

APPENDIX B

CIRCUIT PROTECTION GUIDE

(Informative)

B1 SCOPE

This Appendix provides an example of the general arrangement of electrical installation circuits and identifies the steps required to determine the essential circuit arrangements that affect conductor size and selection of protective devices.

Guidance is also provided on the following:

- (a) Coordination of the characteristics of conductors and protective devices for protection against overload current.
- (b) Automatic disconnection of supply to provide fault protection, including determination of maximum earth fault-loop impedance and maximum length of a circuit that will allow a protective device to operate within the specified disconnection time.

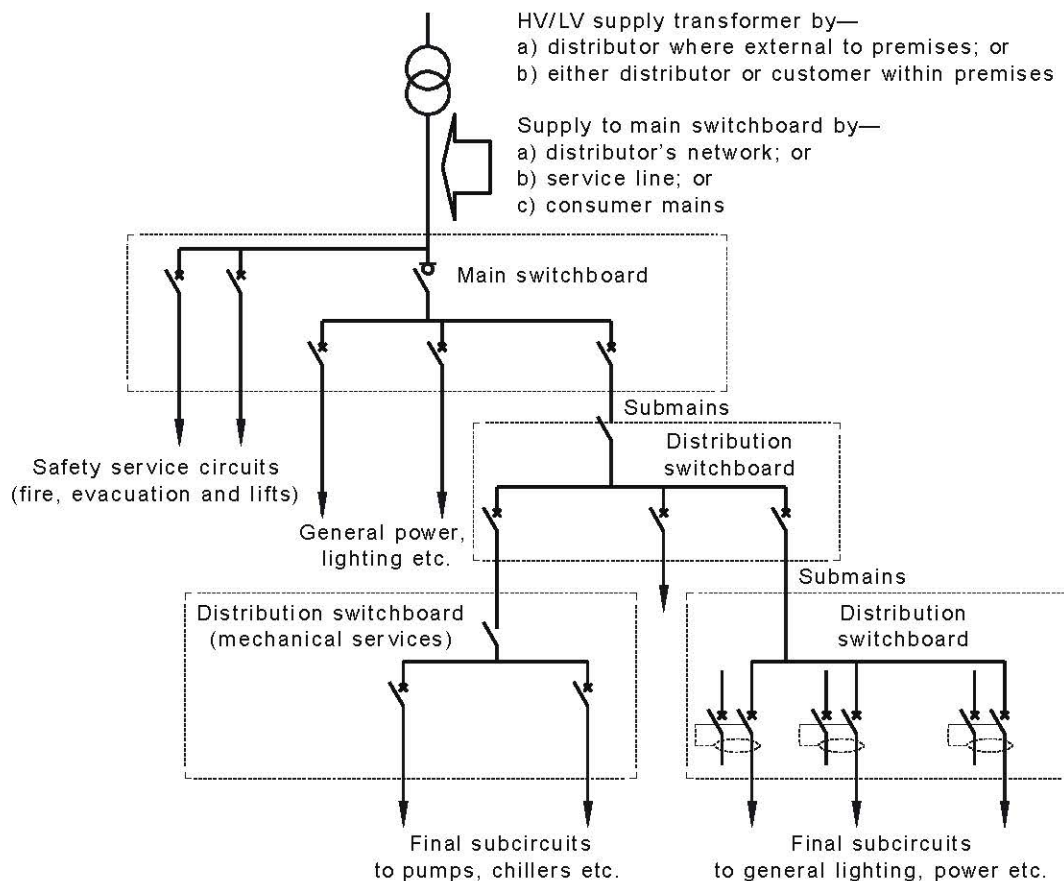
B2 CIRCUIT ARRANGEMENTS

The electrical installation is required to be arranged with an appropriate number of independent circuits to different parts, in accordance with Clause 2.2.1.1.

The most common distribution arrangement for a low-voltage electrical installation is radial branched distribution, an example of which is shown in Figure B1.

The steps that should be taken to ensure correct circuit arrangements are as follows:

- (a) Determine the required current-carrying capacity, in accordance with the AS/NZS 3008.1 series, for circuit conductors dependent on the method of installation and the presence of external influences.
- (b) Determine overcurrent requirements, in accordance with Clause 2.5. Overcurrent includes both overload currents and short-circuit currents (see Paragraph B3).
- (c) Determine voltage drop requirements, in accordance with Clause 3.6.
NOTE: Guidance on the calculation of voltage drop is given in the AS/NZS 3008.1 series.
- (d) Determine the automatic disconnection of supply requirements, in accordance with Clause 5.7 (see also Paragraphs B4 and B5).



