MALAYSIAN STANDARD

DMS 1979:2026

Domestic electrical installations of buildings – Code of practice (second revision)

ICS: 29.020; 91.140.50

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Committee representation

The National Standards Committee on Generation, Transmission and Distribution of Energy (NSC 05) under whose authority this Malaysian Standard was developed, comprises representatives from the following organisations:

Association of Consulting Engineers Malaysia
Department of Standards Malaysia (Secretariat)
Energy Commission
Federation of Malaysian Manufacturers
Malaysian Cable Manufacturers Association
Malaysian Communications and Multimedia Commission
Malaysian Electrical Appliances and Distributors Association
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The Electrical and Electronics Association of Malaysia
The Institution of Engineers, Malaysia
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The Technical Committee on Electrical Installation, Protection and Insulation Practices (NSC 05/TC 14) which supervised the development of this Malaysian Standard consists of representatives from the following organisations:

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The Electrical and Electronics Association of Malaysia
The Institution of Engineers, Malaysia

The Working Group on Electrical Installation of Buildings (NSC 05/TC 14/WG 1) which developed this Malaysian Standard consists of representatives from the following organisations:

Association of Consulting Engineers Malaysia
Department of Standards Malaysia (Secretariat)
Energy Commission
Malaysian Cable Manufacturers Association
Public Works Department
The Electrical and Electronics Association of Malaysia
The Institution of Engineers Malaysia

Foreword

This Malaysian Standard was developed by the Working Group on Electrical Installation of Buildings (NSC 05/TC 14/WG 1) under the authority of the National Standards Committee on Generation, Transmission and Distribution of Energy (NSC 05).

This second revision of MS 1979 cancels and replaces MS 1979: 2015, *Electrical Installations of Buildings – Code of practice*.

Major modifications in this revision are as follows:

a) COP 01 Nominal voltages have been updated including Terra-Terra (TT) system and Terre-Neutre-Séparé (TN-S) system.
b) COP 02 is updated to include additional item for external outdoor application, if applicable, also add compliance to regulatory authority requirements.
c) COP 03 is updated to specify compliance requirements, national standards followed by international and other regional national standards.
d) Illustration on Figure 2 is updated.
e) COP 05 is updated to define cable management system.
f) COP 6 is updated where definition of protective conductor, main equipotential bonding conductor and figure for type of protective conductor are added.
g) COP 07 is updated to revise equation based on IEC standards for isolation of earth fault.
h) COP 08 is updated on revision of earthing requirements and omitted measuring method.
i) COP 18 is updated for additional requirements for neutral conductor reduction.
j) Technical update on equation for COP 19.
k) Technical update on equation for COP 20.
l) Technical update on equation type B for COP 21.
m) COP 26 is updated by inclusion of MET diagram.
n) COP 29 is updated to state that only copper cables are allowed.
o) COP 31 is updated to include concealed and buried underground conduits.
p) COP 32 is updated to change bending radius based on BS standard.
q) COP 34 is updated due to technical change where value of space factor for cable ducts was incorrect.
r) COP 35 is updated to define the space for cable management system and inclusion of IBS and precast.
s) COP 36 is updated to include requirements for flexible conduits
t) COP 37 is updated to define wet mechanical services closed to electrical equipment.
u) COP 38 is updated to include additional requirements for water heater for connector and connection box.
v) COP 39 is updated where socket outlet for air conditioner connection is removed.
w) COP 40 High current using equipment rated at 1.5 kW and above is included as new COP
x) COP 41 is updated where requirement for children's room is removed.
y) COP 48 is updated where requirements from private LV supply is removed.
z) COP 55 is updated where additional requirement for RCD installation is added.
aa) COP 61 is updated where recommended periodic testing to be done at least every 6 months is changed to monthly.

bb) COP 64 is updated where risk assessment method to determine requirements and selection of SPD is added.
cc) Technical requirement of SPD is simplified in COP 66.
dd) Technical requirement for connection of SPD to distribution board is added in COP 67.
ee) COP 72 is updated for inclusion of additional use of earthing.
ff) COP 73 is updated for equipotential bonding.
gg) COP 75 is added as new requirement for earthing resistance value.
hh) COP 78 is updated for value of CSA.
ii) COP 80 is updated where exothermic welding is required and testing to be done before structural works.
jj) COP 82 is updated where CSA value is simplified.
kk) COP 86 is updated where earthing for standby system and alternative system shall be connected to each other.
ll) COP 87 is updated to oblige the latest requirements and in accordance with the Electricity Regulations 1994.
mm) Requirements for IR values is deleted.
nn) COP 94 is updated where term Extra Low Voltage services is added.
oo) COP 95 is amended where green-yellow cable changed to green with yellow stripe.
pp) COP 95 is updated where a phrase of cable colour code changes is added.
qq) COP 96 is updated where diagram for earthing arrangement is added.
rr) Technical updates on diagrams Annex A and Annex B.
ss) New COP 97, 98, 99, 100, 101, 102, 103 are added in this document.

Compliance with a Malaysian Standard does not of itself confer immunity from legal obligations.

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Introduction

This Malaysian Standard has been developed based on the source material as contained in MS 1936, Electrical installations of building - Guide to MS IEC 60364.

More than 82% of Malaysian low voltage electricity customers are domestic dwellings and residential houses catering to uninformed consumers. On the other hand, less than 18% of Malaysian electricity customers are commercial, industrial consumers or other non-domestic and non-residential consumers. Therefore, whilst MS IEC 60364 as a set of standards provides guidelines for the whole spectrum of low voltage electrical installations of buildings for both the informed as well as the uninformed consumers, this Malaysian Standard developed under the direction of the regulatory body, however, deals with the low voltage electrical safety of uninformed consumers.

In stating the safety requirements for uninformed consumers, this Malaysian Standard articulates the practices relating to low voltage domestic electrical installations of buildings.

Furthermore, this Malaysian Standard also addresses certain instances where and when other forms of low voltage electrical installations of buildings have impact upon the electrical safety requirements for uninformed persons as long as the low voltage public electricity supply is of the TT earthing system and the installations are not in contradiction to the judgement of the professional electrical engineer.

Each code of practice has its own discreet reference number. The chronological appearance of the listing of code of practices generally follows the flow of the chapters and sections as addressed in MS 1936. Each code of practice is a concise statement of the relevant requirement as prescribed by electrical safety consideration for uninformed consumers' protection; as is the Malaysian industrial norm and per the law.

Domestic electrical installations of buildings – Code of practice

1 Scope

This document provides the requirement for domestic low voltage electrical installations. This document excludes domestic low voltage electrical installations of hostels, Small Office Home Office (SOHO) and Small Office Virtual Office (SOVO).

For other than domestic low voltage electrical installations, the requirements shall refer to MS 1936 and MS IEC 60364.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

MS 1936, *Electrical installations of buildings – Guide to MS IEC 60364*

MS IEC 60038, *IEC standard voltages*

MS IEC 60364, *Electrical installations of buildings (all parts)*

MS IEC 61643, *Low voltage surge protective devices (all parts)*

MS IEC 62305, *Protection against lightning (all parts)*

IEC 62275, *Cable management system – Cable tie for electrical installations*

BS 7671, *Requirements for electrical installations – IET wiring regulations*

Electrical Supply Act 1990 (Act 447)

Electricity Regulations 1994

Suruhanjaya Tenaga Circular 1/2008: Use of Malaysian Standards on Electrical Installations of Buildings as Guidelines in Electrical Installation for Peninsular Malaysia and Sabah

Suruhanjaya Tenaga – Pemberitahuan: Voltan Nominal

Electricity Supply Application Handbook, guidelines or similar issued by relevant licensee or supply authority (Hereinafter refer as Licensee guidelines)

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
supply authority or licensee
statutory authority established by an Act of Parliament of any other law to generate and/or supply electricity. Licensee means a person licensed under section 9, Electricity Supply Act 1990

3.2
competent person
a person who holds a certificate of competency issued by the Commission to perform work in accordance with the restrictions, if any, stated in the certificate

3.3
professional electrical engineer
a professional electrical engineer is a person registered under Section 10(2) of the Registration of Engineer Act 1967

3.4
domestic electrical installation
an installation in a private dwelling which is not used in any hotel or boarding house or for the purpose of carrying out any business, trade, profession or service

3.5
basic protection
protection against electric shock under fault-free conditions

3.6
fault protection
protection against electric shock under single-fault conditions

3.7
lightning protection system (LPS)
a complete system used to protect a structure and its content against the effects of lightning

3.8
surge protective device (SPD)
a device that is intended to protect the electrical apparatus from transient overvoltages and to divert surge currents

4 Requirements

The requirements as prescribed in this Malaysian Standard are the minimum requirements conform to those as stipulated in the Electricity Supply Act 1990 (Act 447), the Electricity Regulations 1994, and those parts and sections suitable for Malaysian practices as specified in MS IEC 60364 and MS 1936, and Licensee guidelines.

