Clause 4 for voltage drop for these types of cable as they are generally installed for relatively short connections to high temperature equipment. However, on longer cable runs, as the increase in conductor impedance at 150°C is considerable, it may be necessary to take voltage drop into account.
4. These ratings are based on 30°C ambient air temperature. For other conditions, see Clause 3.5.3.

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### TABLE 18

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**CURRENT-CARRYING CAPACITIES OF BARE SINGLE-CORE MINERAL-INSULATED COPPER-SHEATHED CABLES**

**WITH COPPER CONDUCTORS— SHEATH TEMPERATURE: 100°C**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| **Conductor size**  **mm2** | **Current-carrying capacity, A** | | | | | |
| **Vertical spaced — spaced from**  **wall** | **Flat horizontal — spaced from**  **wall** | **Flat vertical — clipped to**  **wall** | **Vertical spaced — spaced from**  **wall** | **Trefoil — spaced from wall** | **Flat vertical — clipped to**  **wall** |
|  |  |  |  |  |  |

**0.6/0.6 kV cables**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | 23 | 20 | 18 | 20 | 18 | 16 |
| 1.5 | 27 | 25 | 22 | 26 | 22 | 20 |
| 2.5 | 38 | 34 | 30 | 37 | 30 | 28 |
| 4 | 51 | 46 | 41 | 48 | 41 | 37 |

**1/1 kV cables**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 1.5 | 33 | 29 | 26 | 32 | 26 | 24 |
| 2.5 | 42 | 39 | 35 | 42 | 35 | 32 |
| 4 | 59 | 52 | 47 | 56 | 47 | 43 |
| 6 | 74 | 66 | 60 | 74 | 60 | 54 |
| 10 | 100 | 91 | 82 | 97 | 82 | 74 |
| 16 | 140 | 120 | 110 | 130 | 110 | 100 |
| 25 | 175 | 165 | 145 | 170 | 145 | 135 |
| 35 | 215 | 200 | 180 | 210 | 180 | 165 |
| 50 | 280 | 255 | 225 | 270 | 225 | 205 |
| 70 | 350 | 315 | 285 | 340 | 285 | 260 |
| 95 | 410 | 370 | 235 | 400 | 340 | 305 |
| 120 | 480 | 435 | 390 | 465 | 400 | 355 |
| 150 | 565 | 505 | 455 | 540 | 465 | 415 |
| 185 | 660 | 595 | 535 | 635 | 545 | 485 |
| 240 | 790 | 710 | 640 | 755 | 650 | 580 |
| 300 | 875 | 795 | 710 | 850 | 745 | 650 |
| 400 | 1090 | 985 | 885 | 1050 | 920 | 805 |

NOTES:

1. The current-carrying capacities given in this Table are based on a maximum operating temperature of 100°C for the external surface of the bare copper sheath. The current-carrying capacities of served cables may be 1.1 times higher than these if they are served with a material which is suitable for a copper sheath temperature of 105°C. See Clause 3.2.2 and Table 1 for conditions where higher cable operating temperatures may be permitted for bare sheathed cables.
2. To determine the three-phase voltage drop, refer to the appropriate value in Table 48. To determine the single- phase voltage drop, multiply the three-phase value by 1.155.
3. The current-carrying capacities apply to single circuits. For grouped cable circuits see—
   1. Clause 3.5.2 and Tables 22 to 26 for derating factors for served cables; and
   2. Clause 3.5.2.2(a) for the treatment of unserved cables.
4. For earth sheath return system, temperature rises could be higher. Refer to manufacturer.
5. These ratings are based on 30°C ambient air temperature. For other conditions, see Clause 3.5.3.

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### TABLE 19

**CURRENT-CARRYING CAPACITIES OF BARE MULTICORE MINERAL-INSULATED COPPER-SHEATHED**

**CABLES WITH COPPER CONDUCTORS— SHEATH TEMPERATURE: 100°C**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| **Conductor size**  **mm2** | **Current-carrying capacity, A** | | | | | |
| **Two core — spaced from wall** | **Two core — clipped to wall** | **Three and four core — spaced from wall** | **Three and four core — clipped to wall** | **Seven core — spaced from wall** | **Seven core — clipped to wall** |
|  |  |  |  |  |  |

**0.6/0.6 kV cables**



|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | 19 | 17 | 17 | 16 | 12 | 11 |
| 1.5 | 25 | 23 | 21 | 19 | 16 | 15 |
| 2.5 | 34 | 31 | 29 | 28 | 22 | 21 |
| 4 | 46 | 43 | — | — | — | — |

**1/1 kV cables**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 1.5 | 29 | 27 | 24 | 23 | 18 | 17 |
| 2.5 | 38 | 35 | 32 | 30 | 24 | 22 |
| 4 | 51 | 47 | 43 | 41 | 32 | 30 |
| 6 | 66 | 62 | 55 | 52 | — | — |
| 10 | 91 | 84 | 77 | 73 | — | — |
| 16 | 125 | 115 | 105 | 96 | — | — |
| 25 | 165 | 155 | 140 | 135 | — | — |

NOTES:

1. The current-carrying capacities given in this Table are based on a maximum operating temperature of 100°C for the external surface of the bare copper sheath. The current-carrying capacities of served cables may be 1.1 times higher than these if they are served with a material which is suitable for a copper sheath temperature of 105°C. See Clause 3.2.2 and Table 1 for conditions where higher cable operating temperatures may be permitted for bare sheathed cables.
2. To determine the three-phase voltage drop, refer to the appropriate value in Table 48. To determine the single-phase voltage drop, multiply the three-phase value by 1.155.
3. The current-carrying capacities apply to single circuits. For grouped cable circuits see—
   1. Clause 3.5.2 and Tables 22 to 26 for derating factors for served cables; and
   2. Clause 3.5.2.2(a) for the treatment of unserved cables.
4. For earth sheath return system, temperature rises could be higher. Refer to manufacturer.
5. These ratings are based on 30°C ambient air temperature. For other conditions, see Clause 3.5.3.

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### TABLE 20

### CURRENT-CARRYING CAPACITIES OF AERIAL CABLES WITH COPPER CONDUCTORS

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|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| **Conductor size, mm2, or stranding (No./mm)** | **Current-carrying capacity, A** | | | | | | | | | | | |
| **Bare conductors** | | | **PVC insulated single-core** | | | **PVC insulated two-core twisted, two-core neutral screened and two-core or three-core**  **parallel webbed cable** | | | **PVC insulated three-core and four-core twisted and three-core or four-core neutral screened cable** | | |
| **Still air** | **1 m/s wind** | **2 m/s wind** | **Still air** | **1 m/s wind** | **2 m/s wind** | **Still air** | **1 m/s wind** | **2 m/s wind** | **Still air** | **1 m/s wind** | **2 m/s wind** |
| 7/1.00 | 42 | 85 | 100 | — | — | — | — | — | — | — | — | — |
| 6 | 43 | 86 | 102 | 40 | 80 | 90 | 34 | 57 | 67 | 30 | 55 | 64 |
| 7/1.25 | 56 | 111 | 131 | — | — | — | — | — | — | — | — | — |
| 10 | 60 | 119 | 141 | 55 | 109 | 125 | 46 | 78 | 91 | 41 | 74 | 87 |
| 16 | 81 | 159 | 187 | 74 | 143 | 165 | 59 | 103 | 120 | 54 | 97 | 114 |
| 7/1.75 | 86 | 169 | 199 | — | — | — | — | — | — | — | — | — |
| 7/2.00 | 102 | 198 | 234 | — | — | — | — | — | — | — | — | — |
| 25 | 110 | 212 | 251 | 100 | 188 | 217 | 78 | 137 | 160 | 72 | 131 | 154 |
| 35 | 133 | 258 | 304 | 120 | 234 | 262 | 93 | 165 | 194 | 87 | 154 | 182 |
| 7/2.75 | 152 | 293 | 345 | — | — | — | — | — | — | — | — | — |
| 50 | 162 | 310 | 366 | 148 | 274 | 314 | 111 | 200 | 234 | 105 | 188 | 217 |
| 19/1.75 | 162 | 311 | 367 | — | — | — | — | — | — | — | — | — |
| 19/2.00 | 191 | 366 | 432 | — | — | — | — | — | — | — | — | — |
| 70 | 204 | 389 | 459 | 188 | 348 | 393 | 137 | 245 | 291 | 131 | 234 | 274 |
| 7/3.50 | 206 | 393 | 464 | — | — | — | — | — | — | — | — | — |
| 7/3.75 | 225 | 428 | 506 | — | — | — | — | — | — | — | — | — |
| 95 | 246 | 467 | 552 | 228 | 410 | 473 | — | — | — | — | — | — |
| 37/1.75 | 246 | 468 | 553 | — | — | — | — | — | — | — | — | — |

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**TABLE 20** (*continued*)

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|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| **Conductor size, mm2, or stranding (No./mm)** | **Current-carrying capacity, A** | | | | | | | | | | | |
| **Bare conductors** | | | **PVC insulated single-core** | | | **PVC insulated two-core twisted, two-core neutral screened and two-core or three-core**  **parallel webbed cable** | | | **PVC insulated three-core and four-core twisted and three-core or four-core neutral screened cable** | | |
| **Still air** | **1 m/s wind** | **2 m/s wind** | **Still air** | **1 m/s wind** | **2 m/s wind** | **Still air** | **1 m/s wind** | **2 m/s wind** | **Still air** | **1 m/s wind** | **2 m/s wind** |
| 19/2.75 | 286 | 541 | 639 | — | — | — | — | — | — | — | — | — |
| 120 | 290 | 548 | 648 | 268 | 485 | 553 | — | — | — | — | — | — |
| 19/3.00 | 320 | 602 | 712 | — | — | — | — | — | — | — | — | — |
| 150 | 331 | 623 | 737 | 302 | 542 | 627 | — | — | — | — | — | — |
| 185 | 383 | 716 | 846 | 353 | 616 | 707 | — | — | — | — | — | — |
| 37/2.50 | 387 | 723 | 855 | — | — | — | — | — | — | — | — | — |

NOTES:

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1. The current-carrying capacities are based on an ambient air temperature of 30°C, a maximum conductor temperature of 75°C and exposure to direct sunlight having an intensity of 1000 W/m2. In addition the values for bare conductors are based on black (weathered) conductors and the values of insulated conductors are based on the use of black PVC.
2. Under normal circumstances there will always be some air movement and a minimum rating for 1.0 m/s wind is recommended.
3. To determine the three-phase voltage drop of these configurations, refer to the following Tables:
   1. For twisted cables, see Table 40.
   2. For parallel and webbed cables, see Table 41.
   3. For bare and single insulated cables, see Table 49.
4. These ratings are based on 30°C ambient air temperature. For other conditions, see Clause 3.5.3.

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### TABLE 21

**CURRENT-CARRYING CAPACITIES OF AERIAL AND ABC CABLES WITH ALUMINIUM CONDUCTORS**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| **Conductor size, mm2, or stranding (No./mm)** | **Current-carrying capacity, A** | | | | | | | | | | | | | | | | | |
| **Bare conductors** | | | **PVC insulated single-core** | | | **PVC insulated two-core twisted, two-core neutral screened and two-core or three-core parallel webbed cable** | | | **PVC insulated three-core and four-core twisted and three-core or four- core neutral screened cable** | | | **XLPE insulated two-core twisted cable**  **and ABC** | | | **XLPE insulated three- core and four-core twisted cable**  **and ABC** | | |
| **Still air** | **1 m/s wind** | **2 m/s wind** | **Still air** | **1 m/s wind** | **2 m/s wind** | **Still air** | **1 m/s wind** | **2 m/s wind** | **Still air** | **1 m/s wind** | **2 m/s wind** | **Still air** | **1 m/s wind** | **2 m/s wind** | **Still air** | **1 m/s wind** | **2 m/s wind** |
| 16 | 63 | 124 | 146 | 56 | 111 | 125 | 47 | 81 | 96 | 41 | 75 | 88 | 55 | 87 | 102 | 49 | 83 | 96 |
| 25 | 86 | 167 | 197 | 76 | 148 | 165 | 60 | 104 | 125 | 55 | 99 | 114 | 72 | 118 | 134 | 66 | 109 | 129 |
| 35 | 105 | 202 | 239 | 93 | 177 | 205 | 72 | 125 | 148 | 67 | 120 | 143 | 87 | 140 | 162 | 81 | 134 | 151 |
| 7/2.50 | 106 | 205 | 242 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 7/2.75 | 120 | 231 | 273 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 50 | 127 | 244 | 288 | 113 | 211 | 245 | 86 | 154 | 182 | 81 | 143 | 171 | 105 | 168 | 202 | 99 | 157 | 185 |
| 7/3.00 | 134 | 257 | 303 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 70 | 160 | 306 | 361 | 143 | 268 | 302 | 105 | 188 | 228 | 101 | 177 | 211 | 129 | 213 | 252 | 123 | 196 | 230 |
| 7/3.75 | 178 | 338 | 399 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 95 | 194 | 367 | 434 | 177 | 319 | 371 | 125 | 234 | 279 | 125 | 217 | 262 | 157 | 258 | 308 | 151 | 241 | 286 |
| 7/4.50 | 223 | 422 | 499 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 120 | 228 | 431 | 510 | 205 | 371 | 428 | — | — | — | — | — | — | — | — | — | 174 | 280 | 336 |
| 7/4.75 | 239 | 451 | 533 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 150 | 260 | 489 | 578 | 234 | 416 | 479 | — | — | — | — | — | — | — | — | — | 202 | 314 | 386 |
| 19/3.25 | 278 | 523 | 618 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 185 | 301 | 563 | 665 | 274 | 479 | 547 | — | — | — | — | — | — | — | — | — | — | — | — |
| 19/3.50 | 307 | 574 | 678 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |

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NOTES TO TABLE 21:

1. The current-carrying capacities are based on an ambient air temperature of 30°C, a maximum conductor temperature of 75°C for PVC or 80°C for XLPE, and exposure to direct sunlight having an intensity of 1000 W/m2. In addition the values for bare conductors are based on black (weathered) conductors and the values for insulated conductors are based on the use of black PVC or XLPE.
2. Under normal circumstances there will always be some air movement and a minimum rating for 1.0 m/s wind is recommended.
3. To determine the three-phase voltage drop of these configurations, refer to the following Tables:
   1. For twisted cables, see Table 43.
   2. For parallel and webbed cables, see Table 44.
   3. For bare and single insulated cables, see Table 50.
4. These ratings are based on 30°C ambient air temperature. For other conditions, see Clause 3.5.3.

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### TABLE 22

**DERATING FACTORS FOR BUNCHED CIRCUITS OF SINGLE-CORE OR MULTICORE CABLES IN AIR OR IN WIRING ENCLOSURES**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| **Item No.** | **Arrangement of cables (see Notes 1 & 2)** | | **Derating factors** | | | | | | | | | | | | | | |
| **Number of circuits** | | | | | | | | | | | | | | |
| **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **12** | **14** | **16** | **18** | **20 or more** |
| 1 | Bunched in air | | 1.00 | 0.87 | 0.75 | 0.72 | 0.70 | 0.67 | — | — | — | — | — | — | — | — | — |
| 2 | Bunched on a surface or enclosed | | 1.00 | 0.80 | 0.70 | 0.65 | 0.60 | 0.57 | 0.54 | 0.52 | 0.50 | 0.48 | 0.45 | 0.43 | 0.41 | 0.39 | 0.38 |
| 3 | Single layer on wall or floor | Touching | 1.00 | 0.85 | 0.79 | 0.75 | 0.73 | 0.72 | 0.72 | 0.71 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 | 0.70 |
| 4 | Spaced (see Notes 5 & 6) | 1.00 | 0.94 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 | 0.90 |
| 5 | Single layer under ceiling | Touching | 0.95 | 0.81 | 0.72 | 0.68 | 0.66 | 0.64 | 0.63 | 0.62 | 0.61 | 0.61 | 0.61 | 0.61 | 0.61 | 0.61 | 0.61 |
| 6 | Spaced (see Notes 5 & 6) | 0.95 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 |

NOTES:

1. Where the cable in the arrangements shown in Columns 2 and 3 consist of *n* loaded conductors, the conductors may be considered as—
   1. groups of two loaded conductors; or
   2. groups of three loaded conductors.
2. Earthing conductors, lightly loaded neutral conductors of three-phase circuits and conductors subject only to momentary loading, such as control wiring, are not taken into account when considering the number of circuits.
3. These factors are based on uniform groups of cables, equally loaded. In accordance with Clause 3.5.6 the factors for circuits subject to intermittent or varying loads may be higher.
4. These factors are applicable to numbers of circuits comprising the following:
   1. Groups of two, three or four single-core cables.
   2. Multicore cables.
   3. Cables passing more than once through the same group of cables or wiring enclosures and circuits connected in parallel in accordance with Clause 3.5.2.7.
5. ‘Spaced’ means a clearance of one cable diameter between cable surfaces of adjacent cables. Where the cables concerned are not of the same size, the spacing will be based on the largest cable diameter in the adjacent groups.
6. No derating factor is applicable for the minimum spacings specified in Clause 3.5.2.2(c) and Figure 1.