NOTE: Alternative arrangements are permitted; however, this arrangement offers the following advantages:

- (a) One circuit only will be shut down (by fuses or circuit-breakers) in case of a fault.
- (b) Location of the fault is simplified.
- (c) Maintenance or extensions to a circuit can be performed, leaving the remainder of the electrical installation in service.
- (d) Conductor sizes can be reduced at protective devices installed on switchboards to suit the decreasing demand towards the final subcircuits.
- (e) Conversely, a fault occurring on one of the circuits from the main switchboard will shut down supply to all circuits of related downstream distribution boards.

FIGURE B1 EXAMPLE OF CIRCUIT ARRANGEMENTS FOR AN ELECTRICAL INSTALLATION (TO THREE LEVELS)
(Symbols are explained in Table J1)

B3 PROTECTION AGAINST OVERCURRENT

B3.1 General

The term 'overcurrent' includes both overload current and short-circuit current.

The danger to the system from overload currents is that the temperature of conductors and their insulation will rise to levels at which the effectiveness of the insulation and its expected service life will be reduced.

Short-circuit currents may be up to several thousand times normal current and will cause overheating and mechanical stresses of conductors and associated connections.

NOTE: See Clause 2.5.4 and the AS/NZS 3008.1 series.

Clause 2.5.1 requires active conductors to be protected by one or more protective devices in the event of overload or short-circuit.

The protection of conductors by protective devices is shown graphically in Figure B2. The conductor is deemed to be protected if its damage curve, determined in accordance with Clause 2.5.4.5, is to the right of the time/current characteristic curve of the protective device.

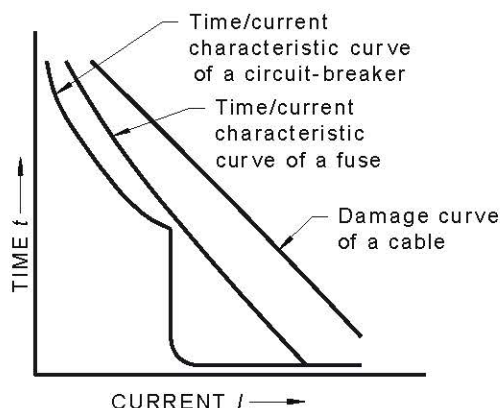


FIGURE B2 TYPICAL OVERCURRENT PROTECTION OF CONDUCTORS

B3.2 Coordination between conductors and overload protective devices

B3.2.1 General

Clause 2.5.3 requires a protective device to interrupt overload currents and that the operating characteristics of such a device satisfies the following two conditions that are shown as Equations 2.1 and 2.2 of Clause 2.5.3.1:

$$I_B \leq I_N \leq I_Z$$

$$I_Z \leq 1.45 \times I_N$$

where

I_B = the current for which the circuit is designed, e.g. maximum demand

I_N = the nominal current of the protective device

NOTE: For adjustable devices, the nominal current (I_N) is the current setting selected.

I_Z = the continuous current-carrying capacity of the conductor (see the AS/NZS 3008.1 series)

I_2 = the current ensuring effective operation of the protective device and may be taken as equal to either the—

- (a) operating current in conventional time for circuit-breakers ($1.45 I_N$); or
- (b) fusing current in conventional time for fuses ($1.6 I_N$ for fuses in accordance with the IEC 60269 series).

NOTE: The conditions of the equations are shown graphically in Figure B3.

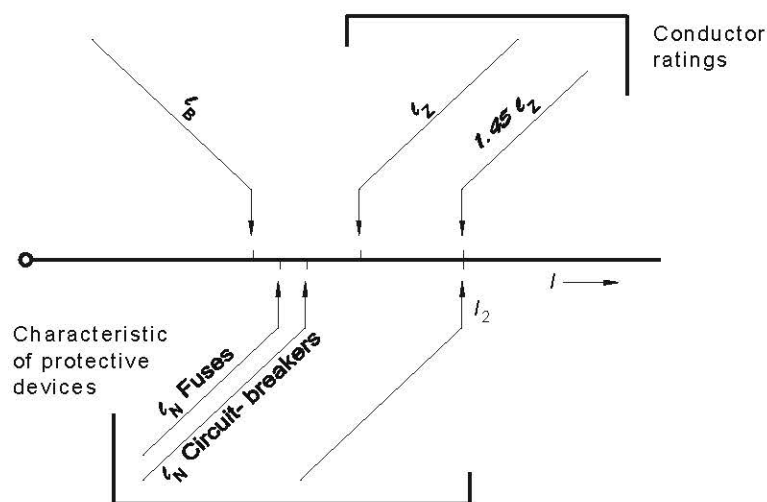


FIGURE B3 COORDINATION OF THE CHARACTERISTICS OF CONDUCTORS AND PROTECTIVE DEVICES

B3.2.2 Application

B3.2.2.1 General

As shown in Equations 2.1 and 2.2, a protective device functions correctly if—

- (a) its nominal current I_N is greater than the maximum load current I_B but less than the maximum allowable current I_Z for the circuit; and
- (b) its tripping current I_2 setting is less than $1.45I_Z$.