5 Code of Practice (COP)

5.1 General characteristics of low voltage electricity supply

Almost all Malaysia's low voltage electrical installations for domestic installations receive their low voltage electricity from supply authority or licensee.

5.1.1 COP 01, characteristics of low voltage electricity supply

The low voltage electricity supply has the following characteristics:

a) with reference to MS IEC 60038 Voltage:

   230 V AC for single phase 2-wire system.

   400 V AC for three phase 4-wire system.

   Voltage variation is +10% and -6%

   Frequency: 50 Hz ± 1%.

b) wiring system: The TT system shall be applicable for domestic low voltage electrical installations as per Figure 1. For TN-S system, the electrical installations requirements shall be referred to MS 1936.

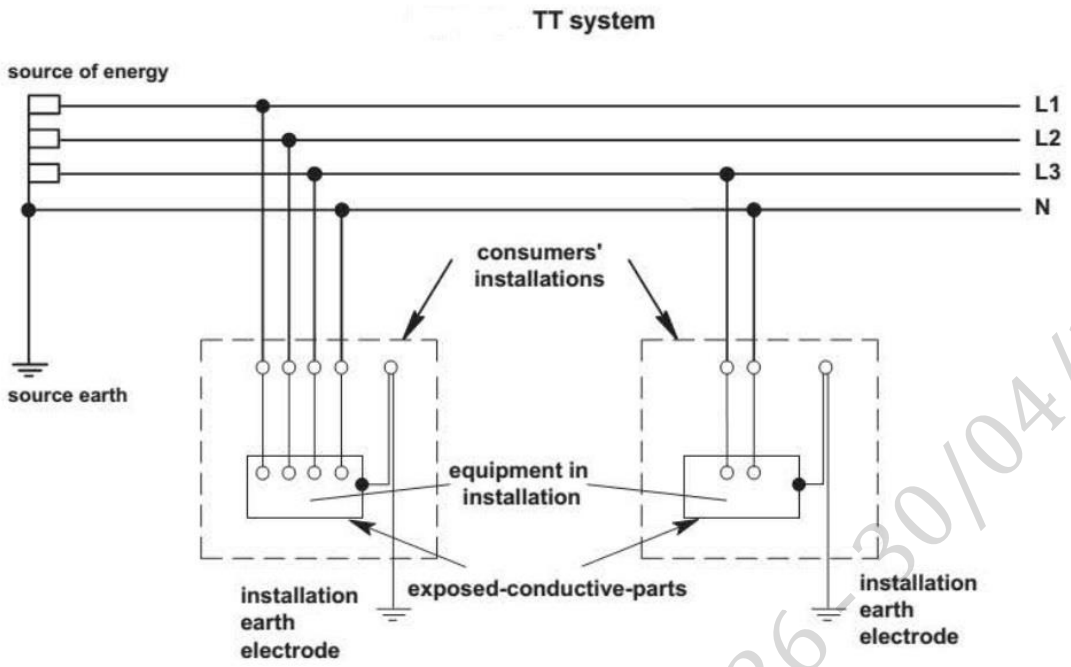


Figure 1 – TT system

5.1.2 COP 02, suitability for use

All material, products e.g. conduits, cables, electrical and electronic or similar electricity using equipment (hereinafter referred as electrical equipment) selected shall be suitable for use under the conditions as stated in 5.1.1 and external outdoor application if applicable.

All electrical equipment selected shall comply with relevant national and/or international electrical standards. If relevant standards do not exist, manufacturer's technical specifications may be adopted after carrying out a technical specification analysis which certifies the electrical equipment selected is suitable for use. All electrical equipment (regulated and non-regulated) shall comply to regulatory authority requirements.

5.1.2.1 COP 03, compliance with regulatory requirements and electrical standards

Regulatory authority requirements and/or electrical standards shall take precedent over international requirements. If national standards are not available, relevant IEC, ISO and ISO/IEC, followed by regional and other national standards shall be the preferred standards in this order.

5.1.3 COP 04, application for supply of electricity

Pursuant to the requirements under Section 24 of the Electricity Supply Act 1990 (Act 447), the Electricity Regulations 1994, and Licensee guidelines, a person requiring a supply of low voltage electricity shall make an application to the respective supply authority or licensee, stating the location of the premise where electricity supply is required, the minimum period for which the supply is required to be given, the maximum demand required and the date of commencement of supply. The licensee shall confirm in writing that the application is acceptable, the applicable tariff, payment for expenses incurred under section 27 (1) of the Electricity Supply Act 1990 (Act 447), and the Electricity Regulations 1994, if any, and amount of security required, and any documentation required by the licensee and approved by the regulatory body before any electrical installation work commences.

5.2 Protection against electric shock

Protection against electric shock, including basic protection (protection against direct contact) and fault protection (protection against indirect contact) shall be provided. In practice, direct contact occurs when a person is in contact with live parts, live conductor with exposed conductive parts that have become live under fault conditions.