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### TABLE 23

### DERATING FACTORS FOR CIRCUITS OF SINGLE-CORE CABLES INSTALLED IN TRAYS, RACKS, CLEATS, OR OTHER SUPPORTS IN AIR



--`,,,``,`,,``,,,,,`````,`,,`,,`-`-`,,`,,`,`,,`---

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| **Item No.** | **Installation** | | **Number of tiers or rows of cable supports** | **Arrangements of cables in a circuit (see Note 1)** | **Derating factors** | | |
| **Number of circuits per tier or row** | | |
| **1** | **2** | **3** |
| 1 | Unperforated trays | (See Note 6) | 1 | 2 or 3 cables in horizontal formation | 0.95 | 0.85 | 0.84 |
| 2 | 2 | 0.92 | 0.83 | 0.79 |
| 3 | 3 | 0.91 | 0.82 | 0.76 |
| 4 | Perforated trays | (See Note 6) | 1 | 2 or 3 cables in horizontal formation | 0.97 | 0.89 | 0.87 |
| 5 | 2 | 0.94 | 0.85 | 0.81 |
| 6 | 3 | 0.93 | 0.84 | 0.79 |
| 7 | Ladder supports, racks and cleats | (See Note 6) | 1 | 2 or 3 cables in horizontal formation | 1.00 | 0.95 | 0.94 |
| 8 | 2 | 0.95 | 0.90 | 0.88 |
| 9 | 3 | 0.95 | 0.89 | 0.85 |
| 10 | Vertical perforated trays | (See Note 7) | 1 | 2 or 3 cables in vertical formation | 0.94 | 0.85 | — |
| 11 | 2 | 0.92 | 0.83 | — |
| 12 | Unperforated trays | (See Note 6) | 1 | 2 or 3 cables in horizontal formation | 0.98 | 0.96 | 0.94 |
| 13 | 2 | 0.95 | 0.91 | 0.87 |
| 14 | 3 | 0.94 | 0.90 | 0.85 |
| 15 | Perforated trays | (See Note 6) | 1 | 2 or 3 cables in horizontal formation | 1.00 | 0.98 | 0.96 |
| 16 | 2 | 0.97 | 0.93 | 0.89 |
| 17 | 3 | 0.96 | 0.92 | 0.86 |
| 18 | Ladder supports | (See Note 6) | 1 | 2 or 3 cables in horizontal formation | 1.00 | 1.00 | 1.00 |
| 19 | 2 | 0.97 | 0.95 | 0.93 |
| 20 | 3 | 0.97 | 0.94 | 0.90 |
| 21 | Vertical perforated trays | (See Note 7) | 1 | 2 or 3 cables in vertical formation | 1.00 | 0.91 | 0.89 |
| 22 | 2 | 1.00 | 0.90 | 0.86 |

NOTES:

|  |  |  |
| --- | --- | --- |
|  |  |  |
|  |  |  |

1. *D* equals cable outside diameter or, in the case of a flat multicore cable, the maximum dimension of the cable.
2. Earthing conductors, lightly loaded neutral conductors of three-phase circuits and conductors subject only to momentary loading, such as control wiring, shall not be taken into account when considering the number of circuits.
3. These derating factors are to be applied to groups of two, three or four single-core cables for which the current-carrying capacity for a single circuit is obtained from Columns 4 and 5 of Tables 3, 4, 6 and 7, Column 3 of Tables 5 and 8, and Tables 15 to 19. The factors are also applicable to groups of single-core cables making up parallel circuits in accordance with Clause 3.5.2.7.
4. These factors are based on uniform groups of cables, equally loaded. In accordance with Clause 3.5.6, the factors for circuits subject to intermittent or varying loads may be higher.

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1. These factors are applicable to single layers of cables or trefoil groups, as shown in Column 2. Where there is more than one layer on the same tray or ladder support, Table 22 may be used.
2. The vertical spacing of horizontal trays and ladder supports shall be not less than 300 mm (see also Figure 1).
3. The horizontal spacing of vertical trays mounted back-to-back shall be not less than 230 mm.
4. No derating factor is applicable for the minimum spacings specified in Clause 3.5.2.2(c) and Figure 1(a).

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### TABLE 24

### DERATING FACTORS FOR CIRCUITS OF MULTICORE CABLES INSTALLED IN TRAYS, RACKS, CLEATS OR OTHER SUPPORTS IN AIR

--`,,,``,`,,``,,,,,`````,`,,`,,`-`-`,,`,,`,`,,`---

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| **Item No.** | **Installation** | | **Number of tiers or rows of cable supports** | **Derating factors** | | | | | |
| **Number of cables** | | | | | |
| **1** | **2** | **3** | **4** | **6** | **9** |
| 1 | Unperforated trays | Touching (see Note 6) | 1 | 0.97 | 0.85 | 0.78 | 0.75 | 0.71 | 0.68 |
| 2 | 2 | 0.97 | 0.84 | 0.76 | 0.73 | 0.68 | 0.63 |
| 3 | 3 | 0.97 | 0.83 | 0.75 | 0.72 | 0.66 | 0.61 |
| 4 | Spaced (see Note 6) | 1 | 0.97 | 0.96 | 0.94 | 0.93 | 0.90 | — |
| 5 | 2 | 0.97 | 0.95 | 0.92 | 0.90 | 0.86 | — |
| 6 | 3 | 0.97 | 0.94 | 0.91 | 0.89 | 0.84 | — |
| 7 | Perforated trays | Touching (see Note 6) | 1 | 1.00 | 0.88 | 0.82 | 0.78 | 0.76 | 0.73 |
| 8 | 2 | 1.00 | 0.87 | 0.80 | 0.76 | 0.73 | 0.68 |
| 9 | 3 | 1.00 | 0.86 | 0.79 | 0.75 | 0.71 | 0.66 |
| 10 | Spaced (see Note 6) | 1 | 1.00 | 1.00 | 0.98 | 0.95 | 0.91 | — |
| 11 | 2 | 1.00 | 0.99 | 0.96 | 0.92 | 0.87 | — |
| 12 | 3 | 1.00 | 0.98 | 0.95 | 0.91 | 0.85 | — |
| 13 | Ladder supports, racks and cleats | Touching (see Note 6) | 1 | 1.00 | 0.87 | 0.82 | 0.80 | 0.79 | 0.78 |
| 14 | 2 | 1.00 | 0.86 | 0.80 | 0.78 | 0.76 | 0.73 |
| 15 | 3 | 1.00 | 0.85 | 0.79 | 0.76 | 0.73 | 0.70 |
| 16 | Spaced (see Note 6) | 1 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | — |
| 17 | 2 | 1.00 | 0.99 | 0.98 | 0.97 | 0.96 | — |
| 18 | 3 | 1.00 | 0.98 | 0.97 | 0.96 | 0.93 | — |
| 19 | Vertical perforated trays | Touching (see Note 7) | 1 | 1.00 | 0.88 | 0.82 | 0.77 | 0.73 | 0.72 |
| 20 | 2 | 1.00 | 0.88 | 0.81 | 0.76 | 0.72 | 0.70 |
| 21 | Spaced (see Note 7) | 1 | 1.00 | 0.91 | 0.89 | 0.88 | 0.87 | — |
| 22 | 2 | 1.00 | 0.91 | 0.88 | 0.87 | 0.86 | — |

NOTES:

1. *D* equals cable outside diameter or, in the case of a flat multicore cable, the maximum dimension of the cable.
2. Earthing conductors, lightly loaded neutral conductors of three-phase circuits and conductors subject only to momentary loading, such as control wiring, shall not be taken into account when considering the number of circuits.
3. These derating factors are to be applied to groups of multicore cables for which the current-carrying capacity for a single circuit is obtained from Columns 2 and 3 of Tables 9, 10, 12 and 13, Column 2 of Tables 11 and 14, and Tables 15 to 19. The factors are also applicable to groups of multicore cables making up parallel circuits in accordance with Clause 3.5.2.7.
4. These factors are applicable to uniform groups of cables, equally loaded. In accordance with Clause 3.5.6 the factors for circuits subject to intermittent or varying loads may be higher.
5. These factors are applicable to single layers of cables as shown in Column 2. Where there is more than one layer on the same tray or ladder support, Table 22 may be used.
6. The vertical spacing of horizontal trays and ladder supports shall be not less than 300 mm.
7. The horizontal spacing of vertical trays mounted back-to-back shall be not less than 230 mm.
8. No derating factor is applicable for the minimum spacings specified in Clause 3.5.2.2(c) and Figure 1(b).

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### TABLE 25(1)

**DERATING FACTORS FOR GROUPS OF CIRCUITS OF SINGLE-CORE OR MULTICORE CABLES BURIED DIRECT IN THE GROUND—**

**SINGLE-CORE CABLES**



|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| **Number of circuits** |  | | | | | |
| **Derating factors** | | | | | |
| **Touching** | | **Distance (*S*), m** | | | |
| **0.15** | **0.30** | **0.45** | **0.60** |
| **Trefoil** | **Laid flat** |
| 2  3  4  5  6  7  8  9  10  11  12 | 0.78  0.66  0.61  0.56  0.53  0.50  0.49  0.47  0.46  0.44  0.43 | 0.81  0.70  0.64  0.60  0.57  0.54  0.53  0.51  0.50  0.49  0.48 | 0.83  0.73  0.68  0.64  0.61  0.59  0.57  0.56  0.55  0.54  0.53 | 0.88  0.79  0.74  0.73  0.71  0.69  0.68  0.67  0.67  0.66  0.66 | 0.91  0.84  0.81  0.79  0.78  0.76  0.76  0.75  0.75  0.74  0.74 | 0.93  0.87  0.85  0.83  0.82  0.82  0.81  0.81  0.80  0.80  0.80 |

**TABLE 25(2)**

**DERATING FACTORS FOR GROUPS OF CIRCUITS OF SINGLE-CORE OR MULTICORE CABLES BURIED DIRECT IN THE GROUND—**

**MULTICORE CABLES**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 6 |
| **Number of cables in group** |  | | | | |
| **Derating factors** | | | | |
| **Touching** | **Distance (*S*), m** | | | |
| **0.15** | **0.30** | **0.45** | **0.60** |
| 2 | 0.81 | 0.87 | 0.91 | 0.93 | 0.95 |
| 3 | 0.70 | 0.78 | 0.84 | 0.88 | 0.90 |
| 4 | 0.63 | 0.74 | 0.81 | 0.86 | 0.89 |
| 5 | 0.59 | 0.70 | 0.78 | 0.84 | 0.87 |
| 6 | 0.55 | 0.68 | 0.77 | 0.83 | 0.87 |
| 7 | 0.52 | 0.66 | 0.75 | 0.82 | 0.86 |
| 8 | 0.50 | 0.64 | 0.75 | 0.81 | 0.86 |
| 9 | 0.48 | 0.63 | 0.74 | 0.81 | 0.85 |
| 10 | 0.47 | 0.62 | 0.73 | 0.80 | 0.85 |
| 11 | 0.45 | 0.61 | 0.73 | 0.80 | 0.85 |
| 12 | 0.44 | 0.60 | 0.72 | 0.80 | 0.84 |

NOTES:

1. For derating factors applicable to other arrangements of single-core and multicore cables laid direct in the ground, refer to ERA Report 69-30 or alternative specifications.
2. The derating factors have been determined from the hottest cable in the group and assume that all cables are of the same thermal grade of insulation.

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### TABLE 26(1)

**DERATING FACTORS FOR GROUPS OF CIRCUITS OF SINGLE-CORE OR MULTICORE CABLES INSTALLED IN UNDERGROUND WIRING ENCLOSURES— SINGLE CORE CABLES ENCLOSED SEPARATELY**

|  |  |  |  |
| --- | --- | --- | --- |
| 1 | 2 | 3 | 4 |
| **Number of circuits** |  | | |
| **Derating factor** | | |
| **Touching** | **Distance (*S*), m** | |
| **0.45** | **0.60** |
| 2 | 0.87 | 0.91 | 0.93 |
| 3 | 0.78 | 0.84 | 0.87 |
| 4 | 0.74 | 0.81 | 0.85 |
| 5 | 0.70 | 0.79 | 0.83 |
| 6 | 0.69 | 0.78 | 0.82 |
| 7 | 0.67 | 0.76 | 0.82 |
| 8 | 0.66 | 0.76 | 0.81 |
| 9 | 0.65 | 0.75 | 0.81 |
| 10 | 0.64 | 0.75 | 0.80 |
| 11 | 0.63 | 0.74 | 0.80 |
| 12 | 0.63 | 0.74 | 0.80 |

**TABLE 26(2)**

### DERATING FACTORS FOR GROUPS OF CIRCUITS OF SINGLE-CORE OR MULTICORE CABLES INSTALLED IN UNDERGROUND WIRING ENCLOSURES— MULTICORE

--`,,,``,`,,``,,,,,`````,`,,`,,`-`-`,,`,,`,`,,`---

**CABLES ENCLOSED SEPARATELY OR MORE THAN ONE SINGLE-CORE CABLE PER WIRING ENCLOSURE**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 |
| **Number of circuits** |  | | | |
| **Derating factor** | | | |
| **Touching** | **Distance (*S*), m** | | |
| **0.30** | **0.45** | **0.60** |
| 2 | 0.90 | 0.93 | 0.95 | 0.96 |
| 3 | 0.83 | 0.88 | 0.91 | 0.93 |
| 4 | 0.79 | 0.85 | 0.89 | 0.92 |
| 5 | 0.75 | 0.83 | 0.88 | 0.91 |
| 6 | 0.73 | 0.82 | 0.87 | 0.90 |
| 7 | 0.71 | 0.81 | 0.86 | 0.89 |
| 8 | 0.70 | 0.80 | 0.85 | 0.89 |
| 9 | 0.68 | 0.79 | 0.85 | 0.89 |
| 10 | 0.67 | 0.79 | 0.85 | 0.89 |
| 11 | 0.66 | 0.78 | 0.84 | 0.88 |
| 12 | 0.66 | 0.78 | 0.84 | 0.88 |

NOTE: For derating factors applicable to other arrangements of cables in underground wiring enclosures, refer to ERA Report 69-30 or alternative specifications.

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### TABLE 27(1)

**RATING FACTORS FOR VARIATIONS IN AMBIENT TEMPERATURE FOR CABLES IN AIR OR HEATED CONCRETE SLABS AND FOR CABLES BURIED DIRECT IN GROUND OR IN UNDERGROUND WIRING ENCLOSURES— AIR**

**AND CONCRETE SLAB TEMPERATURES**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
| **Conductor tempera- ture**  **°C** | **Rating factor** | | | | | | | | | | | | | | | | | | | | |
| **Ambient temperature (See Notes 1, 2 & 3), °C** | | | | | | | | | | | | | | | | | | | | |
| **15** | **20** | **25** | **30** | **35** | **40** | **45** | **50** | **55** | **60** | **65** | **70** | **75** | **80** | **85** | **90** | **100** | **110** | **120** | **130** | **140** |
| 150 | 1.07 | 1.05 | 1.03 | 1.00 | 0.98 | 0.96 | 0.94 | 0.91 | 0.89 | 0.87 | 0.85 | 0.82 | 0.80 | 0.77 | 0.74 | 0.71 | 0.66 | 0.58 | 0.50 | 0.41 | 0.29 |
| 110 | 1.08 | 1.06 | 1.03 | 1.00 | 0.97 | 0.93 | 0.90 | 0.87 | 0.83 | 0.79 | 0.75 | 0.71 | 0.66 | 0.61 | 0.56 | 0.50 | 0.36 | — | — | — | — |
| 90 | 1.15 | 1.09 | 1.05 | 1.00 | 0.95 | 0.91 | 0.85 | 0.80 | 0.74 | 0.66 | 0.59 | 0.52 | 0.43 | 0.31 | 0.17 | — | — | — | — | — | — |
| 80 | 1.17 | 1.12 | 1.06 | 1.00 | 0.95 | 0.89 | 0.82 | 0.75 | 0.68 | 0.59 | 0.50 | 0.40 | 0.24 | — | — | — | — | — | — | — | — |
| 75 | 1.18 | 1.12 | 1.06 | 1.00 | 0.94 | 0.88 | 0.80 | 0.72 | 0.63 | 0.53 | 0.43 | 0.32 | — | — | — | — | — | — | — | — | — |

NOTES:

1. For heated concrete slabs, the ambient temperature shall be taken as the operating temperature of the slab.
2. The normal usage of high temperature insulant cables is in ambient air temperatures greater than 30°C, see Table 17.
3. For cables with a maximum permissible operating temperature above the normal use temperatures specified in Table 2, derating may not be necessary (see Notes to Table 1 for further details).