B3.2.2.2 Protection by circuit-breakers

Standards, such as the AS/NZS 60898 series, require the tripping current for circuit-breakers (I_2 in Equation 2.2) to be less than $1.45I_N$, therefore, the condition of Equation 2.2 will always be satisfied. For circuit-breakers, $1.45I_N$ is known as the conventional tripping current.

B3.2.2.3 Protection by fuses

Fuses complying with the IEC 60269 series have a conventional tripping current of $1.6I_N$, therefore, to satisfy the conditions of Equation 2.2, the rating of such fuses should not exceed $0.9I_Z$.

NOTE: The factor 0.9 is derived from $1.45/1.6$.

B4 PROTECTION BY AUTOMATIC DISCONNECTION OF SUPPLY

B4.1 Application

This Paragraph (Paragraph B4) provides guidance on the application of—

- (a) the disconnection times required for protection by automatic disconnection of supply;
- (b) the earthing system impedance (earth fault-loop impedance) requirements of Clause 5.7; and
- (c) the earth fault-loop impedance test outlined in Clause 8.3.9.3.

B4.2 Principle

The principle of protection by automatic disconnection of supply is intended to prevent a person being subjected to a dangerous touch voltage for a time sufficient to cause organ damage, in the event of an insulation fault.

In order to meet this requirement, in the event of such a fault, the circuit protective device has to interrupt the resulting fault current sufficiently quickly to prevent the touch voltage persisting long enough to be dangerous.

It follows that this method of protection relies on the combination of two conditions:

- (a) The provision of a conducting path, designated the 'earth fault-loop', to provide for circulation of the fault current.

- (b) The interruption of the fault current within a maximum time by an appropriate protective device. This maximum time depends on parameters such as the highest touch voltage, the probability of a fault, and the probability of a person touching equipment during a fault.

NOTE: Acceptable limits of touch voltage and duration are based on a knowledge of the effects of electric current on the human body described in the AS/NZS 60479 series.

Condition (a) requires the installation of protective earthing conductors connecting all exposed conductive parts of the electrical equipment supplied by the installation to an earthing system, thus forming the earth fault-loop as shown in Figure B5. The protective earthing conductors need to be of appropriate size and installed in a sound and reliable manner, in accordance with Section 5 of this Standard.

Condition (b) requires the installation of protective devices with appropriate characteristics as specified in Section 2 of this Standard.

B4.3 Disconnection times

The AS/NZS 60479 series defines two components that permit the establishment of a relationship between the prospective touch voltage and its duration that does not usually result in harmful physiological effects on any person subjected to that touch voltage.

These two components are—

- (a) the effect on the human body of electrical currents of various magnitudes and durations flowing through the body; and
- (b) the electrical impedance of the human body as a function of touch voltage.

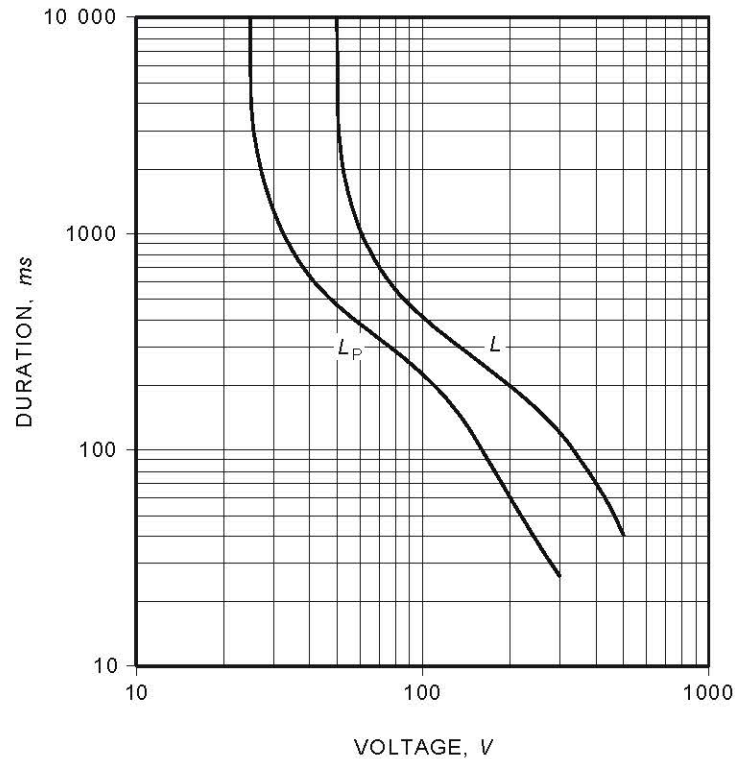
The required relationship between prospective touch voltage and disconnection time is derived for the normal situation as shown in Curve *L* of Figure B4.