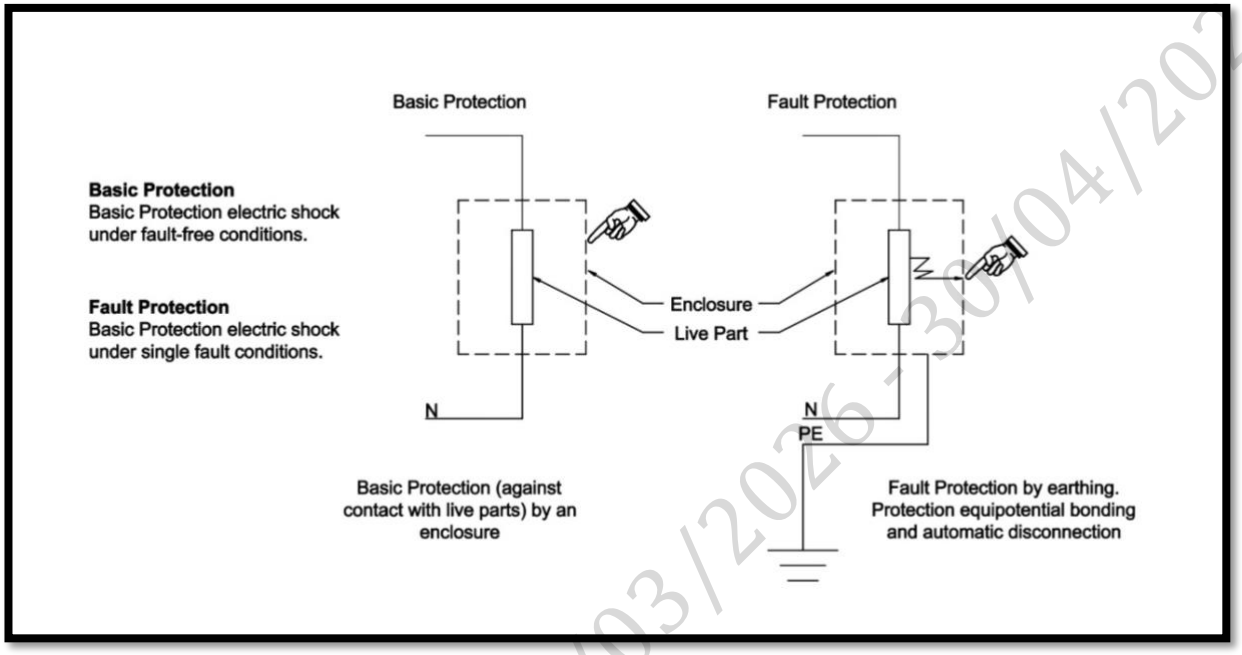


Figure 2 – Illustration on basic and fault protection

5.2.1 COP 05, basic protection

To provide basic protection for all live, protective earthing and equipotential bonding conductors in the wiring system shall be insulated with a suitable dielectric medium (electrically insulating material) such as polyvinyl chloride (PVC) or cross- linked polyethylene (XLPE), and installed in cable management system which includes but not limited to Galvanised Steel (GS) or Unplasticised Polyvinyl Chloride (UPVC) Conduits, Cable Trunking or Cable Tray. Supplementary measures to protect against direct contact using barriers or enclosures and placing live conductors out of reach are encouraged.

5.2.2 COP 06, fault protection

All exposed conductive parts such as metallic enclosures, removable panels and doors of electrical or electronic equipment, switchgears, appliances, apparatus, electrical and electronic circuit or similar, shall be earthed by connecting to a protective conductor. Each electrical and electronic equipment, switchgears, appliances, apparatus, electrical and electronic circuit or similar shall have its dedicated protective conductor. For example of earthing arrangements and protective conductors, refer Annex C (IEC 60364-5-54 Annex B).

5.2.3 COP 07, isolation on earth fault

In case of an earth fault between a live conductor and the conductive part of equipment and/or extraneous conductive parts, the earth fault shall be isolated by a circuit overcurrent protective device, such as circuit breaker or fuses with an additional earth fault protection provided by Residual Current Device (RCD).

RCD shall not be used as a standalone earth fault protective device. An appropriate overcurrent protective device shall be installed in a series and downstream (RCD nearer to load) of the RCD in RCD protected circuit.

Protection against earth fault leakage current by an overcurrent protective device shall fulfil the following condition:

$$Z_s \, x \, I_n \leq 230 \; V \; a.c. \qquad (1)$$

where

I_n is the rated operating current of the overcurrent protective device with circuit disconnection timer as per Table 1, expressed in Ampere (A).

Z_s is the earth fault loop impedance, expressed in Ohm (Ω).

Protection against earth fault leakage current by an RCD shall fulfil the following condition

$$R_A \, x \, I_{\triangle n} \leq 50 \; V \qquad (2)$$

where

R_A is the sum of the resistance in Ω of the earth electrode and the protective conductor for the exposed conductive parts, expressed in Ohm (Ω).

$I_{\triangle n}$ is the rated residual operating current of the RCD with the circuit disconnection time as per Table 1, expressed in Ampere (A).

Note 1 to entry: Fault protection is provided in this case also if the fault impedance is not eligible.

Note 2 to entry: Where discrimination between RCDs is necessary, see 535.5 of IEC 60364-5-53.

Note 3 to entry: Where R_A is not known, it may be replaced by Z_s.

Note 4 to entry: The disconnection times in accordance with Table 1.

Table 1 – Maximum disconnection time (seconds) of LV electrical system with phase to earth voltage (U_0): 120 V AC < 230 V AC

Earthing system	(a) Final circuit with a rated current not exceeding 63A with one or more socket-outlets	(b) Final circuit with rated current not exceeding 32A supplying only fixated connected current-using equipment	Distribution circuit or circuits not covered by (a) and (b)
TT	≤ 0.2 s	≤ 0.2 s	≤ 1 s

NOTE Refer IEC 60364-4 clause 41 section 411 Requirement of installation earthing system

5.2.4 COP 08, installation requirement of earthing system

The primary objective of the installation earthing system is to ensure effective operation of the earth fault circuit protective device. For effective and reliable operation of earth fault circuit protective devices, the resistance of the installation earth, RE shall be maintained reliably as low as possible, less than 200 ohms.

5.3 Protection against thermal effects

There are four (4) major factors to be considered for protection against thermal effects, as follows:

a) protection against fire;

b) protection against burns;

c) protection against overheating; and

d) protection against harmful effects, such as smoke and deleterious effects on adjacent equipment.

Protection against thermal effects shall be achieved by the construction of the equipment, by protection methods described in this subclause, or by additional measures such as temperature cut-off device.

5.3.1 COP 09, protection against fire

To protect against fire, as a minimum, electrical equipment that could cause a fire shall:

a) be installed so as to allow safe and reliable dissipation of heat generated by the equipment and/or prevent any deleterious effects on adjacent equipment and material;

b) be installed with sufficient safety distance from people and livestock, adjacent equipment and/or combustible materials; and

c) mount and protected by suitable thermal barrier and/or enclosed within non- combustible material of low thermal conductance that can withstand the temperatures produced by the equipment.

5.3.2 COP 10,protection against burns

Any accessible part of electrical equipment within arm's reach (refer 5.3.3) shall not attain a a temperature in excess of the appropriate limit stated in Table 2, except for electrical equipment for standards which specify a limiting temperature. Every such part likely to attain under normal load conditions, even for a short period, a temperature exceeding the appropriated limit in Table 2, shall be guarded so as to prevent accidental contact.

Table 2 – Temperature limit under normal load conditions for an accessible part within arm's reach

Accessible part	Material of accessible surfaces	Maximum temperature (°C)
A hand-held part	Metallic	55
	Non-metallic	65
A part intended to be touched but mot hand-held	Metallic	70
	Non-metallic	80
A part which need not be touched for normal operation	Metallic	80
	Non-metallic	90

NOTE Refer to IEC 60364-4, chapter 42, section 423.

5.3.3 COP 11, protection by placing out of reach

Electrical equipment intended to be operated in such a way that they are within arm's reach shall not attain temperatures likely to cause burns to persons (refer 5.3.2). If this condition is not assured, the electrical equipment shall be put behind a guard and placed out of reach from accidental contact by people and/or livestock by an out-of-reach distance of at least 2.5 m. The requirements exclude the appliances approved under the regulatory authority for electrical equipment.

5.3.4 COP 12, protection against overheating

Forced air heating system, electric oven, appliances producing hot water or steam and similar shall be equipped with thermal safety devices to protect against overheating.

5.3.5 COP 13, requirements of thermal cut-off devices

Any thermal cut-off device shall have manual reset. Thermal cut-off device should have visual status indicator.

5.4 Overcurrent protection

Overcurrent in a conductor causes a temperature rise which may result in a fire.

5.4.1 COP 14, overcurrent protection of phase conductors

Overcurrent protection shall be provided for all phase conductors.

5.4.2 COP 15, overcurrent protection of neutral conductors

Overcurrent protection need not be provided for any neutral conductor in TT system. If the neutral conductor has to be disconnected, all line conductors need to be disconnected simultaneously with neutral conductor or prior to the disconnection of neutral conductor.

5.4.3 COP 16, overcurrent protection of protective earthing and equipotential bonding conductors

Overcurrent protection is not permitted and shall not be provided for any protective earthing and equipotential bonding conductor.

5.4.4 COP 17, cross section area of neutral conductor

The neutral conductor shall have the same cross-sectional area as the phase conductors.

5.4.4.1 COP 18, neutral conductor reduction at the discretion of professional electrical engineer

Not withstanding COP 18, cross section area of neutral conductor. the professional electrical engineer may reduce the size of the neutral conductors between the transformers of the supply authority or licensee and the main switchboard after taking into account the requirements of the particular electrical installation. This is only allowed for cable 16 mm^2 and above.