### TABLE 27(2)

**RATING FACTORS FOR VARIATIONS IN AMBIENT TEMPERATURE FOR CABLES IN AIR OR HEATED CONCRETE SLABS AND FOR**

**CABLES BURIED DIRECT IN GROUND OR IN UNDERGROUND WIRING ENCLOSURES— SOIL TEMPERATURES**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| **Conductor temperature**  **°C** | **Rating factor** | | | | | | |
| **Soil ambient temperature, °C** | | | | | | |
| **10** | **15** | **20** | **25** | **30** | **35** | **40** |
| 110 | 1.02 | 1.00 | 0.97 | 0.94 | 0.92 | 0.89 | 0.86 |
| 90 | 1.04 | 1.00 | 0.96 | 0.93 | 0.91 | 0.87 | 0.83 |
| 80 | 1.04 | 1.00 | 0.95 | 0.92 | 0.88 | 0.83 | 0.78 |
| 75 | 1.04 | 1.00 | 0.95 | 0.91 | 0.86 | 0.81 | 0.75 |

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### TABLE 28(1)

**RATING FACTORS FOR VARIATIONS IN DEPTH OF LAYING FOR CABLES BURIED DIRECT IN THE GROUND AND FOR CABLES**

**INSTALLED IN UNDERGROUND WIRING ENCLOSURES— SINGLE-CORE OR MULTICORE CABLES BURIED DIRECT**

|  |  |  |  |
| --- | --- | --- | --- |
| 1 | 2 | 3 | 4 |
| **Depth of laying m** | **Rating factor** | | |
| **Conductor size, mm2** | | |
| **Up to 50** | **Above 50 up to 300** | **Above 300** |
| 0.5 | 1.00 | 1.00 | 1.00 |
| 0.6 | 0.99 | 0.98 | 0.97 |
| 0.8 | 0.97 | 0.96 | 0.94 |
| 1.0 | 0.95 | 0.94 | 0.92 |
| 1.25 | 0.94 | 0.92 | 0.90 |
| 1.5 | 0.93 | 0.91 | 0.89 |
| 1.75 | 0.92 | 0.89 | 0.87 |
| 2.0 | 0.91 | 0.88 | 0.86 |
| 2.5 | 0.90 | 0.87 | 0.85 |
| 3.0 or more | 0.89 | 0.86 | 0.83 |

NOTE: The ambient temperature at the surface is to be taken at 30°C and not 15°C as at a depth of 0.5 m. For depth less than 0.5 m, see Table 2.3.

### TABLE 28(2)

**RATING FACTORS FOR VARIATIONS IN DEPTH OF**

**LAYING FOR CABLES BURIED DIRECT IN THE GROUND AND FOR CABLES INSTALLED IN UNDERGROUND**

**WIRING ENCLOSURES— SINGLE-CORE AND MULTICORE CABLES IN UNDERGROUND WIRING ENCLOSURES**

|  |  |  |
| --- | --- | --- |
| 1 | 2 | 3 |
| **Depth of laying m** | **Rating factor** | |
| **Single-core\*** | **Multicore** |
| 0.5 | 1.00 | 1.00 |
| 0.6 | 0.98 | 0.99 |
| 0.8 | 0.95 | 0.97 |
| 1.0 | 0.93 | 0.96 |
| 1.25 | 0.90 | 0.95 |
| 1.5 | 0.89 | 0.94 |
| 1.75 | 0.88 | 0.94 |
| 2.0 | 0.87 | 0.93 |
| 2.5 | 0.86 | 0.93 |
| 3.0 or more | 0.85 | 0.92 |

\* These rating factors apply to single-core cables enclosed separately, or grouped in a single wiring enclosure.

NOTE: The ambient temperature at the surface is to be taken as 30°C and not 15°C as at a depth of 0.5 m. For depth less than 0.5 m, see Table 2.4.

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### TABLE 29

**RATING FACTORS FOR CABLES BURIED DIRECT IN GROUND AND FOR CABLES INSTALLED IN UNDERGROUND WIRING ENCLOSURES WHERE THE THERMAL RESISTIVITY OF THE SOIL VARIES**

**FROM 1.2°C.m/W**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 1 | 2 | 3 | 4 | 5 | 6 |
| **Thermal resistivity of soil**  **°C.m/W** | **Rating factor** | | | | |
| **Multicore cable buried direct** | **Two or three single-core cables buried direct** | **Multicore cable in a wiring**  **enclosure** | **Two single- core cables in a wiring enclosure\*** | **Three single- core cables in a wiring enclosure\*** |
| 0.8 | 1.09 | 1.16 | 1.03 | 1.06 | 1.08 |
| 0.9 | 1.07 | 1.11 | 1.02 | 1.04 | 1.06 |
| 1.0 | 1.04 | 1.07 | 1.02 | 1.03 | 1.04 |
| 1.2 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 1.5 | 0.92 | 0.90 | 0.95 | 0.94 | 0.92 |
| 2.0 | 0.81 | 0.80 | 0.88 | 0.86 | 0.83 |
| 2.5 | 0.74 | 0.72 | 0.83 | 0.80 | 0.77 |
| 3.0 | 0.69 | 0.66 | 0.78 | 0.75 | 0.71 |

\* These rating factors apply to single-core cables enclosed separately, or grouped in a single wiring enclosure.

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## S E C T I O N 4 V O L T A G E D R O P

* 1. **GENERAL** The provisions of this Section apply to the selection of conductor sizes with regard to voltage drop.

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NOTE: NZS 3000 imposes limitations on circuit arrangements in order to restrict excessive voltage drop between supply and load.

Clauses 4.2 and 4.3 describe a simplified method of determining the voltage drop for use with Tables 40 to 50 for applications where only the route length and load current of balanced circuits are known.

Clauses 4.4 and 4.5 describe a more accurate method of determining the voltage drop for use with Tables 30 to 39 where the cable size is known or anticipated.

Clause 4.6 describes a method for determining the voltage drop where unbalanced load current conditions occur.

* 1. **DETERMINATION OF VOLTAGE DROP FROM MILLIVOLTS PER AMPERE METRE** The voltage drop (mV/A.m) values given in Tables 40 to 50 are for various cable types and configurations and maximum operating temperatures.

In applying these voltage drop values, the smallest permissible conductor is the smallest which satisfies the following equations:

. . . 4.2(1)



. . . 4.2(2)



*V*p  sum of *V*d on circuit run where

*V*c = the millivolt drop per ampere-metre route length of circuit, as shown in the tables for various conductors, in millivolts per ampere metre (mV/A.m)

NOTE: To convert single-phase voltage drop (mV/A.m) values to three-phase values, multiply the single-phase values by 0.866. To convert three-phase values to single-phase values, multiply the three-phase values by 1.155.

*V*d = actual voltage drop, in volts

*V*p = permissible voltage drop on the circuit run, e.g. 5 % of supply voltage, in volts

*L* = route length of circuit, in metres

*I* = the current to be carried by the cable, in amperes.

The voltage drop values in Tables 40 to 50 may not be applicable under the following conditions:

1. Where the cable operating temperature is lower than the maximum temperature permitted for the insulant material. See Clause 4.4 for a method of determining the cable operating temperature for use with the tables.
2. Where the load power factor and cable power factor do not give rise to conditions for maximum voltage drop, or the load power factor for larger size conductors varies from 0.8 lagging. See Clause 4.5 for a method of determining the voltage drop where other power factor values are known to be consistent.

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1. Where out-of-balance load conditions exist. See Clause 4.6 for a method of determining the actual voltage drop on a circuit where out-of-balance loads are known to be consistent.

### DETERMINATION OF VOLTAGE DROP FROM CIRCUIT IMPEDANCE

* + 1. **General** Voltage drop in a circuit represents the vectorial difference in voltage between the origin or supply end and the load end. For the purpose of determining the maximum voltage drop value in Clause 4.2, the voltage drop (*V*d) has been related to the impedance of the cables forming the circuit when the power factor of the cable is equal to the power factor of the load, in which case—

*V*d = *IZ*c . . . 4.3(1)

where

*V*d = voltage drop in cable, in volts

*I* = current flowing in cable, in amperes

*Z*c = impedance of cable, in ohms

= (*R*2c + *X*2c)

where

*R*c = cable resistance, in ohms; a function of the material, size and temperature of the conductors

*X*c = cable reactance, in ohms; a function of the conductor shape and cable spacing

= 0, for direct current conditions.

The impedance of cables is usually expressed in units of ohms per metre or ohms per kilometre, which enables the total impedance for any given cable length to be readily calculated. In voltage drop applications it is not uncommon for the unit to be expressed as volts per ampere metre which, because of the physical size of the unit with relation to commonly used cable sizes, is expressed in this Standard as millivolts per ampere metre (mV/A.m).

Therefore the actual volt drop in a cable is obtained by multiplying the cable impedance value by the length of cable and the current as follows:

. . . 4.3(2)



In circuit applications more than one cable is involved and the term (*L*) is generally defined as the route length of the circuit. (See Clause 1.4.4.)

* + 1. **Single-phase, two-wire supply system** For a single-phase circuit the impedance of the active and neutral conductors are taken into account. As these conductors are of the same material and generally the same size, the voltage drop on the circuit is twice what it would be for a single cable—

. . . 4.3(3)



or



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* + 1. **Three-phase, three-wire or four-wire supply system** For a balanced three-phase circuit no current is flowing in the neutral conductor and at any given instant the current flowing in one active conductor will be balanced by the currents flowing in the other active conductors. The voltage drop per phase to neutral is the voltage drop in one cable and the voltage drop between phases is therefore—

. . . 4.3(4)



or



As the single-phase voltage drop (mV/A.m) values represent 2*Z*c and the three-phase voltage drop (mV/A.m) values represent 3*Z*c, then the following conversions may be used:

1. Single-phase voltage drop (mV/A.m) value = 1.155 × three-phase voltage drop (mV/A.m) value.
2. Three-phase voltage drop (mV/A.m) value = 0.866 × single-phase voltage drop (mV/A.m) value.
   * 1. **Two-phase, three-wire, earthed neutral 120-degree supply system** For a balanced two-phase circuit of this type the current flowing in the neutral conductor will balance the currents flowing in the active conductors. The voltage drop may be assessed on a single-phase basis by summing the voltage drop in one active conductor (*IZ*c) with the in-phase component of voltage drop in the neutral (0.5*IZ*c), i.e.



. . . 4.3(5)



* + 1. **Single-phase, three-wire, earthed centre-tapped 180-degree supply system** For a balanced single-phase circuit of this type no current is flowing in the neutral or centre-tapped conductor. Therefore the voltage drop on a single-phase basis will only be that associated with the current flowing in one active conductor, i.e.

. . . 4.3(6)



* 1. **DETERMINATION OF VOLTAGE DROP FROM CABLE OPERATING TEMPERATURE** As described in Clause 3.2.2 and Table 1 of this Standard, the sustained cable current-carrying capacities given in Tables 3 to 19 are based on cables operating at the maximum conductor temperature permitted by the cable insulation material when installed in specified ambient conditions. In many situations, however, the cable operating temperature is considerably less than the maximum figure. Some situations where this will occur are as follows:

1. Cables sizes are selected in order not to exceed a certain voltage drop figure.
2. Cable sizes are selected for convenience, mechanical strength or short-circuit capacity as required by NZS 3000.

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1. The ambient air or soil temperatures are consistently below the specified or standard conditions.

An accurate calculation of conductor temperature can be made using the following equation:

. . . 4.4(1)



where

*I*0 = operating current, in amperes

*I*R = rated current given in Tables 3 to 21, in amperes

0 = operating temperature of cable when carrying *I*0, in degrees Celsius

R = rated or maximum operating temperature determined from Table 1 when carrying *I*R, in degrees Celsius

A = ambient air or soil temperature, in degrees Celsius

= under rated conditions— 30°C for air

15°C for ground

(For different ambient temperatures it will be necessary to correct *I*R by means of factors given in Table 27.)

The calculated operating temperature (0) is then raised to the nearest temperature 45°C, 60°C, 75°C, 80°C, 90°C or 110°C for use with Tables 34 to 50 to determine the cable a.c. resistance and three-phase voltage drop.

* 1. **DETERMINATION OF VOLTAGE DROP FROM LOAD POWER FACTOR** The relationship between the supply and load voltages under different conditions of load power factor is illustrated in the phasor diagrams of Figure 2.

From the phasor diagrams of Figure 2 it can be seen that a larger value of supply voltage is required to maintain a given load voltage when the current is lagging the voltage than when the same current and voltage are in phase. Furthermore, a still smaller supply voltage is required to maintain the given load voltage when the current leads the load voltage.

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The voltage drop (*IZ*c) is the same in all cases, but because of the different power factors the voltage (*IZ*c) is added to the load voltage at a different angle in each case. It can be seen that in the particular instance where the cable power factor and the load power factor are equal, the voltage drop (*V*d) is a maximum of *IZ*c as discussed in Clause 4.3.

In other situations of load power factor the difference between the magnitudes of the supply voltage (*E*) and the load voltage (*V*L) is smaller. It will be noted that the magnitude of the phasors *IR*c and *IX*c has been exaggerated with respect to *V*L in Figure 2 to illustrate the point. In practice the voltage drop is very much smaller than the supply voltage and

|  |  |  |  |
| --- | --- | --- | --- |
| the difference between the magnitudes of the supply approximated by the following equation: | and | load | voltages may be |
| *E* − *V*L = *I*(*R*c cos  + *X*c sin ) for lagging p.f. |  |  | . . . 4.5(2) |
| = *I*(*R*c cos  − *X*c sin ) for leading p.f. |  |  | . . . 4.5(3) |

Therefore for a single-phase system:

*V*d1 = *IL* [2(*R*c cos  + *X*c sin )] . . . 4.5(4) and for a three-phase system:

*V*d3 = *IL* [ 3(*R*c cos  + *X*c sin )] . . . 4.5(5)

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where

*L* = route length of circuit, in metres

*R*c = cable resistance, in ohms per metre

*X*c = cable reactance, in ohms per metre.

Values of *R*c and *X*c are given in units of ohms per kilometre (/km) in Tables 30 to 39. It will be noted that the influence of skin effect on resistance has been taken into account in the specification of cable resistance values in Tables 34 to 39 and as such are referred to as values of a.c. resistance.









FIGURE 2 PHASOR DIAGRAMS ILLUSTRATING VOLTAGE DROP VARIATION WITH LOAD POWER FACTOR FOR SINGLE CABLE

* 1. **DETERMINATION OF VOLTAGE DROP IN UNBALANCED MULTIPHASE CIRCUITS** For unbalanced multiphase circuits, current will be flowing in the neutral conductor as illustrated in the phasor diagram of Figure 3.

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FIGURE 3 PHASOR DIAGRAM OF CURRENTS IN UNBALANCED THREE-PHASE CIRCUIT

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A conservative solution to the voltage drop assessment in these situations would be to assume balanced three-phase load conditions and perform calculations using the current flowing in the heaviest-loaded phase. In many cases this will still be necessary if the out-of-balance conditions are inconsistent or intermittent.

However, where the currents in each phase can be shown to be of different magnitudes for consistent periods, voltage drop calculations can be performed on a single-phase basis by geometrically summing the voltage drop in the heaviest loaded phase and the voltage drop in the neutral, as follows:

*V*d = voltage drop in heaviest loaded active + voltage drop in neutral

= *I*A*L*A*Z*cA + *I*N*L*N*Z*cN . . . 4.6(1)

The voltage drop in each conductor can then be assessed with a knowledge of the specific conductor material, size, temperature and length, the magnitude and phase angle of the current flowing in each conductor, and the phase angle of the load by using the appropriate equations given in this Clause.