Figure B4 shows the maximum duration that a person may be in contact with an exposed live part of a circuit for a range of touch voltages under normal conditions (Curve *L*).

Normal situations were identified as having the following general characteristics:

- (i) Dry locations; and
- (ii) Floor presenting significant resistance.

Particular situations, including damp or wet locations and those involving exposure to wet or bare skin, require touch voltages to be further limited as shown by curve *L_p*. Damp situations are covered in Section 6 of this Standard.



L	for normal conditions	touch voltage limit 50 V
L_p	for wet conditions	touch voltage limit 25 V

[Source: IEC TR 61200-413:1996 © 1996 (IEC), Geneva, Switzerland, www.iec.ch.]

FIGURE B4 MAXIMUM DURATION OF PROSPECTIVE 50 Hz TOUCH VOLTAGE

These curves demonstrate that for normal conditions—

- (A) a touch voltage of 50 V can be sustained by a person indefinitely; and
- (B) a touch voltage of 100 V cannot be sustained and has to be disconnected.

The required disconnection time depends on environmental conditions and whether a person is likely to be in contact with exposed conductive parts at the time of the fault.

The protective device is selected so that the fault current, $I_A = U_o/Z_s$, ensures its operation in a time t not greater than the required time.

This requires the calculation of the earth fault-loop impedance, Z_s , which is possible only if all the elements of the loop, including the source, are known.

Z_s may be calculated if the live and protective earthing conductors are in close proximity to one another and are not separated by ferromagnetic material. Alternatively, it may be determined by measurement.

Reactance may generally be ignored for conductors of 35 mm² or less where the active and earthing conductors are in close proximity to one another. Thus, for such circuits, the current I_A may be calculated using only conductor resistance by—

$$I_A = U_O / (R_{PE} + R_L) \quad \dots B1$$

where

U_O = the nominal a.c. r.m.s. voltage to earth

R_{PE} = the resistance of the protective earthing conductor from the reference point to the exposed conductive part

R_L = the resistance of the phase (active) conductor from the reference point to the exposed conductive part

A study was made of the influence of the variations in the different parameters on the value of the prospective touch voltage and the corresponding disconnection time.

These parameters are as follows:

- (1) The factor c that represents the proportion of the supply voltage available at the reference point during operation of the protective device. Depending on the circuit considered, this may vary between 0.6, e.g. a circuit very far from the source, and 1.0, e.g. a circuit supplied directly from the source.
- (2) The value m is the ratio of the cross-sectional area of the phase conductor compared to the cross-sectional area of the protective earthing conductor in the circuit considered.

The supply voltage U_O may vary within the limits specified in AS 60038 in Australia, or IEC 60038 in New Zealand.

Using a mean value of 0.8 for the factor c and a ratio m of 1, values that exist in most final subcircuits, the prospective touch voltage U_T for a circuit is given by—

$$U_T = c U_O m / (1 + m) = 0.8 \times 230 \times 1/2 = 92 \text{ V} \quad \dots B2$$

thus

$$U_T = 92 \text{ V}$$

This touch voltage approximates to a time of 0.4 s, according to curve L of Figure B4.

Therefore, for hand-held equipment, the maximum disconnection time for a 230 V nominal a.c. r.m.s. voltage to earth should not exceed 0.4 s.

Disconnection times up to but not exceeding 5 s are permitted for circuits not directly supplying portable or hand-held equipment for the following reasons:

(aa) Faults in such circuits are less likely.

- (bb) There is less likelihood of persons being in contact with equipment supplied by such circuits during a fault.
- (cc) Equipment supplied by these circuits is not usually gripped and can therefore be released easily if a fault occurs.
- (dd) Touch voltages are not expected to exceed the values set out in Figure B4 for the time/touch-voltage relationship.

The time limit of 5 s does not imply intentional delayed operation of protective devices or touch voltages that are unsafe.

Where the conditions for protection by automatic disconnection of supply cannot be fulfilled by overcurrent protective devices, such protection may be provided by RCDs having a suitable tripping time. This may occur with circuits supplying socket-outlets, the length of which is unknown, or circuits of great length and small cross-sectional area thus having high impedance.

NOTE: Maximum disconnection times will vary for other operating voltages or installation conditions. In particular, lower values of disconnecting time and touch voltage may be required for damp situations or special installations, in accordance with the requirements of Sections 6 and 7 of this Standard.