5.4.5 COP 19, nominal rated current, I_n of an overload protective device

The nominal rated current, I_n of an overload protective device shall be greater than the design current (maximum demand), I_B of the protected circuit.

$$I_B < I_n \tag{3}$$

where

I_n is the nominal rated current of an overload protective device, expressed in Ampere (A)

I_B is the design current (maximum demand) of the protected circuit, expressed in Ampere (A)

5.4.6 COP 20, thermal or long-delay overload trip current, I_2

The thermal or long-delay overload trip current, I_2 shall be as per Table 3 and greater than the nominal rated current of the overload protective device, I_n.

$$I_2 > I_n \tag{4}$$

where

I_2 is the thermal or long-delay overload trip current, expressed in Ampere (A).

Table 3 – Thermal or long-delay overload trip current (I_2)

Miniature circuit breaker (MCB) to MS IEC 60898	Type B	1.45 x I_n
	Type C	1.45 x I_n
	Type D	1.45 x I_n
Moulded case circuit breaker (MCCB) or air circuit breaker (ACB) to MS IEC 60947	Refer to MCCB / ACB'S characteristics curve	
	Refer to fuse's characteristics curve	

5.4.7 COP 21, current carrying capacity of phase conductor to ensure effective operation of overload protective device.

The continuous current carrying capacity of a phase conductor, I_z shall comply with the following conditions.

$$I_B < I_n < I_2 < I_z \quad (5)$$

where

I_z is the continuous current carrying capacity of a phase conductor, expressed in Ampere (A)

I_2 is the thermal or long-delay overload trip current, expressed in Ampere (A);

EXAMPLE 1

A single final power circuit using single-core 70 °C polyvinyl chloride (PVC) thermoplastic insulated copper cables, non-armoured with sheath, protected by a Type C MCB and installed in suspended cable trunking. Assume no derating effects and ignore voltage drop with the following design and installation requirements.

Design (maximum demand) current, I_B = 13.1 A

Reference method of installation: refer Annex B of IEC 60364-5-52

Step 1: Choose the overload protective device (OPD)

Choose OPD Type C MCB with I_n = 16 A

Step 2 (initial): Choose of conductor cross-sectional-area

(CSA), mm^2 Choose Cu PVC insulated cable with sheath with CSA = 2.5 mm^2

From Annex B of IEC 60364-5-52, I_z = 24 A

For Type C MCB

I_2 = 1.45 x I_n = 1.45 x 16 = 23.2 ≈ I_z = 24 A →No safety margin, use next conductor size.

Step 2A (Iteration): Choose the conductor with next higher cross-sectional-area

Choose the next Cu PVC insulated cable with sheath with CSA = 4 mm^2

For Annex B of IEC 60364-5-52, I_z = 32 A

For type C MCB

I_r = 1.45 x I_n = 1.45 x 16 = 23.2 << I_z = 32 A →4 mm^2 copper cable is the right choice.

5.4.8 COP 22, recommended overcurrent protective device rating

The recommended overcurrent protective device rating corresponding to the size of cable shall refer Table 4.

Table 4 – The recommended overcurrent protective device rating corresponding based on the cable size

Cable size (mm^2)	Recommended overcurrent protective device rating (A)
1.5	6
2.5	16
4	20
6	25
10	30
16	40
25	63
50	100

5.4.8.1 COP 23, prevention of nuisance tripping of an overload protective device due to inrush current or similar temporary overcurrent

The most onerous inrush current or similar temporary overcurrent of a circuit shall be within the tripping or fusing characteristic curves of the overload protective device.

5.4.9 COP 24, determination of short circuit current, kA (kilo Ampere)

In order to design short circuit protection properly, the short circuit current, kA at every coordinated protection area. of the electrical installation shall be determined. The short circuit current can be ascertained by calculation or by measurement of the impedances. The minimum

short circuit current rating at the point of common coupling of the electrical installation with electricity supply authority or licensee can be ascertained by referring to supply authority or licensee guidelines.

5.4.10 COP 25, rating of short circuit protective device, kA

The short circuit protective device shall have a rated service breaking capacity, kA not less than the most onerous prospective short circuit current at the coordinated protection area of electrical installation.

5.5 Protection against voltage disturbances

Voltage disturbances in the low voltage electrical system can be caused by many factors such as the following:

a) earth fault in the LV system.

b) loss of neutral in TT system.

c) short circuit in the LV system.

d) lightning.

e) large load and/or high voltage switching.

5.5.1 COP 26, installation of Main Earthing Terminal (MET)

There shall be one main installation earthing terminal (MET) as in Figure 3 for each electrical installation to which shall be connected the following using electrically insulated protective earthing and/or equipotential bonding conductors of suitable sizes:

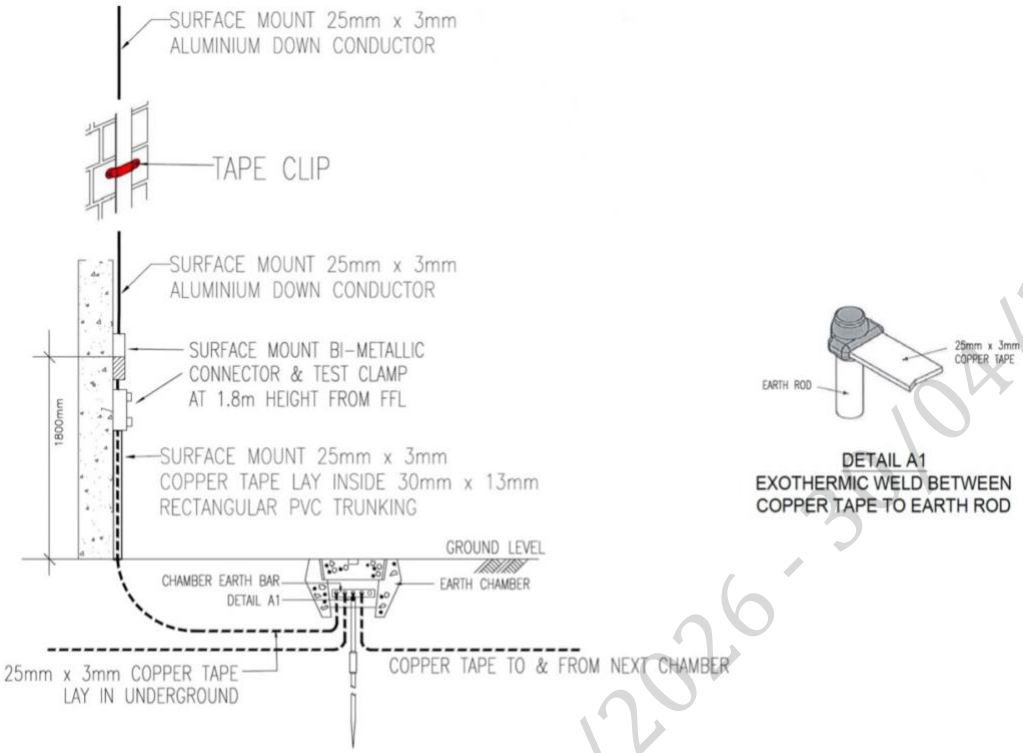


Figure 3 – MET diagram

a) LV earth electrodes (1st earth electrode inspection/test chamber);

b) armouring of cables; and

c) low voltage electrical and electronic equipment, switchboards, appliances, apparatus, etc;

d) other conductive parts such as cable support and management system, conductive water and gas pipelines, equipment control panel, structural steel works; and

e) steel bars of reinforced concrete foundations.

5.6 Wiring systems

5.6.1 COP 27, prevention of eddy current effects

When single core power cables are to be glanded in metallic distribution board ensure that all the phase and neutral conductors are bundled for flux cancellation and installed within the distribution board where the single core cables are glanded shall be made of non-ferrous materials such as hard fibre board, aluminium, brass, etc.