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### TABLE 30

**REACTANCE AT 50 Hz OF ALL CABLES EXCLUDING FLEXIBLE CORDS AND CABLES, MINERAL-INSULATED METAL-SHEATHED CABLES**

**AND AERIAL CONDUCTORS**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Conduc- tor size**  **mm2** | **Reactance at 50 Hz,** **/km** | | | | | | | | | | |
| **Single-core** | | | | | | **Multicore** | | | | |
| **Trefoil (or single phase)** | | | **Flat touching\*** | | | **Circular conductors** | | | **Shaped conductors** | |
| **Elastomer** | **PVC** | **XLPE** | **Elastomer** | **PVC** | **XLPE** | **Elastomer** | **PVC** | **XLPE** | **PVC** | **XLPE** |
| 1.0 | 0.179 | 0.168 | 0.166 | 0.194 | 0.184 | 0.181 | 0.139 | 0.119 | 0.114 | — | — |
| 1.5 | 0.167 | 0.157 | 0.155 | 0.183 | 0.172 | 0.170 | 0.129 | 0.111 | 0.107 | — | — |
| 2.5 | 0.153 | 0.143 | 0.141 | 0.168 | 0.159 | 0.156 | 0.118 | 0.102 | 0.0988 | — | — |
| 4 | 0.142 | 0.137 | 0.131 | 0.157 | 0.152 | 0.146 | 0.110 | 0.102 | 0.0930 | — | — |
| 6 | 0.133 | 0.128 | 0.123 | 0.148 | 0.143 | 0.138 | 0.104 | 0.0967 | 0.0887 | — | — |
| 10 | 0.123 | 0.118 | 0.114 | 0.138 | 0.134 | 0.129 | 0.0967 | 0.0906 | 0.0840 | — | — |
| 16 | 0.114 | 0.111 | 0.106 | 0.130 | 0.126 | 0.122 | 0.0913 | 0.0861 | 0.0805 | 0.0794 | 0.0742 |
| 25 | 0.109 | 0.106 | 0.102 | 0.125 | 0.121 | 0.118 | 0.0895 | 0.0853 | 0.0808 | 0.0786 | 0.0744 |
| 35 | 0.104 | 0.101 | 0.0982 | 0.120 | 0.117 | 0.113 | 0.0863 | 0.0826 | 0.0786 | 0.0761 | 0.0725 |
| 50 | 0.0988 | 0.0962 | 0.0924 | 0.114 | 0.111 | 0.108 | 0.0829 | 0.0797 | 0.0751 | 0.0734 | 0.0692 |
| 70 | 0.0941 | 0.0917 | 0.0893 | 0.109 | 0.107 | 0.104 | 0.0798 | 0.0770 | 0.0741 | 0.0710 | 0.0683 |
| 95 | 0.0924 | 0.0904 | 0.0868 | 0.108 | 0.106 | 0.102 | 0.0790 | 0.0766 | 0.0725 | 0.0706 | 0.0668 |
| 120 | 0.0889 | 0.0870 | 0.0844 | 0.104 | 0.102 | 0.0996 | 0.0765 | 0.0743 | 0.0713 | 0.0685 | 0.0657 |
| 150 | 0.0885 | 0.0868 | 0.0844 | 0.104 | 0.102 | 0.0996 | 0.0765 | 0.0745 | 0.0718 | 0.0687 | 0.0662 |
| 185 | 0.0878 | 0.0862 | 0.0835 | 0.103 | 0.101 | 0.0988 | 0.0762 | 0.0744 | 0.0720 | 0.0686 | 0.0663 |
| 240 | 0.0861 | 0.0847 | 0.0818 | 0.101 | 0.0999 | 0.0970 | 0.0751 | 0.0735 | 0.0709 | 0.0678 | 0.0653 |
| 300 | 0.0852 | 0.0839 | 0.0809 | 0.100 | 0.0991 | 0.0961 | 0.0746 | 0.0732 | 0.0704 | 0.0675 | 0.0649 |
| 400 | 0.0841 | 0.0829 | 0.0802 | 0.0993 | 0.0982 | 0.0955 | 0.0740 | 0.0728 | 0.0702 | 0.0671 | 0.0647 |
| 500 | 0.0830 | 0.0820 | 0.0796 | 0.0983 | 0.0973 | 0.0948 | 0.0734 | 0.0723 | 0.0700 | 0.0666 | 0.0645 |
| 630 | 0.0809 | 0.0800 | 0.0787 | 0.0961 | 0.0952 | 0.0940 | — | — | — | — | — |

* These reactance values may also be used as a conservative estimate for cables which are not strictly arranged ‘flat touching’, e.g. where cables are installed in a wiring enclosure.

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### TABLE 31

**REACTANCE AT 50 Hz OF FLEXIBLE CORDS AND CABLES**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Conductor size**  **mm2** | **Reactance at 50 Hz,** **/km** | | | |
| **Single-core** | | **Multicore** | |
| **Trefoil (or single phase)** | **Flat touching** |
| **Elastomer and PVC** | | **Elastomer** | **PVC** |
| 0.5 | 0.133 | 0.148 | — | 0.115 |
| 0.75 | 0.166 | 0.181 | 0.130 | 0.130 |
| 1.0 | 0.159 | 0.174 | 0.124 | 0.124 |
| 1.5 | 0.151 | 0.167 | 0.118 | 0.118 |
| 2.5 | 0.141 | 0.156 | 0.112 | 0.112 |
| 4 | 0.134 | 0.149 | 0.108 | 0.108 |
| 6 | 0.135 | 0.151 | 0.104 | 0.104 |
| 10 | 0.127 | 0.142 | 0.102 | 0.0982 |
| 16 | 0.118 | 0.134 | 0.0970 | 0.0937 |
| 25 | 0.110 | 0.125 | 0.0921 | 0.0895 |
| 35 | 0.103 | 0.116 | 0.0895 | — |
| 50 | 0.102 | 0.117 | 0.0893 | — |
| 70 | 0.0964 | 0.112 | 0.0859 | — |
| 95 | 0.0957 | 0.111 | 0.0855 | — |
| 120 | 0.0929 | 0.106 | 0.0836 | — |
| 150 | 0.0921 | 0.107 | 0.0833 | — |
| 185 | 0.0920 | 0.107 | 0.0837 | — |
| 240 | 0.0897 | 0.105 | 0.0829 | — |
| 300 | 0.0883 | 0.104 | 0.0823 | — |
| 400 | 0.0864 | 0.102 | 0.0815 | — |
| 500 | 0.0857 | 0.101 | 0.0812 | — |

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### TABLE 32

**REACTANCE AT 50 Hz OF MINERAL-**

**INSULATED METAL-SHEATHED CABLES**

|  |  |  |
| --- | --- | --- |
| **Conductor size**  **mm2** | **Reactance at 50 Hz,** **/km** | |
| **Single-core (trefoil formation)** | **Multicore** |
| 0.6/0.6 kV cables |  |  |
| 1 | 0.123 | 0.0912 |
| 1.5 | 0.116 | 0.0865 |
| 2.5 | 0.107 | 0.0814 |
| 4 | 0.101 | — |
| 1/1 kV cables |  |  |
| 1.5 | 0.139 | 0.1010 |
| 2.5 | 0.128 | 0.0937 |
| 4 | 0.120 | 0.0879 |
| 6 | 0.112 | 0.0835 |
| 10 | 0.104 | 0.0788 |
| 16 | 0.0976 | 0.0752 |
| 25 | 0.0927 | 0.0723 |
| 35 | 0.0889 | — |
| 50 | 0.0854 | — |
| 70 | 0.0827 | — |
| 95 | 0.0804 | — |
| 120 | 0.0785 | — |
| 150 | 0.0772 | — |
| 185 | 0.0784 | — |
| 240 | 0.0768 | — |
| 300 | 0.0777 | — |
| 400 | 0.0784 | — |

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### TABLE 33

**REACTANCE AT 50 Hz OF SINGLE-CORE AERIAL CONDUCTORS WITH BARE OR INSULATED**

**CONDUCTORS**

|  |  |  |
| --- | --- | --- |
| **Conductor size, mm2, or**  **stranding (No./mm)** | **Reactance of 50 Hz,** **/km\*** | |
| **Single phase and trefoil** | **Three cores in flat formation** |
| 7/1.00 | 0.371 | 0.386 |
| 6 | 0.369 | 0.383 |
| 7/1.25 | 0.357 | 0.372 |
| 10 | 0.352 | 0.367 |
| 16 | 0.338 | 0.352 |
| 7/1.75 | 0.336 | 0.351 |
| 7/2.00 | 0.328 | 0.342 |
| 25 | 0.323 | 0.338 |
| 35 | 0.313 | 0.328 |
| 7/2.50 | 0.314 | 0.328 |
| 7/2.75 | 0.308 | 0.322 |
| 50 | 0.300 | 0.315 |
| 19/1.75 | 0.301 | 0.316 |
| 7/3.00 | 0.302 | 0.317 |
| 19/2.00 | 0.293 | 0.307 |
| 70 | 0.288 | 0.303 |
| 7/3.50 | 0.292 | 0.307 |
| 7/3.75 | 0.288 | 0.303 |
| 95 | 0.278 | 0.293 |
| 37/1.75 | 0.279 | 0.294 |
| 7/4.50 | 0.277 | 0.291 |
| 19/2.75 | 0.273 | 0.287 |
| 120 | 0.270 | 0.284 |
| 7/4.75 | 0.273 | 0.288 |
| 19/3.00 | 0.267 | 0.282 |
| 150 | 0.263 | 0.278 |
| 19/3.25 | 0.262 | 0.277 |
| 185 | 0.256 | 0.271 |
| 19/3.50 | 0.258 | 0.272 |
| 37/2.50 | 0.257 | 0.271 |

\* Values are based on a spacing of 0.4 m.

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### TABLE 34

### a.c. RESISTANCE AT 50 Hz OF SINGLE-CORE CABLES

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|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Conductor size**  **mm2** | **a.c. resistance at 50 Hz,** **/km** | | | | | | | | |
| **Copper\*** | | | | | **Aluminium** | | | |
| **Conductor temperature, °C** | | | | | **Conductor temperature, °C** | | | |
| **45** | **60** | **75** | **90** | **110** | **45** | **60** | **75** | **90** |
| 1 | 23.3 | 24.5 | 25.8 | 27.0 | 28.7 | — | — | — | — |
| 1.5 | 14.9 | 15.7 | 16.5 | 17.3 | 18.4 | — | — | — | — |
| 2.5 | 8.14 | 8.57 | 9.01 | 9.45 | 10.0 | — | — | — | — |
| 4 | 5.06 | 5.33 | 5.61 | 5.88 | 6.24 | — | — | — | — |
| 6 | 3.38 | 3.56 | 3.75 | 3.93 | 4.17 | — | — | — | — |
| 10 | 2.01 | 2.12 | 2.23 | 2.33 | 2.48 | — | — | — | — |
| 16 | 1.26 | 1.33 | 1.40 | 1.47 | 1.56 | 2.10 | 2.22 | 2.33 | 2.45 |
| 25 | 0.799 | 0.842 | 0.884 | 0.927 | 0.984 | 1.32 | 1.39 | 1.47 | 1.54 |
| 35 | 0.576 | 0.607 | 0.638 | 0.668 | 0.710 | 0.956 | 1.01 | 1.06 | 1.11 |
| 50 | 0.426 | 0.448 | 0.471 | 0.494 | 0.524 | 0.706 | 0.745 | 0.783 | 0.822 |
| 70 | 0.295 | 0.311 | 0.327 | 0.342 | 0.363 | 0.488 | 0.515 | 0.542 | 0.568 |
| 95 | 0.213 | 0.225 | 0.236 | 0.247 | 0.262 | 0.353 | 0.372 | 0.392 | 0.411 |
| 120 | 0.170 | 0.179 | 0.188 | 0.197 | 0.208 | 0.279 | 0.295 | 0.310 | 0.325 |
| 150 | 0.138 | 0.145 | 0.153 | 0.160 | 0.169 | 0.228 | 0.240 | 0.253 | 0.265 |
| 185 | 0.111 | 0.117 | 0.123 | 0.129 | 0.136 | 0.182 | 0.192 | 0.202 | 0.212 |
| 240 | 0.0862 | 0.0905 | 0.0948 | 0.0991 | 0.105 | 0.140 | 0.147 | 0.155 | 0.162 |
| 300 | 0.0703 | 0.0736 | 0.0770 | 0.0803 | 0.0846 | 0.113 | 0.119 | 0.125 | 0.130 |
| 400 | 0.0569 | 0.0595 | 0.0620 | 0.0646 | 0.0677 | 0.0890 | 0.0936 | 0.0981 | 0.103 |
| 500 | 0.0467 | 0.0487 | 0.0506 | 0.0525 | 0.0547 | 0.0709 | 0.0744 | 0.0779 | 0.0813 |
| 630 | 0.0389 | 0.0404 | 0.0418 | 0.0432 | 0.0448 | 0.0571 | 0.0597 | 0.0623 | 0.0649 |

* + For the a.c. resistance of tinned copper conductor, multiply copper value by 1.01.

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### TABLE 35

**a.c. RESISTANCE AT 50 Hz OF MULTICORE CABLES WITH CIRCULAR CONDUCTORS**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Conductor size**  **mm2** | **a.c. resistance at 50 Hz,** **/km** | | | | | | | | | |
| **Copper\*** | | | | | **Aluminium** | | | | |
| **Conductor temperature, °C** | | | | | **Conductor temperature, °C** | | | | |
| **45** | **60** | **75** | **90** | **110** | **45** | **60** | **75** | **80** | **90** |
| 1 | 23.3 | 24.5 | 25.8 | 27.0 | 28.7 | — | — | — | — | — |
| 1.5 | 14.9 | 15.7 | 16.5 | 17.3 | 18.4 | — | — | — | — | — |
| 2.5 | 8.14 | 8.57 | 9.01 | 9.45 | 10.0 | — | — | — | — | — |
| 4 | 5.06 | 5.33 | 5.61 | 5.88 | 6.24 | — | — | — | — | — |
| 6 | 3.38 | 3.56 | 3.75 | 3.93 | 4.17 | — | — | — | — | — |
| 10 | 2.01 | 2.12 | 2.23 | 2.33 | 2.48 | — | — | — | — | — |
| 16 | 1.26 | 1.33 | 1.40 | 1.47 | 1.56 | 2.10 | 2.22 | 2.33 | 2.37 | 2.45 |
| 25 | 0.799 | 0.842 | 0.884 | 0.927 | 0.984 | 1.32 | 1.39 | 1.47 | 1.49 | 1.54 |
| 35 | 0.576 | 0.607 | 0.638 | 0.669 | 0.710 | 0.956 | 1.01 | 1.06 | 1.08 | 1.11 |
| 50 | 0.426 | 0.449 | 0.471 | 0.494 | 0.524 | 0.706 | 0.745 | 0.784 | 0.796 | 0.822 |
| 70 | 0.295 | 0.311 | 0.327 | 0.343 | 0.364 | 0.488 | 0.515 | 0.542 | 0.551 | 0.569 |
| 95 | 0.214 | 0.225 | 0.236 | 0.248 | 0.262 | 0.353 | 0.373 | 0.392 | 0.398 | 0.411 |
| 120 | 0.170 | 0.179 | 0.188 | 0.197 | 0.209 | 0.280 | 0.295 | 0.310 | 0.315 | 0.325 |
| 150 | 0.139 | 0.146 | 0.153 | 0.160 | 0.170 | 0.228 | 0.241 | 0.253 | 0.257 | 0.265 |
| 185 | 0.112 | 0.118 | 0.123 | 0.129 | 0.136 | 0.182 | 0.192 | 0.202 | — | 0.212 |
| 240 | 0.0870 | 0.0912 | 0.0955 | 0.0998 | 0.105 | 0.140 | 0.148 | 0.155 | — | 0.162 |
| 300 | 0.0712 | 0.0745 | 0.0778 | 0.0812 | 0.0852 | 0.113 | 0.119 | 0.125 | — | 0.131 |
| 400 | 0.0580 | 0.0605 | 0.0630 | 0.0656 | 0.0685 | 0.0897 | 0.0943 | 0.0988 | — | 0.103 |
| 500 | 0.0486 | 0.0506 | 0.0525 | 0.0544 | 0.0565 | 0.0730 | 0.0765 | 0.0800 | — | 0.0835 |

* + For the a.c. resistance of tinned copper conductor, multiply copper value by 1.01.

### TABLE 36

**a.c. RESISTANCE AT 50 Hz OF MULTICORE CABLES WITH SHAPED CONDUCTORS**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Conductor size**  **mm2** | **a.c. resistance at 50 Hz,** **/km** | | | | | | | |
| **Copper\*** | | | | **Aluminium** | | | |
| **Conductor temperature, °C** | | | | **Conductor temperature, °C** | | | |
| **45** | **60** | **75** | **90** | **45** | **60** | **75** | **90** |
| 16 | 1.26 | 1.33 | 1.40 | 1.47 | 2.10 | 2.22 | 2.33 | 2.45 |
| 25 | 0.799 | 0.842 | 0.884 | 0.927 | 1.32 | 1.39 | 1.47 | 1.54 |
| 35 | 0.576 | 0.607 | 0.638 | 0.669 | 0.956 | 1.01 | 1.06 | 1.11 |
| 50 | 0.426 | 0.448 | 0.471 | 0.494 | 0.706 | 0.745 | 0.783 | 0.822 |
| 70 | 0.295 | 0.311 | 0.327 | 0.342 | 0.488 | 0.515 | 0.542 | 0.568 |
| 95 | 0.213 | 0.224 | 0.236 | 0.247 | 0.353 | 0.372 | 0.392 | 0.411 |
| 120 | 0.170 | 0.179 | 0.187 | 0.196 | 0.279 | 0.295 | 0.310 | 0.325 |
| 150 | 0.138 | 0.145 | 0.153 | 0.160 | 0.228 | 0.240 | 0.253 | 0.265 |
| 185 | 0.111 | 0.117 | 0.123 | 0.128 | 0.182 | 0.192 | 0.202 | 0.211 |
| 240 | 0.0859 | 0.0902 | 0.0945 | 0.0988 | 0.139 | 0.147 | 0.154 | 0.162 |
| 300 | 0.0698 | 0.0732 | 0.0766 | 0.0800 | 0.112 | 0.118 | 0.124 | 0.130 |
| 400 | 0.0563 | 0.0589 | 0.0615 | 0.0641 | 0.0886 | 0.0932 | 0.0978 | 0.102 |
| 500 | 0.0465 | 0.0485 | 0.0508 | 0.0526 | 0.0716 | 0.0752 | 0.0788 | 0.0824 |

\* For the a.c. resistance of tinned copper conductor, multiply copper value by 1.01.