B4.4 The earth fault-loop

The earth fault-loop in an MEN system comprises the following parts, starting and ending at the point of fault (see Figure B5):

- (a) The protective earthing conductor (PE) including the main earthing terminal/connection or bar and MEN connection.
- (b) The neutral-return path, consisting of the neutral conductor (N) between the main neutral terminal or bar and the neutral point at the transformer (the earth return path R_G to R_B has a relatively high resistance and may be ignored for an individual installation in an MEN system).
- (c) The path through the neutral point of the transformer and the transformer winding.
- (d) The active conductor as far as the point of the fault.

The earth fault-loop is normally regarded as consisting of the following two parts:

- (i) Conductors upstream or 'external' to the reference point.
- (ii) Conductors downstream or 'internal' to the circuit from the reference point.

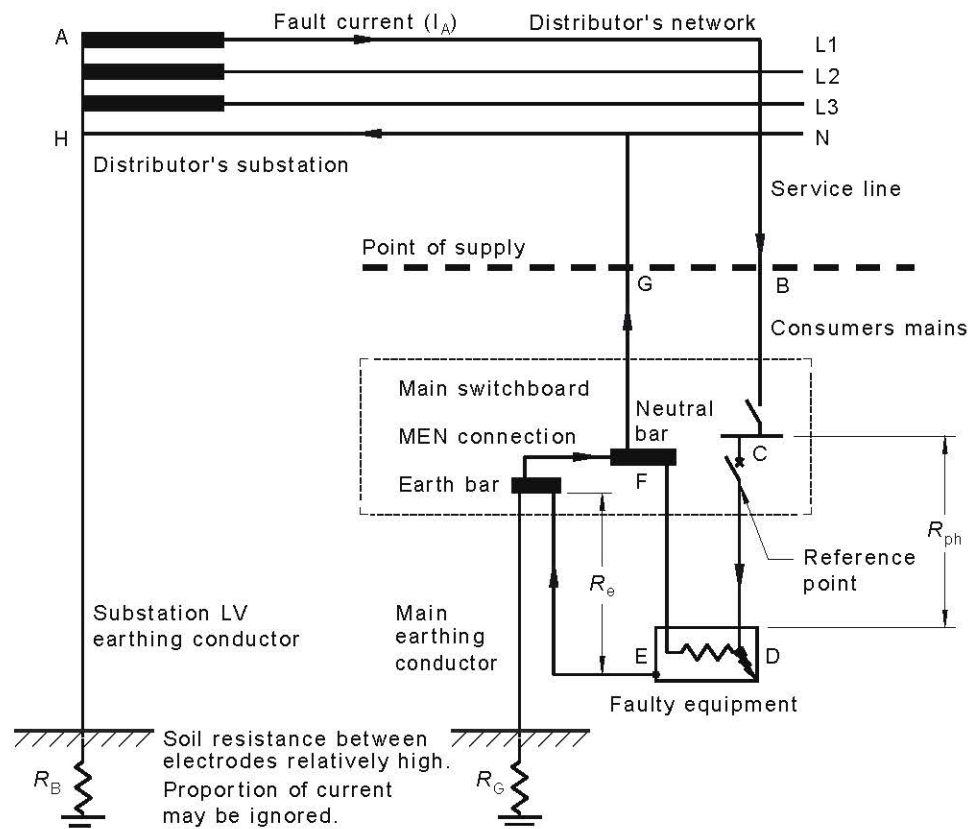
Figure B5 shows an active-to-earth fault which, for the purposes of calculations, is deemed to be of negligible impedance.

At the instant of the fault, current will flow through the earth fault-loop and its magnitude is only limited by the total system impedance Z_s that is obtained from all the individual impedances in the earth fault-loop as follows:

$$Z_s = Z_{AB} + Z_{BC} + Z_{CD} + Z_{DE} + Z_{EF} + Z_{FG} + Z_{GH} + Z_{HA} \quad \dots B3$$

In Figure B5, impedances Z_{AB} , Z_{BC} , Z_{FG} , Z_{GH} and Z_{HA} are all upstream of the protective device within the electrical installation under consideration and are regarded as being external to the reference point, hence, they may be collectively referred to as Z_{ext} . The remainder that are downstream (or 'internal') may be referred to as Z_{int} , therefore, $Z_s = Z_{ext} + Z_{int}$.

This ratio is used to determine a suitable circuit length (see Paragraph B5).



NOTE: Although supply from a distribution system is shown, the same principle applies where the substation forms part of the electrical installation.