5.6.2 COP 28, separation of High Voltage (HV), Low Voltage (LV), Extra Low Voltage (ELV), signal, control and instrumentation cables

HV, LV, ELV, signal, control and instrumentation cables shall not be installed within the same cable management system which includes but not limited to Galvanised Steel (GS) or Unplasticised Polyvinyl Chloride (UPVC) conduits, cable trunking or cable tray and termination boxes to ensure safety, reliability and protection against hazards such as electromagnetic interference (EMC), induction coupling purposes as in Figure 4.

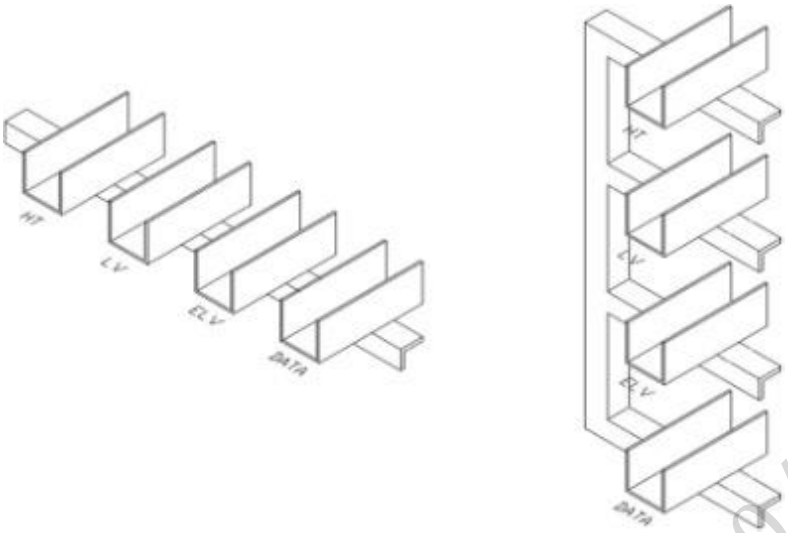


Figure 4 – Example of separation of HV, LV, ELV, control, signal and instrumentation cables

5.6.3 COP 29, installation of LV single-phase and three-phase circuits

LV single-phase and three-phase circuits supplied from the same distribution board may share the same management system.

5.6.4 COP 30, no connection of conductors made of dissimilar metals

No connection of conductors made of dissimilar metals is allowed. Only copper graded cables are allowed for domestic installations from supply authority or licensee meter onwards until electrical final circuit.

5.6.5 COP 31, concealed conduits or buried cable ducts

Conduits, cable duct systems or similar intended to be concealed in structures or buried underground such as plastered brick walls or pipe sleeves under the beam shall be completely erected before any insulated conductor is drawn in. Inspection boxes, intermediate junction boxes shall be installed in appropriate location along the cable management system to ensure reliable installation and inspection of the wiring works.

5.6.6 COP 32, bending radius of cables

The radius of every bend in the cable management and/or wiring system shall be sufficiently large to prevent damage to the cables. The internal bending radii of PVC insulated stranded copper cables should not be less than the values given in the Table 5. In order to satisfy this criterion, elbows, and junction boxes and/or similar shall be included in cable management system at places where the cable run changes direction.

Table 5 – The internal bending radii of PVC insulated stranded copper cables

Overall Diameter of Cable, D	Minimum Internal Bending Radius	
	Non-armoured	Armoured
Not exceeding 10 mm	3D	6D
Exceeding 10 mm but not exceeding 25 mm	4D	6D
Exceeding 25 mm	6D	6D

5.6.7 COP 33, support and clamping or typing of cables

When cables of large cross-sectional areas are installed vertically in cable management system, they may be damaged by their own weight. Moreover, for compliance with installation reference method and to ensure cables are held in place during faults, any cable shall be adequately supported, clamped and/or tied at regular intervals of maximum 1.20 m, by cable clamps, cable ties or similar, conforming to IEC 62275.

5.6.8 COP 34, Space Factor (SF)

Cables installed within conduits, trunking, cable ducts or similar shall have a space factor as per Table 6.

Table 6 – Maximum allowable space factor

Cable management system	Maximum space factor (%)
Conduit	40
Trunking	45
Cable ducts	35
Others	As per professional electrical engineer's instruction

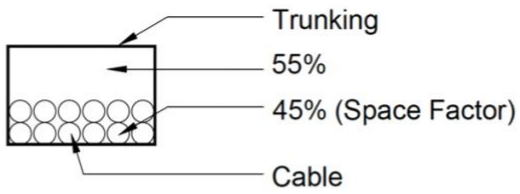
$$\text{SF} = \frac{\text{Sum of external overall CS of all cables sharing the cable management system}}{\text{Internal CSA cable management system}} \quad (2)$$

where

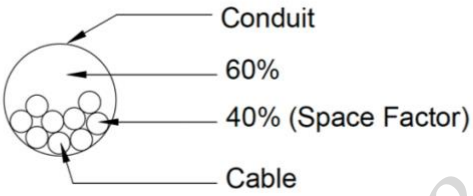
SF is the space factor

CSA is the cross-sectional-area

Refer example of maximum space factor as in Figure 5 below.



Trunking Cross Sectional Area



Conduit Cross Sectional Area

Figure 5 – Example of maximum space factor

5.6.9 COP 35, cable installed or concealed inside walls, within partitions and similar

Cables installed or concealed inside walls, within partitions or similar shall be protected mechanically with suitable cable management system. All cable management system shall be installed or concealed horizontally from the top and 150 mm below the ceiling slab. The cable management system also shall be vertically installed to the finished electrical outlet, with at least 300 mm relative to a horizontal finished floor.

Cables should not be installed or concealed inside floor slabs. If unavoidable such as for installation of protective earthing to electrical earth chamber, in addition to mechanical protection with suitable cable management system, precautions shall be taken to ensure the integrity of structure and water ingress to the cable management system, also shall adopt the following standards:

a) GI conduit – IEC 61386

b) cable trunking – MS IEC 61084

c) Cable tray and cable ladder – MS IEC 61537

Flexible conduits or similar is not permitted as cable management system. Flexible conduit is used for termination to equipment which are subjected to movement or vibration. The length of the flexible conduit shall be as short as possible (< 1.5 m) as in Figure 6. For metal flexible conduit, a separate supplementary bonding conductor shall be provided. This is also applicable for pre-cast structure and Industrialized Building System (BIS) construction.