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### TABLE 37

**a.c. RESISTANCE AT 50 Hz OF FLEXIBLE CABLES AND CORDS WITH COPPER CONDUCTORS\***

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Conductor size**  **mm2** | **a.c. resistance at 50 Hz,** **/km** | | | | | | | |
| **Single-core** | | | | **Multicore** | | | |
| **Conductor temperature, °C** | | | | **Conductor temperature, °C** | | | |
| **45** | **60** | **75** | **90** | **45** | **60** | **75** | **90** |
| 0.5 | 42.8 | 45.1 | 47.4 | 49.7 | 42.8 | 45.1 | 47.4 | 49.7 |
| 0.75 | 28.6 | 30.1 | 31.6 | 33.2 | 28.6 | 30.1 | 31.6 | 33.2 |
| 1.0 | 21.4 | 22.6 | 23.7 | 24.9 | 21.4 | 22.6 | 23.7 | 24.9 |
| 1.5 | 14.6 | 15.4 | 16.2 | 17.0 | 14.6 | 15.4 | 16.2 | 17.0 |
| 2.5 | 8.76 | 9.23 | 9.70 | 10.2 | 8.76 | 9.23 | 9.70 | 10.2 |
| 4 | 5.44 | 5.73 | 6.02 | 6.31 | 5.44 | 5.73 | 6.02 | 6.31 |
| 6 | 3.62 | 3.82 | 4.01 | 4.21 | 3.62 | 3.82 | 4.01 | 4.21 |
| 10 | 2.17 | 2.29 | 2.41 | 2.52 | 2.17 | 2.29 | 2.41 | 2.52 |
| 16 | 1.33 | 1.40 | 1.47 | 1.54 | 1.33 | 1.40 | 1.47 | 1.54 |
| 25 | 0.803 | 0.846 | 0.889 | 0.932 | 0.803 | 0.846 | 0.889 | 0.932 |
| 35 | 0.589 | 0.621 | 0.652 | 0.684 | 0.589 | 0.621 | 0.652 | 0.684 |
| 50 | 0.442 | 0.466 | 0.489 | 0.513 | 0.442 | 0.466 | 0.490 | 0.513 |
| 70 | 0.293 | 0.309 | 0.324 | 0.340 | 0.293 | 0.309 | 0.325 | 0.340 |
| 95 | 0.229 | 0.242 | 0.254 | 0.266 | 0.230 | 0.242 | 0.254 | 0.266 |
| 120 | 0.178 | 0.188 | 0.197 | 0.206 | 0.179 | 0.188 | 0.198 | 0.207 |
| 150 | 0.140 | 0.147 | 0.155 | 0.162 | 0.141 | 0.148 | 0.155 | 0.163 |
| 185 | 0.116 | 0.122 | 0.128 | 0.134 | 0.117 | 0.123 | 0.129 | 0.135 |
| 240 | 0.0909 | 0.0955 | 0.100 | 0.105 | 0.0919 | 0.0965 | 0.101 | 0.106 |
| 300 | 0.0729 | 0.0764 | 0.0800 | 0.0836 | 0.0741 | 0.0776 | 0.0811 | 0.0847 |
| 400 | 0.0558 | 0.0583 | 0.0609 | 0.0634 | 0.0573 | 0.0598 | 0.0623 | 0.0648 |
| 500 | 0.0477 | 0.0496 | 0.0518 | 0.0538 | 0.0494 | 0.0514 | 0.0534 | 0.0554 |

\* For the a.c. resistance of tinned copper conductors, multiply copper value by 1.01.

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### TABLE 38

**a.c. RESISTANCE AT 50 Hz OF MINERAL-INSULATED METAL-SHEATHED CABLES**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Conductor size mm2** | **a.c. resistance at 50 Hz,** **/km** | | | | | |
| **Conductor temperature, °C** | | | | | |
| **45** | **60** | **75** | **90** | **100** | **105** |
| 1 | 18.9 | 19.9 | 20.9 | 21.9 | 22.6 | 22.9 |
| 1.5 | 12.7 | 13.3 | 14.0 | 14.7 | 15.2 | 15.4 |
| 2.5 | 7.61 | 8.02 | 8.43 | 8.83 | 9.11 | 9.24 |
| 4 | 4.76 | 5.02 | 5.27 | 5.53 | 5.70 | 5.78 |
| 6 | 3.16 | 3.33 | 3.50 | 3.67 | 3.79 | 3.84 |
| 10 | 1.89 | 1.99 | 2.09 | 2.20 | 2.26 | 2.30 |
| 16 | 1.19 | 1.25 | 1.31 | 1.38 | 1.42 | 1.44 |
| 25 | 0.758 | 0.799 | 0.840 | 0.880 | 0.907 | 0.921 |
| 35 | 0.541 | 0.570 | 0.599 | 0.628 | 0.647 | 0.657 |
| 50 | 0.379 | 0.400 | 0.420 | 0.440 | 0.454 | 0.460 |
| 70 | 0.271 | 0.286 | 0.300 | 0.315 | 0.325 | 0.329 |
| 95 | 0.201 | 0.211 | 0.222 | 0.233 | 0.240 | 0.243 |
| 120 | 0.160 | 0.168 | 0.176 | 0.185 | 0.190 | 0.193 |
| 150 | 0.129 | 0.135 | 0.142 | 0.149 | 0.153 | 0.155 |
| 185 | 0.105 | 0.110 | 0.116 | 0.121 | 0.125 | 0.127 |
| 240 | 0.0825 | 0.0866 | 0.0906 | 0.0947 | 0.0975 | 0.0988 |
| 300 | 0.0674 | 0.0706 | 0.0739 | 0.0771 | 0.0792 | 0.0803 |
| 400 | 0.0527 | 0.0550 | 0.0574 | 0.0597 | 0.0613 | 0.0621 |

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### TABLE 39

**a.c. RESISTANCE AT 50 Hz OF SINGLE-CORE AERIAL CABLES WITH BARE OR INSULATED CONDUCTORS**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Conductor size, mm2, or**  **stranding (No./mm)** | **a.c. resistance at 50 Hz,** **/km\*** | | | | | | |
| **Copper** | | | **Aluminium** | | | |
| **Conductor temperature, °C** | | | **Conductor temperature, °C** | | | |
| **45** | **60** | **75** | **45** | **60** | **75** | **80** |
| 7/1.00 | 3.57 | 3.76 | 3.95 | — | — | — | — |
| 6 | 3.48 | 3.67 | 3.86 | — | — | — | — |
| 7/1.25 | 2.30 | 2.42 | 2.54 | — | — | — | — |
| 10 | 2.07 | 2.18 | 2.29 | — | — | — | — |
| 16 | 1.30 | 1.37 | 1.44 | 2.10 | 2.22 | 2.33 | 2.37 |
| 7/1.75 | 1.16 | 1.23 | 1.29 | — | — | — | — |
| 7/2.00 | 0.895 | 0.943 | 0.991 | — | — | — | — |
| 25 | 0.822 | 0.867 | 0.911 | 1.32 | 1.39 | 1.47 | 1.49 |
| 35 | 0.593 | 0.625 | 0.657 | 0.956 | 1.01 | 1.06 | 1.08 |
| 7/2.50 | — | — | — | 0.917 | 0.967 | 1.02 | 1.03 |
| 7/2.75 | 0.476 | 0.501 | 0.527 | 0.759 | 0.800 | 0.842 | 0.856 |
| 50 | 0.438 | 0.461 | 0.485 | 0.706 | 0.744 | 0.783 | 0.796 |
| 19/1.75 | 0.434 | 0.457 | 0.481 | — | — | — | — |
| 7/3.00 | — | — | — | 0.637 | 0.672 | 0.707 | 0.719 |
| 19/2.00 | 0.333 | 0.351 | 0.369 | — | — | — | — |
| 70 | 0.303 | 0.320 | 0.336 | 0.488 | 0.515 | 0.541 | 0.550 |
| 7/3.50 | 0.295 | 0.310 | 0.326 | — | — | — | — |
| 7/3.75 | 0.256 | 0.270 | 0.284 | 0.407 | 0.430 | 0.452 | 0.460 |
| 95 | 0.219 | 0.231 | 0.242 | 0.352 | 0.372 | 0.391 | 0.398 |
| 37/1.75 | 0.223 | 0.235 | 0.247 | — | — | — | — |
| 7/4.50 | — | — | — | 0.284 | 0.300 | 0.315 | 0.321 |
| 19/2.75 | 0.176 | 0.186 | 0.195 | — | — | — | — |
| 120 | 0.174 | 0.183 | 0.192 | 0.279 | 0.294 | 0.309 | 0.314 |
| 7/4.75 | — | — | — | 0.256 | 0.270 | 0.284 | 0.288 |
| 19/3.00 | 0.148 | 0.156 | 0.163 | — | — | — | — |
| 150 | 0.141 | 0.148 | 0.156 | 0.227 | 0.240 | 0.252 | 0.256 |
| 19/3.25 | — | — | — | 0.202 | 0.213 | 0.224 | 0.228 |
| 185 | 0.113 | 0.119 | 0.125 | 0.181 | 0.191 | 0.201 | 0.204 |
| 19/3.50 | — | — | — | 0.173 | 0.183 | 0.192 | 0.195 |
| 37/2.50 | 0.110 | 0.116 | 0.122 | — | — | — | — |

\* Values are based on a spacing of 0.4 m.

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### TABLE 40

**THREE-PHASE VOLTAGE DROP AT 50 Hz OF SINGLE-CORE INSULATED AND SHEATHED COPPER CONDUCTORS,**

**LAID IN TREFOIL**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Conductor size**  **mm2** | **Three-phase voltage drop at 50 Hz, mV/A.m** | | | | | | | | | |
| **Conductor temperature, °C** | | | | | | | | | |
| **45** | | **60** | | **75** | | **90** | | **110** | |
| **Max.** | **0.8 p.f.** | **Max.** | **0.8 p.f.** | **Max.** | **0.8 p.f.** | **Max.** | **0.8 p.f.** | **Max.** | **0.8 p.f.** |
| 1 | 40.3 | — | 42.5 | — | 44.7 | — | 46.8 | — | 49.7 | — |
| 1.5 | 25.9 | — | 27.3 | — | 28.6 | — | 30.0 | — | 31.9 | — |
| 2.5 | 14.1 | — | 14.9 | — | 15.6 | — | 16.4 | — | 17.4 | — |
| 4 | 8.77 | — | 9.24 | — | 9.71 | — | 10.2 | — | 10.8 | — |
| 6 | 5.86 | — | 6.18 | — | 6.49 | — | 6.81 | — | 7.23 | — |
| 10 | 3.49 | — | 3.67 | — | 3.86 | — | 4.05 | — | 4.30 | — |
| 16 | 2.20 | — | 2.31 | — | 2.43 | — | 2.55 | — | 2.70 | — |
| 25 | 1.40 | — | 1.47 | — | 1.54 | — | 1.62 | — | 1.72 | — |
| 35 | 1.01 | — | 1.07 | — | 1.12 | — | 1.17 | — | 1.24 | — |
| 50 | 0.757 | — | 0.795 | — | 0.834 | — | 0.872 | — | 0.924 | — |
| 70 | 0.537 | — | 0.563 | — | 0.589 | — | 0.615 | — | 0.650 | — |
| 95 | 0.402 | — | 0.420 | — | 0.439 | — | 0.457 | — | 0.481 | — |
| 120 | 0.332 | — | 0.345 | — | 0.359 | — | 0.373 | — | 0.392 | — |
| 150 | 0.284 | — | 0.295 | — | 0.305 | — | 0.316 | — | 0.331 | — |
| 185 | 0.245 | 0.245 | 0.253 | 0.253 | 0.261 | — | 0.269 | — | 0.280 | — |
| 240 | 0.211 | 0.208 | 0.216 | 0.214 | 0.221 | 0.220 | 0.227 | 0.226 | 0.235 | 0.234 |
| 300 | 0.191 | 0.185 | 0.195 | 0.190 | 0.198 | 0.195 | 0.202 | 0.199 | 0.208 | 0.206 |
| 400 | 0.175 | 0.166 | 0.178 | 0.169 | 0.181 | 0.173 | 0.183 | 0.176 | 0.187 | 0.181 |
| 500 | 0.165 | 0.150 | 0.166 | 0.153 | 0.168 | 0.156 | 0.170 | 0.158 | 0.172 | 0.162 |
| 630 | 0.155 | 0.138 | 0.156 | 0.140 | 0.157 | 0.142 | 0.159 | 0.144 | 0.160 | 0.146 |

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### TABLE 41

**THREE-PHASE VOLTAGE DROP AT 50 Hz OF SINGLE-CORE INSULATED AND SHEATHED COPPER CONDUCTORS, LAID FLAT TOUCHING**

### OR IN A WIRING ENCLOSURE

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|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Conductor size**  **mm2** | **Three-phase voltage drop at 50 Hz, mV/A.m** | | | | | | | | | |
| **Conductor temperature, °C** | | | | | | | | | |
| **45** | | **60** | | **75** | | **90** | | **110** | |
| **Max.** | **0.8 p.f.** | **Max.** | **0.8 p.f.** | **Max.** | **0.8 p.f.** | **Max.** | **0.8 p.f.** | **Max.** | **0.8 p.f.** |
| 1 | 40.3 | — | 42.5 | — | 44.7 | — | 46.8 | — | 49.7 | — |
| 1.5 | 25.9 | — | 27.3 | — | 28.6 | — | 30.0 | — | 31.9 | — |
| 2.5 | 14.1 | — | 14.9 | — | 15.6 | — | 16.4 | — | 17.4 | — |
| 4 | 8.77 | — | 9.24 | — | 9.71 | — | 10.2 | — | 10.8 | — |
| 6 | 5.86 | — | 6.18 | — | 6.49 | — | 6.81 | — | 7.23 | — |
| 10 | 3.49 | — | 3.68 | — | 3.86 | — | 4.05 | — | 4.30 | — |
| 16 | 2.20 | — | 2.32 | — | 2.43 | — | 2.55 | — | 2.71 | — |
| 25 | 1.40 | — | 1.47 | — | 1.55 | — | 1.62 | — | 1.72 | — |
| 35 | 1.02 | — | 1.07 | — | 1.12 | — | 1.18 | — | 1.25 | — |
| 50 | 0.763 | — | 0.801 | — | 0.840 | — | 0.878 | — | 0.929 | — |
| 70 | 0.545 | — | 0.571 | — | 0.597 | — | 0.623 | — | 0.657 | — |
| 95 | 0.413 | — | 0.431 | — | 0.449 | — | 0.467 | — | 0.491 | — |
| 120 | 0.345 | — | 0.358 | — | 0.371 | — | 0.385 | — | 0.403 | — |
| 150 | 0.299 | 0.299 | 0.309 | — | 0.319 | — | 0.330 | — | 0.344 | — |
| 185 | 0.262 | 0.261 | 0.270 | 0.269 | 0.277 | 0.277 | 0.285 | 0.285 | 0.296 | 0.296 |
| 240 | 0.230 | 0.224 | 0.235 | 0.230 | 0.240 | 0.236 | 0.245 | 0.242 | 0.252 | 0.250 |
| 300 | 0.212 | 0.201 | 0.215 | 0.206 | 0.219 | 0.211 | 0.222 | 0.215 | 0.227 | 0.222 |
| 400 | 0.198 | 0.181 | 0.200 | 0.185 | 0.202 | 0.189 | 0.205 | 0.192 | 0.208 | 0.197 |
| 500 | 0.188 | 0.166 | 0.190 | 0.169 | 0.191 | 0.172 | 0.193 | 0.174 | 0.195 | 0.178 |
| 630 | 0.179 | 0.153 | 0.180 | 0.155 | 0.181 | 0.157 | 0.182 | 0.159 | 0.184 | 0.162 |

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### TABLE 42

**THREE-PHASE VOLTAGE DROP AT 50 Hz OF MULTICORE CABLES WITH CIRCULAR COPPER CONDUCTORS**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Conductor size**  **mm2** | **Three-phase voltage drop at 50 Hz, mV/A.m** | | | | | | | | | |
| **Conductor temperature, °C** | | | | | | | | | |
| **45** | | **60** | | **75** | | **90** | | **110** | |
| **Max.** | **0.8 p.f.** | **Max.** | **0.8 p.f.** | **Max.** | **0.8 p.f.** | **Max.** | **0.8 p.f.** | **Max.** | **0.8 p.f.** |
| 1 | 40.3 | — | 42.5 | — | 44.7 | — | 46.8 | — | 49.7 | — |
| 1.5 | 25.9 | — | 27.3 | — | 28.6 | — | 30.0 | — | 31.9 | — |
| 2.5 | 14.1 | — | 14.9 | — | 15.6 | — | 16.4 | — | 17.4 | — |
| 4 | 8.77 | — | 9.24 | — | 9.71 | — | 10.2 | — | 10.8 | — |
| 6 | 5.86 | — | 6.18 | — | 6.49 | — | 6.80 | — | 7.22 | — |
| 10 | 3.49 | — | 3.67 | — | 3.86 | — | 4.05 | — | 4.29 | — |
| 16 | 2.19 | — | 2.31 | — | 2.43 | — | 2.55 | — | 2.70 | — |
| 25 | 1.39 | — | 1.47 | — | 1.54 | — | 1.61 | — | 1.71 | — |
| 35 | 1.01 | — | 1.06 | — | 1.11 | — | 1.17 | — | 1.24 | — |
| 50 | 0.751 | — | 0.790 | — | 0.829 | — | 0.868 | — | 0.920 | — |
| 70 | 0.530 | — | 0.556 | — | 0.583 | — | 0.609 | — | 0.645 | — |
| 95 | 0.394 | — | 0.413 | — | 0.431 | — | 0.450 | — | 0.475 | — |
| 120 | 0.323 | — | 0.337 | — | 0.351 | — | 0.366 | — | 0.385 | — |
| 150 | 0.274 | — | 0.285 | — | 0.296 | — | 0.307 | — | 0.322 | — |
| 185 | 0.234 | — | 0.242 | — | 0.251 | — | 0.259 | — | 0.271 | — |
| 240 | 0.198 | 0.198 | 0.204 | 0.204 | 0.210 | 0.210 | 0.216 | 0.216 | 0.224 | — |
| 300 | 0.178 | 0.175 | 0.182 | 0.180 | 0.186 | 0.185 | 0.190 | 0.189 | 0.196 | 0.196 |
| 400 | 0.162 | 0.157 | 0.165 | 0.160 | 0.168 | 0.164 | 0.171 | 0.167 | 0.175 | 0.172 |
| 500 | 0.152 | 0.143 | 0.154 | 0.146 | 0.156 | 0.148 | 0.158 | 0.151 | 0.160 | 0.155 |