FIGURE B5 MEN SYSTEM (SIMPLIFIED)—SHOWING FAULT CURRENT (I_A) PATH (EARTH FAULT-LOOP)

B4.5 Calculation of earth fault-loop impedance

Table 8.1 contains calculated examples of the maximum values of earth fault-loop impedance, Z_s , using approximate mean tripping currents, which may be taken as I_a for a limited range of MCBs (taken from the AS/NZS 60898 series and manufacturers' time/current characteristic curves) and fuses (taken from IEC 60269.1) and the appropriate disconnection time.

NOTES:

- 1 The appropriate tolerances permitted by the product Standard should be taken into consideration. Therefore, as part of the simplification process, approximate mean tripping currents have been used.
- 2 See Figure B6 for typical time/current curves for a circuit-breaker and a fuse.

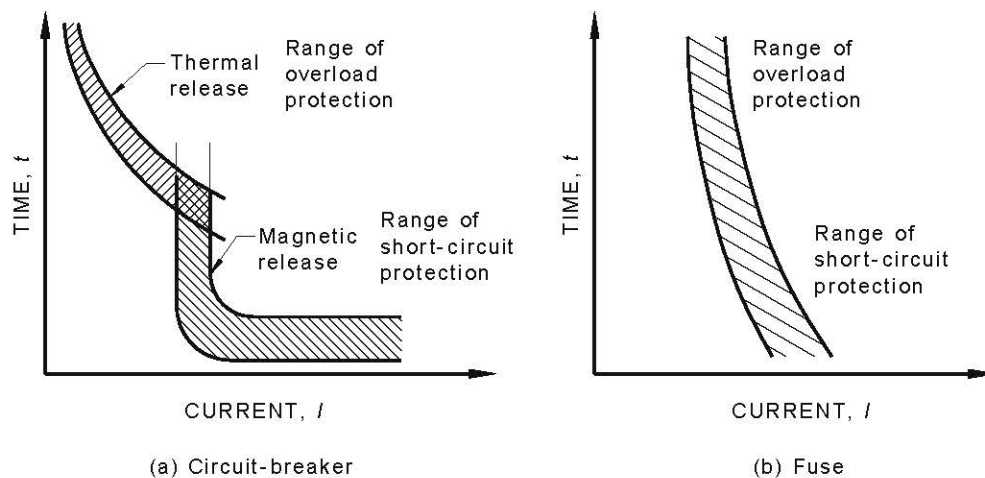


FIGURE B6 TYPICAL TIME/CURRENT CURVES FOR CIRCUIT-BREAKERS AND FUSES

The values of Z_s in Table 8.1 were calculated using the following equation:

$$Z_s = U_o / I_a \quad \dots \text{B4}$$

where

Z_s = earth fault-loop impedance

U_o = nominal phase voltage (230 V)

I_a = current causing automatic operation of the protective device, as follows:

I_a for circuit-breakers is the mean tripping current as follows:

Type B = $4 \times$ rated current

Type C = $7.5 \times$ rated current

Type D = $12.5 \times$ rated current

I_a for fuses consists of approximate mean values from IEC 60269.1

B4.6 Earth fault-loop impedance measurement

Clause 8.3.9 requires an earth fault-loop impedance measurement test. The measured impedance should not exceed the value given for Z_s in Table 8.1 for the appropriate protective device and disconnection time.

The earth fault-loop impedance should be measured using an instrument that has a facility for measuring and indicating low values of impedance.

The MEN connection needs to be left intact.

Measurements can be made as follows:

- (a) For a submain, where the instrument is connected between the relevant active conductor and the main earthing terminal/connection or bar at a switchboard.
- (b) For a final subcircuit, where the instrument is connected between the furthest point on the active conductor and the corresponding point on the associated protective earthing conductor, e.g. at a socket-outlet.

The suitability of the particular overcurrent protective device depends on the value of the earth fault-loop impedance (Z_s).

NOTE: Where the circuit protective device is an RCD, the measurement of earth fault-loop impedance is not necessary; however, it is recommended that such measurement be carried out so as to identify any abnormal circuit conditions that may be present.

B5 MAXIMUM CIRCUIT LENGTHS

B5.1 General

The information in Paragraph B5.2 may be used as a guide to provide a reasonably accurate assessment of maximum circuit lengths, in metres, that will ensure the correct operation of the protective device within the appropriate disconnection time to provide fault protection, in accordance with Clause 5.7.

B5.2 Calculation of maximum length of circuit

B5.2.1 Determination of Z_{int}

As stated in Paragraph B4.4, $Z_s = Z_{ext} + Z_{int}$.