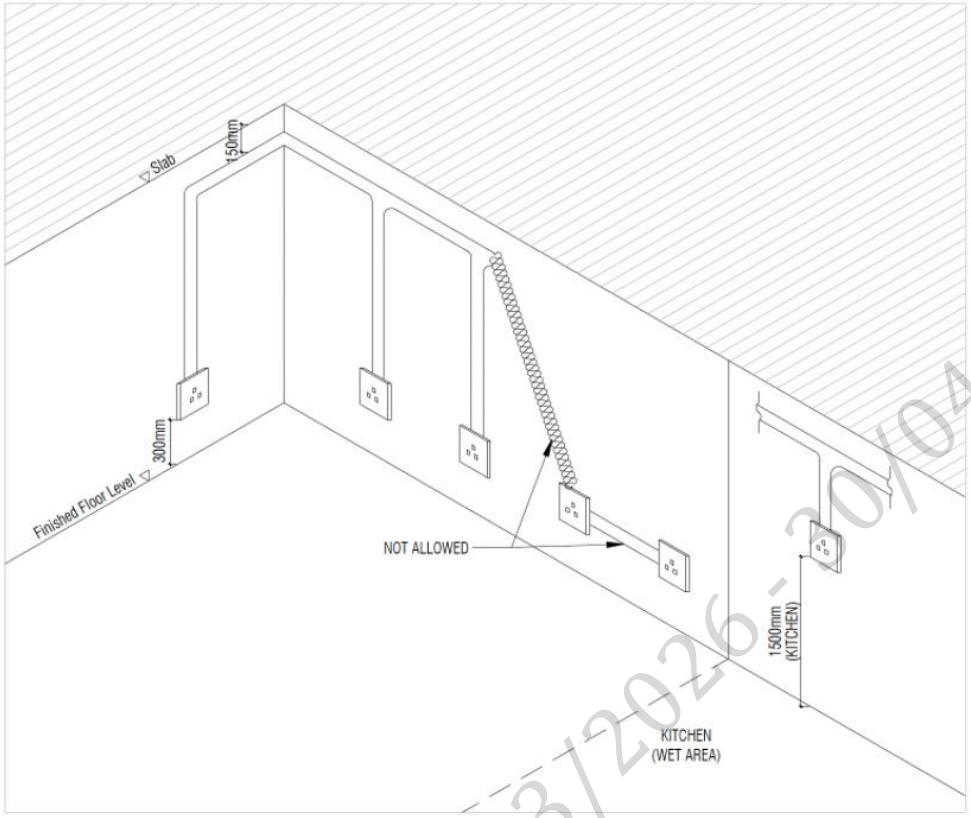


Figure 6 – Position of cable installed or concealed inside walls, within partitions or similar

5.6.10 COP 36, cables not concealed inside walls, within partitions and similar

Cables not concealed inside walls, within partitions or similar, commonly referred as surface wiring, shall be installed in cable management system inside visually rectangular pattern. Flexible conduits are permitted only for final connection from rigid cable management system to apparatus such as light fittings. The recommended maximum length of the flexible conduit is 1.50 m.

5.6.11 COP 37, cables within wet mechanical services

Cable management system shall be installed above wet mechanical services. No electrical equipment such as distribution board shall be installed below wet mechanical services.

5.6.12 COP 38, water heater, booster pump, jacuzzi, water features circulating pumps or similar (hereinafter refers as wet equipment)

Every wet equipment shall be supplied by a power circuit which shall not be shared by any other purpose, only fix and permanent connections are allowed. This power circuit shall have an appropriately sized uninformed-user double pole switch/isolator with illuminated status indicator installed in a prominently visible location in the vicinity of the wet-equipment for switching and isolation and shall be outside the spray zone of water such as zone 2 per IEC 60364-7-701.

For water heater, if there is a connection in between, only approved connector and connection box shall be used. For connection within the shower cubicle and below the ceiling, the connection box shall be IPX5 rated.

For other types of wet equipment, there shall be an appropriately sized maintenance isolator with IP rating of at least IPX5, for maintenance isolation purpose, installed in a location visible and accessible to certified maintenance more than 3 m from electrical coupling terminal on the wet equipment to facilitate the connection/disconnection of the power circuit to the wet equipment and for isolation of the wet equipment during maintenance.

Every dedicated power circuit for wet equipment shall be protected individually by a dedicated residual current device (RCD) with sensitivity of 10 mA or less in series with MCB at the origin of the circuit in the final distribution board in compliance with Regulation 36 of Electrical Regulations 1994 and any local regulatory or statutory requirements.

There shall be no cable joint or similar in this dedicated power circuit. There shall be appropriately sized equipotential bonding cables bonded to the conductive part on the outlet side of wet-equipment and associated extraneous conductive parts.

5.6.13 COP 39, air conditioner, electric oven or similar (hereinafter refer as high-current using equipment circuit) at 1.5 kW and below

Every air conditioner shall be supplied by a dedicated power circuit which shall not be shared by any other purpose. This power circuit shall have an appropriately sized uninformed-user double pole switch with illuminated status indicator installed in a prominently visible location in the vicinity of the wet equipment for switching and isolation. The coupling terminal on the high-current equipment to facilitate the connection/disconnection of the power circuit to the high-current equipment.

5.6.14 COP 40, high current using equipment rated at 1.5 kW and above

Every high-current using equipment circuit shall be supplied by a dedicated power circuit which shall not be shared by any other purpose. This power circuit shall have an appropriately sized uninformed user double pole switch with illuminated status indicator installed in a prominently visible location in the vicinity of the switching and isolation. There shall be an appropriately sized maintenance isolator with appropriate IP rating for maintenance isolation purpose installed in a location visible and accessible and shall not be more than 3 m from the high-current equipment. No cable joint or similar is allowed in this dedicated power circuit.

5.6.15 COP 41, terminations of circuits

Direct termination of low voltage circuits into an apparatus is not permitted. All circuits shall be terminated into an electrical accessory such as switches, socket outlets and switch disconnector.

The termination shall be done with suitable means such as with cable lugs and terminal blocks or strip. All exposed conductive parts shall be properly isolated, such as using cable lug boots for un-sleeved cable lugs to at least ingress protection level of IP2X (or IPXXB). It is not permitted to remove any conductor strand for any purpose such as to ease the termination works.

5.6.16 COP 42, installation requirements of electrical equipment and accessories

The installation requirements of electrical accessories shall take into consideration enhanced safety protection against electric shock for children, elderly and uninformed consumers with medical conditions, and in wet locations. The recommended installation requirements for socket outlet in wet area (toilets, kitchen, bathroom, laundry, indoor pool, etc.) shall be at least 1.5 m from finished floor level.

5.6.17 COP 43, group reduction factor

When groups of low voltage cables are run together or sharing a common cable management system, a group reduction factor shall be applied to take into account the heat generated by the loaded conductors.

5.6.18 COP 44, consideration for loaded conductors in determining group reduction factor

A non-sheathed or sheathed cable which is expected to carry a continuous load current, not greater than 30 % of its grouped current-carrying capacity, may be ignored for the purpose of obtaining the group reduction factor. Hence, for example, the neutral conductor of a balanced three phase circuit need not be considered.

5.6.19 COP 45, cable suitable for the most onerous condition

A cable route may consist of different installation conditions that have different heat dissipation properties. The current carrying capacity of the cable shall be selected based on the most onerous condition encountered along the cable route.

5.6.20 COP 46, minimum size and material of wiring conductors

The minimum cross-sectional-areas of conductors used for wiring purposes shall be 1.5 mm^2 for lighting circuits and 2.5 mm^2 for power circuits. Only copper conductor is permitted for all domestic electrical installations.

5.6.21 COP 47, neutral and protective earthing conductors for every circuit

Every circuit shall have separate neutral and circuit protective earthing conductors which shall be clearly identifiable at the distribution board or similar and arranged in the same order as the phase conductors.

5.6.22 COP 48, allowable voltage drop

The maximum voltage drop between the origin of the consumer's installation (usually the outgoing or consumer terminals at the supply authority or licensee electricity meter) and a final circuit such as socket outlet, the terminals of fixed current using equipment, or similar within 100 m of installation shall not be exceed that stated in Table 7.

Voltage drops during temporary conditions such as motor starting may be exempted from this requirement. For most installations, a voltage drop of 10 % during motor starting may be acceptable.

Table 7 – Voltage drop

Voltage	Lighting	Other uses
Low voltage installation supply directly from supply authority or licensee	3 %	5 %

NOTE 1 Where the wiring systems of the installation are longer than 100 m, the voltage drop above may be increased by 0.005 % per meter of the wiring system beyond 100 m without this increase being greater than 0.5 %.

NOTE 2 The voltage drop is determined from the demand of the current-using equipment, applying diversity factors where applicable, or from the value of the design current (I_B) of the circuit.

5.7 Electrical connections

5.7.1 COP 49, soldered connections

Soldered connections shall not be used to connect conductors or to terminate conductors for low voltage lighting and power circuits. This requirement is not applicable to Extra Low Voltage (ELV), signal, and control and instrumentation cables.