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### TABLE 43

**THREE-PHASE VOLTAGE DROP AT 50 Hz OF SINGLE-CORE INSULATED AND SHEATHED ALUMINIUM CONDUCTORS, LAID IN TREFOIL**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Conductor size**  **mm2** | **Three-phase voltage drop at 50 Hz, mV/A.m** | | | | | | | |
| **Conductor temperature, °C** | | | | | | | |
| **45** | | **60** | | **75** | | **90** | |
| **Max.** | **0.8 p.f.** | **Max.** | **0.8 p.f** | **Max.** | **0.8 p.f.** | **Max.** | **0.8 p.f.** |
| 16 | 3.65 | — | 3.85 | — | 4.05 | — | 4.25 | — |
| 25 | 2.30 | — | 2.42 | — | 2.55 | — | 2.67 | — |
| 35 | 1.66 | — | 1.75 | — | 1.85 | — | 1.94 | — |
| 50 | 1.23 | — | 1.30 | — | 1.37 | — | 1.43 | — |
| 70 | 0.860 | — | 0.906 | — | 0.952 | — | 0.997 | — |
| 95 | 0.631 | — | 0.663 | — | 0.696 | — | 0.727 | — |
| 120 | 0.507 | — | 0.532 | — | 0.558 | — | 0.582 | — |
| 150 | 0.422 | — | 0.443 | — | 0.463 | — | 0.482 | — |
| 185 | 0.349 | — | 0.364 | — | 0.380 | — | 0.394 | — |
| 240 | 0.283 | — | 0.294 | — | 0.305 | — | 0.314 | — |
| 300 | 0.243 | — | 0.251 | — | 0.260 | — | 0.266 | — |
| 400 | 0.211 | 0.209 | 0.216 | 0.216 | 0.222 | 0.222 | 0.226 | 0.226 |
| 500 | 0.188 | 0.183 | 0.192 | 0.188 | 0.196 | 0.193 | 0.197 | 0.195 |
| 630 | 0.170 | 0.162 | 0.173 | 0.166 | 0.175 | 0.169 | 0.177 | 0.172 |

**TABLE 44**

**THREE-PHASE VOLTAGE DROP AT 50 Hz OF SINGLE-CORE INSULATED AND SHEATHED ALUMINIUM CONDUCTORS, LAID FLAT TOUCHING**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Conductor size**  **mm2** | **Three-phase voltage drop at 50 Hz, mV/A.m** | | | | | | | |
| **Conductor temperature, °C** | | | | | | | |
| **45** | | **60** | | **75** | | **90** | |
| **Max.** | **0.8 p.f.** | **Max.** | **0.8 p.f.** | **Max.** | **0.8 p.f.** | **Max.** | **0.8 p.f.** |
| 16 | 3.65 | — | 3.85 | — | 4.05 | — | 4.25 | — |
| 25 | 2.30 | — | 2.42 | — | 2.55 | — | 2.67 | — |
| 35 | 1.67 | — | 1.76 | — | 1.85 | — | 1.94 | — |
| 50 | 1.24 | — | 1.30 | — | 1.37 | — | 1.44 | — |
| 70 | 0.866 | — | 0.911 | — | 0.956 | — | 1.00 | — |
| 95 | 0.638 | — | 0.670 | — | 0.702 | — | 0.733 | — |
| 120 | 0.515 | — | 0.540 | — | 0.565 | — | 0.589 | — |
| 150 | 0.432 | — | 0.452 | — | 0.472 | — | 0.491 | — |
| 185 | 0.361 | — | 0.376 | — | 0.391 | — | 0.404 | — |
| 240 | 0.297 | — | 0.308 | — | 0.319 | — | 0.327 | — |
| 300 | 0.260 | 0.259 | 0.268 | 0.267 | 0.276 | 0.275 | 0.281 | — |
| 400 | 0.229 | 0.225 | 0.235 | 0.231 | 0.240 | 0.238 | 0.243 | 0.242 |
| 500 | 0.208 | 0.199 | 0.212 | 0.204 | 0.216 | 0.209 | 0.216 | 0.211 |
| 630 | 0.192 | 0.178 | 0.195 | 0.181 | 0.197 | 0.185 | 0.198 | 0.188 |

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### TABLE 45

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**THREE-PHASE VOLTAGE DROP AT 50 Hz OF MULTICORE CABLES WITH CIRCULAR ALUMINIUM CONDUCTORS**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Conductor size**  **mm2** | **Three-phase voltage drop at 50 Hz, mV/A.m** | | | | | | | | | |
| **Conductor temperature, °C** | | | | | | | | | |
| **45** | | **60** | | **75** | | **80** | | **90** | |
| **Max.** | **0.8 p.f.** | **Max.** | **0.8 p.f.** | **Max.** | **0.8 p.f.** | **Max** | **0.8 p.f.** | **Max.** | **0.8 p.f.** |
| 16 | 3.64 | — | 3.84 | — | 4.04 | — | 4.11 | — | 4.24 | — |
| 25 | 2.29 | — | 2.42 | — | 2.54 | — | 2.59 | — | 2.67 | — |
| 35 | 1.66 | — | 1.75 | — | 1.84 | — | 1.87 | — | 1.93 | — |
| 50 | 1.23 | — | 1.30 | — | 1.36 | — | 1.39 | — | 1.43 | — |
| 70 | 0.856 | — | 0.902 | — | 0.948 | — | 0.966 | — | 0.993 | — |
| 95 | 0.626 | — | 0.659 | — | 0.691 | — | 0.706 | — | 0.723 | — |
| 120 | 0.501 | — | 0.527 | — | 0.552 | — | 0.565 | — | 0.577 | — |
| 150 | 0.416 | — | 0.436 | — | 0.457 | — | 0.468 | — | 0.476 | — |
| 185 | 0.341 | — | 0.357 | — | 0.373 | — | — | — | 0.388 | — |
| 240 | 0.274 | — | 0.285 | — | 0.297 | — | — | — | 0.307 | — |
| 300 | 0.233 | — | 0.242 | — | 0.251 | — | — | — | 0.258 | — |
| 400 | 0.200 | 0.200 | 0.206 | 0.206 | 0.212 | — | — | — | 0.216 | — |
| 500 | 0.178 | 0.176 | 0.182 | 0.181 | 0.186 | 0.185 | — | — | 0.189 | 0.189 |

NOTE: For aerial bundled cables (ABC) use XLPE single core, trefoil figures.

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### TABLE 46

**THREE-PHASE VOLTAGE DROP AT 50 Hz OF SINGLE-CORE FLEXIBLE CABLES AND CORDS WITH COPPER CONDUCTORS, LAID IN TREFOIL**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Conductor size**  **mm2** | **Three-phase voltage drop at 50 Hz, mV/A.m** | | | | | | | |
| **Conductor temperature, °C** | | | | | | | |
| **45** | | **60** | | **75** | | **90** | |
| **Max.** | **0.8 p,f.** | **Max.** | **0.8 p.f.** | **Max.** | **0.8 p.f.** | **Max.** | **0.8 p.f.** |
| 0.5 | 74.2 | — | 78.2 | — | 82.2 | — | 86.1 | — |
| 0.75 | 49.5 | — | 52.1 | — | 54.8 | — | 57.4 | — |
| 1.0 | 37.1 | — | 39.1 | — | 41.1 | — | 43.1 | — |
| 1.5 | 25.3 | — | 26.7 | — | 28.0 | — | 29.4 | — |
| 2.5 | 15.2 | — | 16.0 | — | 16.8 | — | 17.6 | — |
| 4 | 9.42 | — | 9.92 | — | 10.4 | — | 10.9 | — |
| 6 | 6.28 | — | 6.62 | — | 6.96 | — | 7.29 | — |
| 10 | 3.77 | — | 3.97 | — | 4.18 | — | 4.38 | — |
| 16 | 2.31 | — | 2.43 | — | 2.56 | — | 2.68 | — |
| 25 | 1.40 | — | 1.48 | — | 1.55 | — | 1.63 | — |
| 35 | 1.04 | — | 1.09 | — | 1.14 | — | 1.20 | — |
| 50 | 0.785 | — | 0.825 | — | 0.866 | — | 0.906 | — |
| 70 | 0.534 | — | 0.560 | — | 0.586 | — | 0.612 | — |
| 95 | 0.431 | — | 0.450 | — | 0.470 | — | 0.490 | — |
| 120 | 0.348 | — | 0.363 | — | 0.377 | — | 0.392 | — |
| 150 | 0.290 | — | 0.301 | — | 0.312 | — | 0.323 | — |
| 185 | 0.257 | 0.257 | 0.265 | 0.265 | 0.273 | 0.273 | 0.282 | 0.282 |
| 240 | 0.221 | 0.219 | 0.227 | 0.226 | 0.233 | 0.232 | 0.239 | 0.238 |
| 300 | 0.196 | 0.193 | 0.202 | 0.198 | 0.206 | 0.203 | 0.211 | 0.208 |
| 400 | 0.178 | 0.167 | 0.181 | 0.171 | 0.183 | 0.174 | 0.186 | 0.178 |
| 500 | 0.170 | 0.155 | 0.172 | 0.158 | 0.173 | 0.161 | 0.175 | 0.164 |

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### TABLE 47

**THREE-PHASE VOLTAGE DROP AT 50 Hz OF MULTICORE**

**FLEXIBLE CABLES AND CORDS WITH COPPER CONDUCTORS**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Conductor size**  **mm2** | **Three-phase voltage drop at 50 Hz, mV/A.m** | | | | | | | |
| **Conductor temperature, °C** | | | | | | | |
| **45** | | **60** | | **75** | | **90** | |
| **Max.** | **0.8 p.f.** | **Max.** | **0.8 p.f.** | **Max.** | **0.8 p.f.** | **Max.** | **0.8 p.f** |
| 0.5 | 74.2 | — | 78.2 | — | 82.2 | — | 86.1 | — |
| 0.75 | 49.5 | — | 52.1 | — | 54.8 | — | 57.4 | — |
| 1.0 | 37.1 | — | 39.1 | — | 41.1 | — | 43.1 | — |
| 1.5 | 25.3 | — | 26.7 | — | 28.0 | — | 29.4 | — |
| 2.5 | 15.2 | — | 16.0 | — | 16.8 | — | 17.6 | — |
| 4 | 9.42 | — | 9.92 | — | 10.4 | — | 10.9 | — |
| 6 | 6.28 | — | 6.62 | — | 6.95 | — | 7.29 | — |
| 10 | 3.77 | — | 3.97 | — | 4.17 | — | 4.38 | — |
| 16 | 2.31 | — | 2.43 | — | 2.55 | — | 2.68 | — |
| 25 | 1.40 | — | 1.47 | — | 1.55 | — | 1.62 | — |
| 35 | 1.03 | — | 1.09 | — | 1.14 | — | 1.19 | — |
| 50 | 0.781 | — | 0.822 | — | 0.862 | — | 0.902 | — |
| 70 | 0.529 | — | 0.555 | — | 0.581 | — | 0.608 | — |
| 95 | 0.425 | — | 0.445 | — | 0.465 | — | 0.485 | — |
| 120 | 0.342 | — | 0.357 | — | 0.371 | — | 0.387 | — |
| 150 | 0.283 | — | 0.294 | — | 0.305 | — | 0.317 | — |
| 185 | 0.249 | 0.249 | 0.258 | 0.258 | 0.266 | 0.266 | 0.275 | 0.274 |
| 240 | 0.214 | 0.214 | 0.220 | 0.220 | 0.226 | 0.226 | 0.233 | 0.233 |
| 300 | 0.192 | 0.188 | 0.196 | 0.193 | 0.200 | 0.198 | 0.205 | 0.203 |
| 400 | 0.173 | 0.164 | 0.175 | 0.168 | 0.178 | 0.171 | 0.180 | 0.174 |
| 500 | 0.165 | 0.153 | 0.166 | 0.156 | 0.168 | 0.158 | 0.170 | 0.161 |

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### TABLE 48

**THREE-PHASE VOLTAGE DROP AT 50 Hz OF SINGLE-CORE AND**

### MULTICORE MINERAL-INSULATED METAL-SHEATHED (MIMS) CABLES, LAID IN TREFOIL

--`,,,``,`,,``,,,,,`````,`,,`,,`-`-`,,`,,`,`,,`---

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Conductor size**  **mm2** | **Three-phase voltage drop at 50 Hz, mV/A.m** | | | | | | | | | | | |
| **Conductor temperature, °C** | | | | | | | | | | | |
| **45** | | **60** | | **75** | | **90** | | **100** | | **105** | |
| **Max.** | **0.8 p.f.** | **Max.** | **0.8 p.f.** | **Max.** | **0.8 p.f.** | **Max.** | **0.8 p.f.** | **Max.** | **0.8 p.f.** | **Max.** | **0.8 p.f.** |
| 0.6/0.6 kV |  |  |  |  |  |  |  |  |  |  |  |  |
| cables |  |  |  |  |  |  |  |  |  |  |  |  |
| 1 | 32.8 | — | 34.6 | — | 36.3 | — | 38.1 | — | 39.1 | 31.4 | 39.7 | 31.9 |
| 1.5 | 21.9 | — | 23.0 | — | 24.2 | — | 25.4 | — | 26.3 | 21.2 | 26.7 | 21.5 |
| 2.5 | 13.1 | — | 13.8 | — | 14.5 | — | 15.2 | — | 15.8 | 12.7 | 16.0 | 12.9 |
| 4 | 8.20 | — | 8.64 | — | 9.08 | — | 9.52 | — | 9.87 | 8.00 | 10.01 | 8.11 |
| 1/1 kV |  |  |  |  |  |  |  |  |  |  |  |  |
| cables |  |  |  |  |  |  |  |  |  |  |  |  |
| 1.5 | 21.9 | — | 23.0 | — | 24.2 | — | 25.4 | — | 26.3 | 21.2 | 26.7 | 21.5 |
| 2.5 | 13.1 | — | 13.8 | — | 14.5 | — | 15.2 | — | 15.8 | 12.8 | 16.0 | 12.9 |
| 4 | 8.20 | — | 8.64 | — | 9.08 | — | 9.52 | — | 9.87 | 8.02 | 10.01 | 8.13 |
| 6 | 5.46 | — | 5.77 | — | 6.05 | — | 6.34 | — | 6.57 | 5.37 | 6.65 | 5.44 |
| 10 | 3.30 | — | 3.47 | — | 3.65 | — | 3.83 | — | 3.92 | 3.24 | 3.99 | 3.30 |
| 16 | 2.06 | — | 2.17 | — | 2.28 | — | 2.39 | — | 2.47 | 2.07 | 2.50 | 2.10 |
| 25 | 1.32 | — | 1.39 | — | 1.46 | — | 1.53 | — | 1.58 | 1.35 | 1.60 | 1.37 |
| 35 | 0.949 | — | 0.999 | — | 1.05 | — | 1.10 | — | 1.13 | 0.99 | 1.15 | 1.00 |
| 50 | 0.672 | — | 0.706 | — | 0.741 | — | 0.775 | — | 0.800 | 0.718 | 0.810 | 0.726 |
| 70 | 0.491 | — | 0.515 | — | 0.539 | — | 0.563 | — | 0.581 | 0.536 | 0.588 | 0.542 |
| 95 | 0.375 | — | 0.393 | — | 0.410 | — | 0.427 | — | 0.438 | 0.416 | 0.443 | 0.420 |
| 120 | 0.307 | — | 0.320 | — | 0.333 | — | 0.346 | — | 0.356 | 0.345 | 0.361 | 0.349 |
| 150 | 0.260 | — | 0.270 | — | 0.280 | — | 0.290 | — | 0.297 | 0.292 | 0.300 | 0.295 |
| 185 | 0.228 | — | 0.236 | — | 0.243 | — | 0.251 | — | 0.256 | 0.255 | 0.258 | 0.257 |
| 240 | 0.195 | 0.194 | 0.201 | 0.200 | 0.206 | 0.206 | 0.211 | 0.211 | 0.215 | 0.215 | 0.217 | 0.217 |
| 300 | 0.178 | 0.173 | 0.181 | 0.178 | 0.185 | 0.182 | 0.189 | 0.187 | 0.192 | 0.190 | 0.194 | 0.192 |
| 400 | 0.163 | 0.154 | 0.166 | 0.157 | 0.168 | 0.161 | 0.170 | 0.164 | 0.172 | 0.166 | 0.173 | 0.168 |