When an electrical installation is being designed, Z_{ext} may or may not be available (it will depend on the electricity distributor's transformer and supply cables). If it is not available, Z_{int} may be determined by either of the following methods:

- (a) When the length and cross-sectional area of conductors are known—

$$Z_{int} = Z_{CD} + Z_{EF} \quad \dots B5$$

where

Z_{CD} = impedance of the active conductors (C to D in Figure B5)

Z_{EF} = impedance of the protective earthing conductors (E to F in Figure B5)

NOTES:

- 1 Consumer mains (Z_{BC} and Z_{FG}) form part of Z_{ext} .
 - 2 Impedances for conductors are given in the AS/NZS 3008.1 series.
- (b) When the length and cross-sectional area of the supply conductors are not known, it may be assumed that there will always be 80% or more of the nominal phase voltage available at the position of the circuit protective device. Therefore, Z_{int} should be not greater than $0.8 Z_s$. This may be expressed as follows:

$$Z_{int} = 0.8 U_o / I_a \quad \dots B6$$

B5.2.2 Calculation method

This method is only reliable where the conductors that make up the earth-fault-current loop are in close proximity to each other and are not separated by ferromagnetic materials.

Equation B6 may be expressed in terms of circuit length by considering conductor sizes (active and earth) and protective device tripping current (see Note 1). This gives rise to the following equation:

$$L_{max} = \frac{0.8 U_o S_{ph} S_{pe}}{I_a \rho \left(\frac{S_{ph}}{S_{ph}} + \frac{S_{pe}}{S_{pe}} \right)} \quad \dots B7$$

where

L_{max} = maximum route length, in metres (see Table B1)

U_o = nominal phase volts (230 V)

ρ = resistivity at normal working temperature, in $\Omega \cdot \text{mm}^2/\text{m}$
 = 22.5×10^{-3} for copper
 = 36×10^{-3} for aluminium

I_a = trip current setting for the instantaneous operation of a circuit-breaker
 or

= the current that assures operation of the protective fuse concerned, in the specified time

S_{ph} = cross-sectional area of the active conductor of the circuit concerned, in mm^2

S_{pe} = cross-sectional area of the protective earthing conductor concerned, in mm^2

NOTES:

- 1 Mean tripping currents, as outlined in Note 1 to Paragraph B4.5, are used for I_A .
- 2 This calculation method is considered valid for cable sizes up to 120 mm². For larger sizes, Z_s should be calculated by other methods taking account of cable inductance.

* **B5.2.3** *Guidance table*

Table B1 contains typical maximum route lengths above which the impedance of the conductors could limit the magnitude of the short-circuit current to a level below that required to operate the protective device protecting the circuit in sufficient time to ensure safety against indirect contact.

The lengths were calculated using Equation B7 and the active and protective earthing conductor sizes outlined in the table.

B5.2.4 *Worked example*

The following example calculation demonstrates the use of Table B1:

$$L = [10 \times V_o \times V_d \text{ (as a percentage)}] / (I \times V_c)$$

The route length (m) for—

4% V_d

$$I_N = 20 \text{ A}$$

$$I = 20 \times 0.8$$

2.5 mm² active and neutral.

$$V_c \text{ single phase} = 1.155 \times V_c \text{ three phase at } 60^\circ\text{C}$$

$$L = (10 \times 230 \times 4) / (20 \times 0.8 \times 14.9 \times 1.155) = 33 \text{ m.}$$

This result can be compared to the EFL loop length of 68 m.

TABLE B1

CIRCUIT ROUTE LENGTHS BASED ON EARTH FAULT LOOP IMPEDANCE ASSUMING $Z_{int} = 80\% Z_s$
AND VOLTAGE DROP ON FINAL SUBCIRCUITS WITH A MAXIMUM DEMAND/DIVERSITY CURRENT OF $0.8 I_N$

1	2	3	4	5	6	7	8	9	10	11	12
Final subcircuit route lengths based on earth fault loop impedance and voltage drop											
Copper conductor area, (mm ²)		Circuit-breaker or fuse rated current I _N , (A)	Earth fault loop route length for Z _{int} , I _N , MCB C curve, (m) ^(1,2)	Final subcircuit route length to comply with voltage drop for a maximum demand current 0.8 × I _N ^(3,4)							Fuses to IEC 60269 (BS88 type for industrial use)
Active and neutral	Earth			V _c Table 41 AS/NZS 3008 at 60°C mV/A.m 3 phase ⁽³⁾	Route length single phase (m)			Route length three phase (m)			Earth fault loop route length for Z _{int} , I _N based on mean operating current for ≤0.4 s
					2.5% voltage drop	3% voltage drop	4% voltage drop	2.5% voltage drop	3% voltage drop	4% voltage drop	
1	1	6	91	42.5	24	29	39	28	34	45	204
1	1	10	55	42.5	15	18	23	17	20	27	114
1.5	1.5	10	82	27.3	23	27	36	26	32	42	170
1.5	1.5	16	51	27.3	14	17	23	16	20	26	82
2.5	2.5	16	85	14.9	26	31	42	30	36	48	136
2.5	2.5	20	68	14.9	21	25	33	24	29	39	93
4	2.5	25	67	9.24	27	32	43	31	37	50	90
4	2.5	32	52	9.24	21	25	34	24	29	39	70
6	2.5	32	60	6.18	31	38	50	36	44	58	75
6	2.5	40	48	6.18	25	30	40	29	35	47	60
10	4	50	62	3.68	34	41	54	39	47	63	73
16	6	63	76	2.32	43	51	68	49	59	79	85