5.7.2 COP 50, cables for final circuits

Cables used in final circuits shall be of continuous length and shall contain no cable joint.

5.7.3 COP 51, sealing of walls, floors, partitions and similar

Where a cable management system wiring which is not concealed in structures and passes through walls, floors, partitions or similar, the openings shall be sealed with non-hygroscopic fire-retardant compound complying to fire regulatory requirement. If the wiring system includes conduits, trunking or similar with internal opening with dimensions more than 70 mm^2, then the internal of the conduit, trunking or similar shall also be sealed with non-hygroscopic fire resisting compound with a minimum of 2 h fire rating. National or local regulatory and/or statutory requirements shall take precedent.

5.8 Switching and control

5.8.1 COP 52, multi-pole switching devices of electricity supply to an installation

For single electricity supply installation, the neutral need not be switched at the supply, which is 1 pole + N/3 poles + N for single/three phase configuration. All poles of any multi-pole switching devices such as circuit breaker or disconnector shall operate together.

Example of single electricity supply installation in Malaysia: Residential houses supplied by relevant licensee or supply authority or licensee. Refer to the Basic Schematic Diagram for single phase and three phase installation incoming distribution board in Annex A and Annex B for single electricity supply installation.

For multi electricity supplies installation, the neutral shall be switched at each electricity supply to prevent back-feed, all poles of any multi-pole switching devices shall operate together. The contact for the neutral shall close before and opens after the phase contacts operate.

Example of multi (i.e. two) electricity supplies installation in Malaysia: Bungalow supplied by supply authority or licensee and have a private standby generator set.

5.8.2 COP 53, operation of Residual Current Device (RCD)

In operation, an RCD shall ensure the disconnection of all line and neutral conductors in the protected circuit.

5.8.3 COP 54, conductors passing through the magnetic circuit of an RCD

Only line and neutral conductors shall pass through the magnetic circuit of an RCD. The direction of the current flow in the conductors passing through the magnetic circuit of an RCD shall be correctly installed. Selected RCD shall be with anti-nuisance tripping feature.

5.8.4 COP 55, current operated RCD

RCD shall be current operated type functionally independent of line voltage type. Earth Leakage Circuit Breaker (ELCB) of the voltage operated type is not permitted and shall not be used. RCD shall be installed in the distribution board together with overcurrent protective device. Residual current operated circuit breaker with integral overcurrent protection Residual Current Circuit Breaker with Overcurrent (RCBO) which is voltage independent is allowed for use.

5.8.5 COP 56, RCD for single phase installations

RCD for single phase installations shall have rated residual operating current not exceeding 100 mA.

5.8.6 COP 57, RCD for three phase installations

RCD for three phase installations shall have rated residual operating current not exceeding 100 mA. Provided there are no three phase loads in the installation, it is recommended to install three (3) single phase RCDs instead of a three phase RCD. This practice will limit the power disruption to only one (1) phase in the installation, in case there is an earth fault in one phase.

5.8.7 COP 58, RCD for power circuits, hand-held and fixed apparatus

RCD with rated residual operating current not exceeding 30 mA shall be installed to protect an individual final power circuit or to protect a group of final power circuits. RCD with rated residual operating current not exceeding 30 mA shall be installed in installations where portable or fixed apparatus such as electric power tools, hairdryer, electric kettle and washing machine, is used.

5.8.8 COP 59, RCD for special locations

RCDs with rated residual operating current not exceeding 10 mA shall be installed in the following instances:

a) where the floor is likely to be wet such as water fountain, bathroom and swimming pool;

b) for the protection of equipment and apparatus supplying to wet areas, such electric water heaters, booster pumps and similar; and

c) where supplying apparatus used by children, elderly, uninformed consumers with medical conditions, or similar.

5.8.9 COP 60, location of RCD in single RCD protected installation

If an installation is protected by a single RCD, it shall be located at the origin of the installation, that is, immediately after the main incoming overcurrent protective device at the distribution board.

5.8.10 COP 61, periodic testing of RCD

RCD is recommended to be tested monthly to ensure its proper operation.

5.8.11 COP 62, selection of short circuit protective device

Selection of a short circuit protective device shall be based on its rated service short circuit breaking capacity instead of its ultimate short circuit breaking capacity.

5.8.12 COP 63, requirement for devices for emergency switching

Devices for emergency switching shall be red in colour and clearly labelled. They shall be of latching type or restrained in the "STOP" or "OFF" position when operated. Moreover, it shall be of manually reset type so that when released, the emergency switching device shall not re-energise the installation until it has been manually reset.

5.9 Surge Protective Device (SPD)

5.9.1 COP 64, installation of SPD

A risk assessment (MS IEC 62305) is required to be carried to determine the requirements and selection of SPD. In the event it is required, an SPD shall be installed in the distribution board immediate after the incoming protective device but before any instrumentation, branch overcurrent protective devices or RCDs.

All wirings, especially external wirings which may be exposed to lightning activities hazards such as for outdoor cameras, card access readers and satellite master antenna television shall be suitably protected with SPD. The SPD shall be provided with an overcurrent protective device isolator for maintenance purposes.

5.9.2 COP 65, standards compliances for SPD

The SPD selection shall comply with the following standards:

a) MS IEC 60364;

b) MS IEC 62305; and

c) MS IEC 61643

5.9.3 COP 66, ratings of SPD

The minimum requirements of SPD shall be as follows:

a) overcurrent protective device shall be installed for protection against risk of fire; and

b) nominal discharge current value shall be referred to the risk assessment results as per 5.9.3.

5.9.4 COP 67, earth connection of SPD

For an SPD to function properly, an effective and reliable connection to the earthing system is mandatory. The minimum cross-sectional-area of the insulated copper conductor connecting the SPD to the earthing terminal shall be ≥ 10 mm^2 or as recommended by the SPD manufacturer, whichever is larger. The earthing conductor shall be as short as possible and shall not exceed 0.5 m. The earthing conductor shall be connected to the Intermediate Earthing Terminal (IET) of the distribution board.

6 Isolation

6.1 COP 68, requirement for circuit isolation

Every circuit shall be provided with a means of isolation from each of the live conductors of the source of supply.

An example of isolation for overcurrent fault and maintenance is miniature circuit breakers (MCB).

An example of isolation for earth fault is residual current device (RCD).

6.2 COP 69, marking of isolation devices

The isolation devices, such as MCBs and switch disconnector shall have markings to indicate that the contacts are in open (OFF or O") or close position (ON or 'I').

6.3 COP 70, prohibition on the use of semiconductor devices for isolation

Semiconductor devices shall not be used as means of isolation. Only mechanically operated electrically isolated isolation devices such as MCBs and switch disconnectors are permitted.

6.4 COP 71, prevention of unintentional re-energising

Means shall be provided to prevent electrically operated equipment, especially rotating or moving machinery, such as electric grass cutter, from being unintentionally re-energised during maintenance by tag-out, padlocking, warning notices or installing isolation means of apparatus within lockable enclosures. Auto-reclosing circuit breaker and residual current device shall be prohibited.

6.5 Earthing

6.5.1 COP 72, uses of earthing system

The earthing system may be used solely for earth protection, lightning and surge protection and equipotential bonding purposes, it may also serve other functional earthing purposes such as the reference earth for electronic systems, including information, and communication technologies (ICT), solar photovoltaic system and electric vehicle charging system purposes.

6.5.2 COP 73, sharing of and interconnecting installation earthing systems of different buildings

The installation of earthing systems of different buildings, such as clusters of sub- buildings within one "building group", or residential link houses shall be interconnected to ensure electrical equipotential bonding is achieved and low resistance of the earthing system.

An example of building group: A bungalow with guard house, garage and utility outhouse in common plot of land.

6.5.3 COP 74, earth electrodes

Earth electrodes may be established using round copper jacketed steel rods or equivalent, such as steel tapes, rods, wire mesh, plates, or steel bars in reinforced concrete foundations of buildings or similar. Wherever reinforced concrete foundations, including piles exist, they shall be incorporated into the earthing system of the installation.