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### TABLE 49

**THREE-PHASE VOLTAGE DROP AT 50 Hz OF AERIAL CABLES WITH BARE OR INSULATED COPPER CONDUCTORS**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Conductor size, mm2, or**  **stranding (No./mm)** | **Three-phase voltage drop at 50 Hz, mV/A.m** | | | | | |
| **Conductor temperature, °C** | | | | | |
| **45** | | **60** | | **75** | |
| **Max.** | **0.8 p.f.** | **Max.** | **0.8 p.f.** | **Max.** | **0.8 p.f.** |
| 7/1.00 | 6.22 | — | 6.55 | — | 6.88 | — |
| 6 | 6.07 | — | 6.39 | — | 6.71 | — |
| 7/1.25 | 4.02 | — | 4.23 | — | 4.45 | — |
| 10 | 3.64 | — | 3.83 | — | 4.02 | — |
| 16 | 2.33 | — | 2.45 | — | 2.56 | — |
| 7/1.75 | 2.10 | — | 2.20 | — | 2.31 | — |
| 7/2.00 | 1.65 | — | 1.73 | — | 1.81 | — |
| 25 | 1.53 | — | 1.60 | — | 1.67 | — |
| 35 | 1.16 | — | 1.21 | — | 1.26 | — |
| 7/2.75 | 0.981 | — | 1.02 | — | 1.06 | — |
| 50 | 0.920 | — | 0.953 | — | 0.988 | — |
| 19/1.75 | 0.915 | — | 0.948 | — | 0.982 | — |
| 19/2.00 | 0.768 | 0.766 | 0.791 | 0.790 | 0.815 | 0.815 |
| 70 | 0.725 | 0.720 | 0.746 | 0.743 | 0.767 | 0.765 |
| 7/3.50 | 0.719 | 0.712 | 0.739 | 0.734 | 0.759 | 0.756 |
| 7/3.75 | 0.668 | 0.654 | 0.684 | 0.673 | 0.700 | 0.692 |
| 95 | 0.613 | 0.592 | 0.626 | 0.609 | 0.639 | 0.625 |
| 37/1.75 | 0.619 | 0.600 | 0.632 | 0.616 | 0.646 | 0.633 |
| 19/2.75 | 0.562 | 0.528 | 0.571 | 0.541 | 0.581 | 0.554 |
| 120 | 0.556 | 0.521 | 0.565 | 0.534 | 0.574 | 0.547 |
| 19/3.00 | 0.529 | 0.482 | 0.536 | 0.493 | 0.543 | 0.504 |
| 150 | 0.517 | 0.469 | 0.524 | 0.479 | 0.530 | 0.490 |
| 185 | 0.485 | 0.423 | 0.489 | 0.431 | 0.494 | 0.439 |
| 37/2.50 | 0.484 | 0.419 | 0.488 | 0.428 | 0.492 | 0.436 |

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### TABLE 50

### THREE-PHASE VOLTAGE DROP AT 50 Hz OF AERIAL CABLES WITH BARE OR INSULATED ALUMINIUM CONDUCTORS

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|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Conductor size, mm2, or**  **stranding (No./mm)** | **Three-phase voltage drop at 50 Hz, mV/A.m** | | | | | | | |
| **Conductor temperature, °C** | | | | | | | |
| **45** | | **60** | | **75** | | **80** | |
| **Max.** | **0.8**  **p.f.** | **Max.** | **0.8 p.f.** | **Max.** | **0.8 p.f.** | **Max.** | **0.8 p.f.** |
| 16 | 3.69 | — | 3.89 | — | 4.08 | — | 4.15 | — |
| 25 | 2.36 | — | 2.48 | — | 2.60 | — | 2.64 | — |
| 35 | 1.74 | — | 1.83 | — | 1.92 | — | 1.94 | — |
| 7/2.50 | 1.68 | — | 1.76 | — | 1.84 | — | 1.87 | — |
| 7/2.75 | 1.42 | — | 1.48 | — | 1.55 | — | 1.57 | — |
| 50 | 1.33 | — | 1.39 | — | 1.45 | — | 1.47 | — |
| 7/3.00 | 1.22 | — | 1.28 | — | 1.33 | — | 1.34 | — |
| 70 | 0.982 | — | 1.02 | — | 1.06 | — | 1.08 | — |
| 7/3.75 | 0.864 | 0.864 | 0.896 | 0.895 | 0.929 | 0.926 | 0.940 | 0.936 |
| 95 | 0.778 | 0.777 | 0.804 | 0.804 | 0.831 | 0.831 | 0.840 | 0.840 |
| 7/4.50 | 0.687 | 0.681 | 0.707 | 0.703 | 0.727 | 0.725 | 0.734 | 0.732 |
| 120 | 0.672 | 0.667 | 0.691 | 0.688 | 0.711 | 0.709 | 0.718 | 0.716 |
| 7/4.75 | 0.648 | 0.638 | 0.665 | 0.658 | 0.682 | 0.677 | 0.688 | 0.684 |
| 150 | 0.602 | 0.588 | 0.617 | 0.606 | 0.631 | 0.623 | 0.636 | 0.629 |
| 19/3.25 | 0.573 | 0.552 | 0.585 | 0.568 | 0.597 | 0.583 | 0.601 | 0.588 |
| 185 | 0.543 | 0.517 | 0.553 | 0.531 | 0.564 | 0.544 | 0.567 | 0.549 |
| 19/3.50 | 0.538 | 0.508 | 0.547 | 0.521 | 0.557 | 0.534 | 0.560 | 0.538 |

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## S E C T I O N 5 S H O R T - C I R C U I T P E R F O R M A N C E

* 1. **GENERAL** This Section is applicable to the short-circuit maximum temperature rating of electric cables having a rated voltage not exceeding 0.6/1.0 kV. Guidance is given on the following aspects:

1. Maximum permissible short-circuit temperatures for cable—
   1. insulating materials;
   2. outer jacket and bedding materials; and
   3. conductor and metallic sheath materials and components.
2. Influence of the method of installation on the temperature limit.
3. Calculation of the permissible short-circuit current in the current-carrying components of the cable.
   1. **FACTORS GOVERNING THE APPLICATION OF THE TEMPERATURE LIMITS** The short-circuit temperatures given in Clause 5.5 are the actual temperatures of the current-carrying component as limited by the adjacent materials in the cable and are valid for short-circuit durations of up to 5 s. These temperatures will only be obtained in practice if non-adiabatic heating is assumed (that is, an appropriate allowance for heat loss into the dielectric during the short circuit is made) when calculating the allowable short-circuit current for a given time (not longer than 5 s). The use of the adiabatic method (that is, when heat loss from the current-carrying component during the short circuit is neglected) gives short-circuit currents that are on the safe side. The 5-second period quoted is the limit for the temperatures quoted to be valid, not for the application of the adiabatic calculation method. The time limit for the use of the adiabatic method has a different definition, being a function of both the short-circuit duration and the cross-sectional area of the current-carrying component.

For thermoplastic insulating materials the limits must be applied with caution when the cables are either directly buried or securely clamped when in air. Local pressure due to clamping or the use of an installation radius less than 8 times the cable outside diameter, especially for cables that are rigidly restrained, can lead to high deforming forces under short-circuit conditions. Where these conditions cannot be avoided it is suggested that the limit be reduced by 10°C. The limits quoted are based on average hardness grades of PVC and some adjustment may be necessary for other grades, especially those compounded for improved low-temperature properties.

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NOTES:

1. Caution should be exercised when using the limits recommended for thermosetting materials on large conductors because the high mechanical forces combined with any residual characteristics could result in deformation sufficient to cause failure.
2. Caution may be needed with total cross-sectional areas in the region of 1000 mm2 when using the conductor temperatures specified for impregnated paper, butyl, cross-linked polyethylene (XLPE) and ethylene propylene rubber (EPR) insulation and the cable is sheathed with a lower-temperature material.
3. Information on the short-circuit performance of MIMS cable is not included in this Standard and reference should be made to manufacturer’s recommendations.

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* 1. **CALCULATION OF PERMISSIBLE SHORT-CIRCUIT CURRENTS** The following adiabatic method, which neglects heat loss, is accurate enough for calculating permissible conductor and metallic sheath short-circuit currents for the majority of practical cases and any error is on the safe side. However, for thin screens the adiabatic method indicates much higher temperature rises than actually occur in practice and thus must be used with some discretion.

The generalized form of the adiabatic temperature rise equation which is applicable to any starting temperature is as follows:

*I*2*t* = *K*2*S*2 . . . 5.3(1)

where

*I* = short-circuit current (r.m.s. over duration), in amperes

*t* = duration of short circuit, in seconds

*K* = constant depending on the material of the current-carrying component, the initial temperature and the final temperature

NOTE: Refer to Table 51 for values of constant (*K*).

*S* = cross-sectional area of the current-carrying component, in square millimetres.

NOTE: For conductors and metallic sheaths it is sufficient to take the nominal cross-sectional area but in the case of screens, this quantity requires careful consideration.

### TABLE 51

**VALUES OF CONSTANT *K* FOR DETERMINATION OF PERMISSIBLE SHORT-CIRCUIT CURRENTS**

**Constant (*K*)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Initial temp. of conductor**  **°C** | **Final temperature of conductor, °C** | | | | | | | | | | | | | |
| **Copper** | | | | | | **Aluminium** | | | | **Lead** | | **Steel** | |
| **140** | **150** | **160** | **220** | **250** | **350** | **140** | **150** | **160** | **250** | **150** | **200** | **150** | **200** |
| 130 | 37.2 | 52.2 | 63.6 | 106 | 121 | 155 | 24.6 | 34.5 | 42.0 | 79.6 | 9.5 | 17.3 | 18.9 | 34.1 |
| 125 | 45.7 | 58.6 | 68.9 | 109 | 123 | 158 | 30.2 | 38.7 | 45.5 | 81.5 | 10.7 | 17.9 | 21.2 | 35.4 |
| 110 | 65.3 | 74.9 | 83.2 | 119 | 132 | 164 | 43.2 | 49.5 | 55.0 | 87.1 | 13.7 | 19.9 | 27.1 | 39.3 |
| 90 | 85.6 | 93.1 | 99.9 | 131 | 143 | 173 | 56.6 | 61.5 | 66.0 | 94.5 | 17.0 | 22.3 | 33.7 | 44.1 |
| 85 | 90.1 | 97.3 | 104 | 134 | 146 | 176 | 59.5 | 64.3 | 68.6 | 96.3 | 17.8 | 22.9 | 35.2 | 45.3 |
| 80 | 94.4 | 101 | 108 | 137 | 149 | 178 | 62.4 | 67.0 | 71.1 | 98.1 | 18.5 | 23.5 | 36.7 | 46.4 |
| 75 | 98.7 | 105 | 111 | 140 | 151 | 180 | 65.2 | 69.6 | 73.6 | 99.9 | 19.2 | 24.0 | 38.2 | 47.6 |
| 70 | 103 | 109 | 115 | 143 | 154 | 182 | 68.0 | 72.2 | 76.0 | 102 | 19.9 | 24.6 | 39.6 | 48.8 |
| 65 | 107 | 113 | 119 | 146 | 157 | 185 | 70.7 | 74.7 | 78.4 | 104 | 20.6 | 25.2 | 41.0 | 49.9 |
| 60 | 111 | 117 | 122 | 149 | 159 | 187 | 73.3 | 77.2 | 80.8 | 105 | 21.3 | 25.7 | 42.4 | 51.0 |
| 55 | 115 | 120 | 126 | 152 | 162 | 189 | 75.8 | 79.6 | 83.1 | 107 | 22.0 | 26.3 | 43.7 | 52.2 |
| 50 | 118 | 124 | 129 | 155 | 165 | 192 | 78.4 | 82.0 | 85.5 | 109 | 22.7 | 26.9 | 45.1 | 53.3 |
| 45 | 122 | 128 | 133 | 158 | 168 | 194 | 80.9 | 84.4 | 87.7 | 111 | 23.3 | 27.4 | 46.4 | 54.4 |
| 40 | 126 | 131 | 136 | 160 | 170 | 196 | 83.3 | 86.8 | 90.0 | 113 | 24.0 | 28.0 | 47.7 | 55.6 |
| 35 | 130 | 135 | 140 | 163 | 173 | 199 | 85.8 | 89.1 | 92.3 | 114 | 24.6 | 28.5 | 49.1 | 56.7 |
| 30 | 133 | 138 | 143 | 166 | 176 | 201 | 88.2 | 91.5 | 94.5 | 116 | 25.3 | 29.1 | 50.4 | 57.8 |
| 25 | 137 | 142 | 146 | 169 | 179 | 204 | 90.6 | 93.8 | 96.8 | 118 | 25.9 | 29.6 | 51.7 | 59.0 |

* 1. **INFLUENCE OF METHOD OF INSTALLATION** When it is intended to make full use of the short-circuit limits of a cable, consideration should be given to the influence of the method of installation. An important aspect concerns the extent and nature of the mechanical restraint imposed on the cable. Longitudinal expansion of a cable during a short circuit can be significant and when this expansion is restrained the resultant forces are considerable.

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Where cables are installed in air, provision should be made so that expansion may be absorbed uniformly along the length by snaking rather than permitting it to be relieved by excessive movement at a few points only. Fixings should be spaced sufficiently far apart to permit lateral movement of multi-core cables or groups of single-core cables.

Where cables are buried directly in the ground, or must be restrained by frequent fixing, then provision should be made to accommodate the resulting longitudinal forces on terminations and joint boxes. Sharp bends should be avoided because the longitudinal forces are translated into radial pressures at bends in the cable route and these may damage thermoplastic components of the cable such as insulation and sheaths. Attention is drawn to the minimum bending radius recommended for the type of cable. For cables in air it is also desirable to avoid fixings at a bend which may cause local pressure on the cable.

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In determining the short-circuit stresses which will be imposed on a cable, the characteristics of the protective devices used shall be considered.

### MAXIMUM PERMISSIBLE SHORT-CIRCUIT TEMPERATURES

* + 1. **General** Taking into account the recommendation given in Clause 5.2, the temperature values given in Tables 52 to 54 are—

1. the actual temperatures of the current-carrying components; and
2. the limits specified for short-circuits of up to 5 s duration.
   * 1. **Insulating materials** The temperature limits given in Table 52 are for all types of conditions when the insulating materials specified are in contact with conductors.

### TABLE 52

**TEMPERATURE LIMITS FOR INSULATING**

**MATERIALS IN CONTACT WITH CONDUCTORS**

|  |  |
| --- | --- |
| **Material** | **Temperature limit**  **°C** |
| PVC — V-75, V-90, V-90HT, HFI-75-TP and |  |
| HFI-90-TP |  |
| — up to and including 300 mm2 | 160 |
| — greater than 300 mm2 | 140 |
| Elastomer R-EP-90, R-CPE-90, R-HF-90, |  |
| R-CSP-90, R-HF-110, and R-E-110 | 250 |
| XLPE, X-90, X-HF-90 and X-HF-110 | 250 |
| Silicone rubber, R-S-150 | 350 |

* + 1. **Outer sheath and bedding materials** The temperature limits given in Table 53 are for the outer sheath and bedding materials comprising a continuous screen/ sheath or a complete layer of armour wires. These temperatures are for materials where there is no electrical or other requirements necessary, i.e. screen/sheath/armour temperature limits when in contact with the outer sheath materials but thermally separated from the insulation by layers of suitable material of sufficient thickness. If thermal separation is not provided, the temperature limits of the insulation should be used if it is lower than that of the sheath.

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### TABLE 53

**TEMPERATURE LIMITS FOR OUTER SHEATH AND BEDDING MATERIALS**

|  |  |
| --- | --- |
| **Material** | **Temperature limit**  **°C** |
| Thermoplastic | 200 |
| Polyethylene | 150 |
| High density polyetheylene | 180 |
| Polychloroprene, chlorosuphonated |  |
| polyethylene and similar | 200 |

* + 1. **Conductor and metallic sheath materials and components** The temperature limits specified in Table 54 apply to the conductor and metallic sheath materials and components.

NOTE: Limitations of materials in contact with these metals should also be considered.

### TABLE 54

**TEMPERATURE LIMITS FOR CONDUCTOR AND METALLIC SHEATH MATERIALS AND COMPONENTS**

|  |  |  |
| --- | --- | --- |
| **Metals** | **Condition** | **Temperature limit**  **°C** |
| Copper and aluminium | Conductor only\* | † |
|  | Welded joint | † |
|  | Exothermic welded joint | 250‡ |
|  | Soldered joint | 160 |
|  | Compression (mechanical deformation) joint | 250‡ |
|  | Mechanical (bolted) joint | § |
| Lead |  | 170 |
| Lead alloy |  | 200 |
| Steel |  | † |

\* Includes concentric neutral conductors.