(continued)

TABLE B1 (continued)

1	2	3	4	5	6	7	8	9	10	11	12
Final subcircuit route lengths based on earth fault loop impedance and voltage drop											
Copper conductor area, (mm ²)		Circuit-breaker or fuse rated current I_N , (A)	Earth fault loop route length for Z_{int} , I_N , MCB C curve, (m) ^(1,2)	Final subcircuit route length to comply with voltage drop for a maximum demand current $0.8 \times I_N^{(3,4)}$							Fuses to IEC 60269 (BS88 type for industrial use)
Active and neutral	Earth			V_c Table 41 AS/NZS 3008 at 60°C mV/A.m 3 phase ⁽³⁾	Route length single phase (m)			Route length three phase (m)			Earth fault loop route length for Z_{int} , I_N based on mean operating current for ≤ 0.4 s
					2.5% voltage drop	3% voltage drop	4% voltage drop	2.5% voltage drop	3% voltage drop	4% voltage drop	
16	6	80	59	2.32	34	40	54	39	46	62	59
25	6	80	66	1.47	53	63	85	61	73	98	66
25	6	100	53	1.47	42	51	68	49	59	78	47
35	10	100	85	1.07	58	70	93	67	81	107	75
35	10	125	68	1.07	47	56	74	54	64	86	58
50	16	125	106	0.801	62	75	99	72	86	115	90
50	16	160	83	0.801	49	58	78	56	67	90	71
70	25	160	126	0.571	68	82	109	79	94	126	108
70	25	200	100	0.571	54	65	87	63	76	101	84

★ NOTES TO TABLE B1:

- 1 Earth fault route lengths (EFLs) are calculated for Z_{int} and rated I_N and apply to single and three phase active to earth circuits. Refer to Table 8.1 for Z_s and Paragraph B5.2 for Z_{int} at $0.8 \times Z_s$.

- 2 Earth fault loop lengths for circuit-breaker operation are calculated for automatic disconnection of supply in ≤ 0.4 s by operation of the instantaneous trip.

Lengths are calculated for MCBs (AS/NZS 60898 series) and RCBOs (AS/NZS 61009) C curve ($7.5 \times I_N$) and also apply to MCCBs (AS/NZS 60947.2) with instantaneous settings equivalent to C curve.

To convert C curve ($7.5 \times I_N$) lengths to B curve ($4 \times I_N$) lengths multiply by 1.87, or for D curve ($12.5 \times I_N$) lengths, multiply by 0.6.

- 3 Voltage drop (VD) route lengths are calculated at $0.8 \times I_N$ using data from AS/NZS 3008.1.1:2017, Table 41, 60°C V_c values for active and neutral conductor sizes.

For an example of the calculation at $0.8 \times 20\text{A}$, 4% V_d , 33 m see B5.2.4.

If the current is not $0.8 \times I_N$ a re-calculation is required using the new current and V_c for the resulting conductor temperature. Example calculation for $1 \times I_N$ values: $1 \times 20\text{A}$ (75°C , V_c 15.6) $L = 33 \times 14.9/15.6 \times 16/20 = 25$ m. This compares to 33 m for $0.8 \times I_N$.

The ratio $25/33 = 0.76$ can be applied to convert $0.8 \times I_N$ values in the table to $1 \times I_N$ values or use the simplified method in Paragraph C4, Appendix C which is for $1 \times I_N$.

For voltage drop loop length on distributed circuits, refer to Clause 3.6.2, exception 1.

- 4 Voltage drop route lengths are for final subcircuits (e.g. 3%) and the voltage drop from the point of supply to the start of the final subcircuit must be added (e.g. 2%) and not exceed 5% as required by Clause 3.6.2.

The earth fault loop route lengths for final subcircuits will satisfy the requirements of Clauses 1.5.5.3, 5.7 and 8.3.9 for automatic disconnection of supply for the conditions of Paragraph B5.2.2 and may be used for compliance of final subcircuits but must not exceed the voltage drop loop length.

To comply with both earth fault loop and voltage drop route length the shortest route length is required.

For example, the route length for 3% voltage drop, single phase is always less than the earth fault loop length and overrides the EFL values.