† Limited by the material with which it is in contact.

‡ Temperature of adjacent conductor; actual joint will be at a lower temperature.

§ Refer to manufacturer’s recommendations.

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APPENDIX A

## EXAMPLES OF THE SELECTION OF CABLES TO SATISFY CURRENT-CARRYING CAPACITY, VOLTAGE DROP AND SHORT-CIRCUIT PERFORMANCE REQUIREMENTS

(Informative)

### A1 EXAMPLE 1

**A1.1 Problem** An underground 1500 A three-phase circuit is to be made up of parallel circuits of 400 mm2 V-75 single-core insulated and sheathed copper cables. Determine the minimum number of active conductors required for each of the following forms of installation:

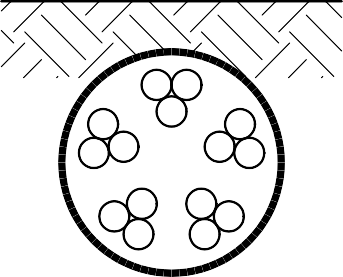
1. All cables in one conduit or duct.
2. Each parallel circuit comprised of three cables in one conduit or duct.
3. Each parallel circuit comprised of a trefoil group of single-way underground ducts.
4. Each parallel circuit comprised of a trefoil group of three cables buried direct.

**A1.2 Solution** Assuming that the conditions specified in Clause 3.4 apply, i.e. soil ambient temperature, thermal resistivity and depth of laying, the following methods would satisfy the load requirements if the voltage drop is acceptable:

1. *Method A—single conduit or duct*

Current-carrying capacity of single 400 mm2 circuit = 561 A (Table 6, Column 16).

From the derating factors of Table 22, which vary according to the number of enclosed circuits, it can be shown that five parallel circuits of 400 mm2 conductors, as illustrated, are required.

The current-carrying capacity of the arrangement is— 561 × 5 × 0.60 = 1683 A

1. *Method B—groups of conduits or ducts*

Current-carrying capacity of single 400 mm2 circuit = 561 A (Table 6, Column 16).

From the derating factors of Table 26(2) for groups of underground enclosures, it can be shown that four conduits or ducts, each containing a circuit of 400 mm2 conductors and touching, as illustrated, are required.

The current-carrying capacity of the arrangement is— 561 × 4 × 0.79 = 1772.8 A

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1. *Method C—trefoil groups of single-way underground ducts*

Current-carrying capacity of single 400 mm2 circuit = 616 A (Table 6, Column 18)

From the derating factors of Table 26(1) for groups of underground enclosures, it can be shown that four trefoil groups of single-way underground ducts, each group representing a circuit of 400 mm2 conductors, as illustrated, are required.

The current-carrying capacity of the arrangement— 616 × 4 × 0.74 = 1823.4 A



1. *Method D—trefoil groups of cable buried direct*

Current-carrying capacity of single 400 mm2 circuit = 649 A (Table 6, Column 14).

From the derating factors of Table 25(1) for groups of single-core cables buried direct, it can be shown that three trefoil groups of single-core cables, each group representing a circuit of 400 mm2 conductors and spaced apart, as illustrated, are required.

The current-carrying capacity of the arrangement is— 649 × 3 × 0.87 = 1694 A

**A1.3 Comparison of different methods** Each of the four methods of installation described in Paragraph A1.2 provides a satisfactory solution to the circuit design problem where the number of 400 mm2 active conductors are to be kept to a minimum for a given installation method. However, in doing so the following factors which may determine the system to be selected are highlighted:

1. *Number of cables* Method A leads to the largest number of cables.
2. *Number of enclosures* Method C requires twelve enclosures (excluding neutral) whilst Method D requires none.
3. *Size of enclosures* The enclosures in Method C need only be sufficient to accommodate one conductor; however, the single enclosure in Method A will need to be considerably larger.
4. *Size of excavated trench* Methods A, B and C require relatively small trench widths in comparison to Method D.

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1. *Provision for additional load* All methods have provision for a further load increase of between 183 and 323 A. Methods A and D have the smallest margin of increased load capability.

The relative importance of these different factors for a particular installation will, in general, determine the cable arrangement selected.

### A2 EXAMPLE 2

**A2.1 Problem** If 12 loaded single-core conductors are run through a wiring enclosure what derating factor should be applied?

**A2.2 Solution** The applicable derating factors could be determined from Table 22. If three-phase circuits, 12/3 is 4 groups, i.e. 4 circuits, and a derating factor of 0.65 could be applied. If the circuits are single-phase, there would be 6 circuits and therefore a derating factor of 0.57 could be applied.

Applying these derating factors for, say, V-75, 4 mm2 conductors, from Table 6 a three-phase current-carrying capacity is 30 A while the single-phase value from Table 3 is 34 A.

Using the three-phase approach, 30 × 0.65 = 19.5 A. Using the single-phase approach, 34 × 0.57 = 19.4 A.

Note that these methods result in approximately the same answer.

### A3 EXAMPLE 3

**A3.1 Problem** A three-phase circuit is to supply a load of 125 A per phase. It is proposed to use two V-75 four-core insulated and sheathed cables bunched together on a surface in a confined ceiling space where the ambient air temperature is 50°C.

Determine—

1. the minimum conductor size; and
2. the maximum route length of the circuit if a voltage drop of 3% is permitted on the circuit;

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for both aluminium and copper conductors.

**A3.2 Solution** The solution is as follows:

1. *Minimum cable size*:

Derating factor for bunching = 0.8 (Table 22, Column 5)

Derating factor for 50°C ambient = 0.72 (Table 27(1), Column 9) Minimum current-carrying capacity of two parallel cables—



or 108.5 A per cable.

From Columns 4 and 5 of Table 12, the minimum size of the two cables making up the circuit are—

Aluminium—50 mm2 Copper—35 mm2.

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1. *Maximum route length*:

With the same length and disposition of the two cables throughout the circuit, balanced current flow between the parallel cables can be expected.

Assuming worst case conditions of cable operating temperature and load power factor, the simplified method of Clause 4.2 may be used to determine the maximum route length of the circuit (*L*), in metres, by substitution of the 62.5 A load current for each cable and 3 % (12.0 V) permissible voltage drop in the following equation:



The values of *V*c are obtained from Table 42 for copper and Table 45 for aluminium and result in the following maximum route lengths:

Aluminium



Copper



### A4 EXAMPLE 4

**A4.1 Problem** Six four-core V-75 insulated and sheathed copper cables are arranged touching in a single horizontal row on a perforated cable tray for the supply of six identical 22 kW motors which have a full-load current of 45 A per phase and are installed at distances of 40 m, 55 m, 90 m, 135 m, 180 m and 225 m from the origin of the cable tray. Determine the minimum conductor size if a voltage drop of 2.3% (10 V) is permitted for each cable.

**A4.2 Solution** The selection of conductor size in this instance must satisfy both the current-carrying capacity requirement, including the effect of the cables being grouped, and the voltage drop limitation.

The cable sizes required to satisfy the voltage drop restriction are assessed using the formula of Clause 4.2, the actual load current of 45 A, the permissible voltage drop, *V*d, of 10 V and the three-phase voltage drop figures of Table 42. The results of these calculations, the current-carrying capacity given in Table 12 and its ratio to the load current, are as follows:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Cable** | **Length**  **m** | **Maximum**  ***V*c**  **mV/A.m** | **Minimum cable size**  **mm2** | **Maximum current- carrying capacity**  **A** | **Ratio of actual load current to max. current- carrying**  **capacity of cable** |
| A B C  D E F | 40  55  90  135  180  225 | 5.56  4.04  2.47  1.65  1.23  0.98 | 10  10  16  25  35  50 | 58  58  78  104  125  154 | 0.78  0.78  0.58  0.43  0.36  0.29 |

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Because of voltage drop limitations, cables C to F are substantially larger than required to meet the maximum current-carrying capacity requirements. As a result the contribution of these cables to the effects of mutual heating will be small; in the case of cables E and F, almost negligible.

An examination of the derating factors for groups of multicore cables on perforated trays given in Table 24 would indicate that a factor of 0.76 (Column 9) would apply if all six cables in the group were loaded to achieve the same conductor temperature. Although these conditions do not exist for all cables in this example, the application of this factor will give a conservative but practical solution, as follows:

Minimum current-carrying capacity required of cables = Minimum cable size = 16 mm2 (Table 12, Column 4)

As expected, only cables A and B are affected and therefore the recommended minimum cable sizes for the cables A, B, C, D, E and F will be 16 mm2, 16 mm2, 16 mm2, 25 mm2, 35 mm2 and 50 mm2 respectively.

NOTE: The actual derating factor in this situation may be closer to 0.82, the derating factor for three cables on a tray, which allows for restricted ventilation to cables nested in the middle of others. Alternative arrangements of the cables, e.g. spacing cables A and B, which operate at a higher temperature, away from each other and others in the group, may also give rise to less onerous derating factors and smaller cable sizes.

### A5 EXAMPLE 5

**A5.1 Problem** Five single-phase circuits of two-core flat V-75 insulated and sheathed cables are fixed to a wall. Where the continuous loading of the cables is assessed as 16, 20, 25, 32, and 40 amps, determine the minimum cable sizes required where the cables are in one of the following conditions:

1. Condition A—spaced apart in a single layer in accordance with Clause 3.5.2.2(c) and Figure 1.
2. Condition B—spaced apart in a single layer by a distance of one cable diameter between adjacent cables.
3. Condition C—touching in a single layer.
4. Condition D—bunched together.

**A5.2 Solution** The solution is as follows:

1. For installation condition A to avoid derating because of grouping, Clause 3.5.2.2(c) and Figure 1 require a minimum vertical spacing between adjacent cables 6 times the diameter of the largest cable in the group.
2. For condition B, the derating factor = 0.90 (Table 22, Column 8).
3. For condition C, the derating factor = 0.73 (Table 22, Column 8).
4. For condition D, the derating factor = 0.60 (Table 22, Column 8).

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The minimum conductor sizes determined from Column 4 of Table 9 are as follows:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Load**  **A** | **Cable size, mm2** | | | |
| **Spaced 6 diameters** | **Spaced 1 diameter** | **Touching single layer** | **Bunched** |
| 16 | 1.0 | 1.5 | 2.5 | 2.5 |
| 20 | 1.5 | 2.5 | 2.5 | 4 |
| 25 | 2.5 | 2.5 | 4 | 6 |
| 32 | 4 | 4 | 6 | 10 |
| 40 | 6 | 6 | 10 | 10 |

### A6 EXAMPLE 6

**A6.1 Problem** A single-phase circuit is comprised of two 16 mm2 copper single-core sheathed cables with V-75 insulation installed unenclosed on a wall for the supply of a 55 A resistive load.

Determine which single-phase voltage drop values will apply when the cable is operating in—

1. an ambient air temperature of 30°C; or
2. an ambient air temperature of 25°C.

**A6.2 Solution** From Table 3 it will be noted that the cable current-carrying capacity of this configuration is 82 A in an ambient air temperature of 30°C. Equation 4.4(1) may therefore be solved directly for cable operating temperature (0) where the ambient air temperature is 30°C but requires some correction to the rated current (*I*R) before application to an ambient air temperature of 25°C. Appropriate calculations are as follows:

1. *Ambient air temperature 30°C*



0 = 50.2°C, say 60°C

The three-phase voltage drop for this cable configuration and operating temperature obtained from Table 41 is 2.32 mV/A.m. The single-phase value is then determined in accordance with Clause 4.3.3(a).

Single-phase voltage drop value = 1.155 × 2.32

= 2.68 mV/A.m.

1. *Ambient air temperature 25°C*

The correction factor for operation in a 25°C ambient air temperature is used to determine the maximum current which will give rise to the maximum operating temperature of 75°C.

Correction factor = 1.06 (from Table 27)



0 = 45.02°C, say 45°C

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The three-phase voltage drop for this cable configuration and operating temperature obtained from Table 41 is 2.20 mV/A.m. The single-phase value is then determined in accordance with Clause 4.3.3(a)—

Single-phase voltage drop value = 1.155 × 2.20

= 2.54 mV/A.m.

### A7 EXAMPLE 7

**A7.1 Problem** A three-phase circuit is comprised of 3 × 150 mm2 single-core copper V-75 sheathed active conductors and a 1 × 70 mm2 single-core copper V-75 sheathed neutral conductor bunched together in free air. Assuming an ambient air temperature of 30°C and the same length of 150 m for all conductors, determine the maximum voltage drop when the magnitude and phase angle of the currents in the respective active conductors are as follows:

*I*A = 195

*I*B = 300

*I*C = 230

0\_°

1\_2\_0 °

2\_4\_0 °

**A7.2 Solution** It is not necessary in this example to take into account the load power factor as the maximum voltage drop conditions are assumed where load power factor and cable power factor are equal. The voltage drop in each cable will then be equal to *ILZ*c.

The 300 A load current in phase B is, according to Table 6, close to the maximum permissible for such an arrangement and consequently the conductor operating temperature may be assessed as 75°C for the application of Table 40 corresponding to a three-phase voltage drop of 0.305 mV/A.m.

The voltage drop on phase B conductor alone is therefore—

= 300

1\_2\_0 ° × 150 ×



= 7.924



1\_2\_0 °

The current flowing in the neutral is determined from the relationship—

*I*A + *I*B + *I*C + *I*N = 0

*I*A + *I*B + *I*C = 195 0° + 300

1\_2\_0 ° + 230 24\_0\_°\_

= 195 + (−150 + j259.8) + (−115 − j199.2)A

= −70 + j60.6

*I*N = 70 − j60.6

= 92.6 \_−4\_0\_.\_9\_° A

The operating temperature of the neutral may then be determined in accordance with Clause 4.4 and the rated figure given in Table 6, i.e.



0 = 38.67°C, say 45°C allowing for contact with conductors operating at higher temperatures.

From Table 40 and a conductor temperature of 45°C the three-phase voltage drop is given as 0.537 mV/A.m.

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The voltage drop on the neutral conductor alone is therefore—



= 4\_0\_.\_9\_° V × 150 ×

= 4.306 \_−4\_0\_.\_9\_° V

92.6 \_−

The maximum single-phase voltage drop is therefore—

|  |  |  |
| --- | --- | --- |
| *V*d | = | *V*dB − *V*dN = 7.924 1\_2\_0 ° − 4.306 −\_4 0\_.9\_° |
|  | =  = | −3.962 + j6.862 − 3.255 + j2.819  −7.217 + j9.681 |
|  | = | 12.08 1\_2\_6 .7\_° V |

### A8 EXAMPLE 8

**A8.1 Problem** Select the minimum size conductor based on thermal consideration, for a copper cable with compression joints connected to a supply where protection is provided by an air circuit-breaker with a clearance time of 1 s and a breaking capacity of 10 kA.

Calculate the minimum conductor size for the following two types of cable:

1. PVC insulated.

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1. XLPE insulated.

**A8.2 Solution** The solution is as follows:

1. *PVC insulated* The following steps are taken:
   1. To find the value of constant (*K*) the initial conductor temperature and the final conductor temperature must be known.

For PVC it is assumed that the initial operating temperature is 75°C (for V-75, V-90 and V-90HT). From Table 52, and assuming that the cable is smaller than 300 mm2, the final operating temperature can be selected as 160°C. From Table 51 the value of *K* can be selected as 111 for a copper conductor.

* 1. As the circuit-breaker protecting the circuit is rated at 10 kA breaking capacity, we can assume a value of 10 000 A for *I*.
  2. As the clearance time of the circuit-breaker is 1 s, it can be assumed that the value of *t*, which is the total time the fault current is flowing, is also 1 s.
  3. Rearranging Equation in Clause 5.3 we get—





Substituting the values for *I*, *t* and *K*, the minimum cross-section area is calculated as—





= 90.1 mm2

Therefore, the minimum cable size would be 95 mm2.



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1. *XLPE insulation* Using the same process as in Item (a) the following steps are taken:
   1. Initial operating temperature for XLPE insulation (assumed maximum) 90°C Final operating temperature from XLPE insulation (from Table 52) . . 250°C Value of constant (*K*) from Table 51 143

(ii) Value of short-circuit current (*I*) . . . . . . . . . . . . . . . . . . . . . . . . . 10 000 A (iii) Value of time (*t*) is . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 1 s



(iv)



= 69.9 mm2.

Therefore, the minimum cable size would be 70 mm2.

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APPENDIX B

## RECOMMENDED CIRCUIT CONFIGURATIONS FOR THE INSTALLATION OF SINGLE-CORE CABLES IN PARALLEL

(Informative)

|  |  |  |
| --- | --- | --- |
| **Mode** | **Two-phase** | **Three-phase** |
| Two conductors per phase |  |  |
| Three conductors per phase | Not recommended |  |
| Four conductors per phase |  |  |

NOTES:

1. Neutral conductors are to be located so as to not disturb the symmetry of the groups as illustrated.
2. Non-symmetrical configuration may cause unequal distribution of current between conductors. Provision should be made to maintain the recommended configurations to avoid these problems.

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