6.5.4 COP 75, earthing system resistance value

The earthing system values are as follow:

Table 8 – Earthing System Resistance Value

No.	Building type	LPS and SPD requirement	Earthing System Value (protected with RCD)
1	Stand alone	No LPS and SPD, only electrical protective earthing system	Less than 200 ohms
		With LPS and SPD Earthing System	Less than 10 ohms
2	Link houses	No LPS and SPD, only Electrical Protective Earthing System	Less than 200 ohms
		LPS and SPD with bonded reinforced concrete foundation	Less than 1 ohm

6.5.5 COP 76, restriction on the use of conductive water pipes and gas pipes for protective earthing

Conductive water pipes and gas pipes shall not be used as the means of protective earthing.

6.5.6 COP 77, maintenance and periodic inspection and test of earthing system

The earthing system of an installation shall be effectively maintained and shall be inspected and tested annually.

6.5.7 COP 78, minimum Cross-Sectional-Area (CSA) of circuit protective conductor earthing conductor

The minimum CSA of circuit protective conductor shall be as per Table 9.

Table 9 – Minimum CSA of circuit protective conductor in relation to the cross-sectional-area of associated line conductor

Cross-sectional-area of line conductor (mm^2)	Minimum cross-sectional-area of the corresponding circuit protective conductor (mm^2)	
	Circuit protective conductor of the same material as the line conductor	
	Yes	No
$S \leq 16$	S	$\frac{k_1}{k_2} \times S$
$16 < S \leq 35$	16	$\frac{k_1}{k_2} \times 16$
$S > 35$	$\frac{S}{2}$	$\frac{k_1}{k_2} \times \frac{S}{2}$

where

k_1 is the line conductor factor according to the materials of both conductor and insulation (refer from manufacturer)

k_2 is the circuit protective conductor factor according to the materials of both conductor and insulation (refer to manufacturer)

S is the cross-sectional-area of line conductor

6.5.8 COP 79, minimum CSA of earthing conductor

The CSA of earthing conductor shall follow the size as per Table 10. All earthing conductors shall be protected against mechanical damage.

Table 10 – Minimum CSA of earthing conductor

Protected against mechanical damage	As required by IEC 6034-5-54 clause 543.1.1 (Table 54.2) or 543.1.2 (Adiabatic Equation Calculation)
Protected against corrosion by a sheath	

6.5.9 COP 80, methods of connecting earthing conductors, earth electrodes, etc. buried in soil or ground

For connections of earth conductors, earth electrodes, etc., that are buried in soil or ground, connections made using exothermic welding.

For connections that are required for periodic inspection and/or testing of the earthing system, clamps or equivalent which can be disconnect/reconnect during testing shall be used. The inspection chamber shall be filled with washed sand or equivalent and the connections shall be protected with suitable means to prevent degradation of connection such as by electrolytic corrosion.

After the earth electrodes and the connection to the earthing system including connection to the reinforced concrete foundation is installed, but before the commencement of the structural works installation, an inspection form shall be completed by a competent person. The form shall contain description, plan and photos and shall from a pair of the whole documentation for the electrical installation.

6.5.10 COP 81, selection of protective earthing

Every protective earthing conductor shall be selected to withstand the highest prospective fault current and shall ensure reliable operation of protective devices.

6.5.11 COP 82, minimum CSA of main equipotential bonding conductors

The main equipotential bonding conductors shall have a CSA not less than half CSA required for earthing conductor of the installation and not less than 6 mm^2 as per Table 11.

Table 11 – Minimum CSA of main equipotential bonding conductor

Material	Minimum CSA (mm2)
Copper	6
Aluminium	16

6.5.12 COP 83, minimum CSA of supplementary equipotential bonding conductor

The supplementary equipotential bonding conductors shall comply to the following:

a) 2.5 mm^2 copper if protection against mechanical damage is provided; and

b) 4 mm^2 copper if protection against mechanical damage is not provided.

6.6 Change-over switch of a standby system or alternative system

Standby systems include generator set or any backup power supply approved by regulatory authority. Alternative systems include renewable electricity source such as solar photovoltaics or any other source approved by regulatory authority.

6.6.1 COP 84, prevention of parallel operation of standby or alternative systems with the electricity supply from the supply authority or licensee

When a standby system or an alternative system is in parallel with the electricity from the supply authority or licensee to an installation, the means of isolation of all phase and neutral conductors shall be using a 4-pole isolator or equivalent to prevent back-feed resulting from parallel operations.

6.6.2 COP 85, separate neutral for the standby or alternative system

When operating a standby or alternative electricity system, the neutral of the standby electricity supply shall be separated from each other and from the supply authority or licensee and shall be switched appropriately.

6.6.3 COP 86, separate earthing for the standby and alternative system

A separate earth chambers shall be installed for the standby system and the alternative system. These earthing shall be interconnected to each other.

6.7 Inspection and testing

Every installation, including rewiring, modification, extension works, etc. shall be inspected during erection or upon completion prior to being energized.

Every installation, including rewiring, modification, extension works, etc. shall be tested before handover to user.

6.7.1 COP 87, supervision and testing of any LV electrical installations

Supervision and testing for any LV electrical installation shall be subject to the latest requirements and in accordance with the Electricity Regulations 1994 or any regulatory authority requirements.

6.7.2 COP 88, condition precedent for energisation of LV installations

LV installation shall not receive electricity from the electricity supply authority or licensee until the supervision and completion certificate and test certificate have been submitted by the owner or management of the installation to and all payments made to the supply authority or licensee.

6.7.3 COP 89, insulation Resistance (IR) test on completed LV installations

IR tests shall be carried out on completed LV installation using suitable IR test equipment as per Table 12.

Table 12 – IR test

Circuit nominal voltage at 50 Hz (V a.c.)	Test voltage (V d.c.)	Minimum IR (MΩ)
SELV and PELV	250	≥ 0.5
Up to and including 500 V a.c. except for the above system	500	≥ 1.0
Above 500 V a.c. but not exceeding 1000 V a.c.	1000	≥ 1.0

NOTE 1 The minimum IR should be temperature corrected to base temperature IR resistance for type of insulation material.

NOTE 2 The base temperature should be mutually agreed.

6.7.4 COP 90, electrical installation, inspection and testing

Circuits protective earthing and equipotential bonding conductors, cable management system, switchboard, and protective, isolation, switching, control and monitoring devices, control devices shall be checked and verified against approved schematic wiring diagrams, contract document or similar and functionally tested.

6.7.5 COP 91, socket polarity check on completed electrical installations

Socket polarity check shall be carried out on all final circuits.

6.7.6 COP 92, phase sequence check on final three phase circuits

Phase sequence check shall be carried out on all final three phase circuits. The conventional phase sequence shall be L1 - L2 - L3 or Red - Yellow – Blue.

6.7.7 COP 93, requirement for labelling

All circuits, installation apparatus and components shall be clearly and appropriately labelled using Bahasa Melayu or English.

The labelling of final circuits shall be consistent with the labelling at the distribution board and shall be documented in the as- built electrical schematic diagram. Special labelling is required to ensure safety of personnel for standby systems or alternative systems.

6.7.8 COP 94, requirement for colour coding of cable management system

The colour code of cable management system shall be per Table 13.

Table 13 – Colour coding for cable management system

Cable management system	Colour coding
LV electrical	Orange
Fire services	Red
Telecommunication	Green
Extra Low Voltage services	White
Others	To be agreed with owner or representative

NOTE 1 The preferred method is 100 % colouring of cable management system.

NOTE 2 If note 1 is not practicable, the recommended colour strips of at least 50 mm wide and length which should cover at least more than 75 % of the outer perimeter of the cable management system. The colour strip should be placed at visible regular intervals along the cable management system. The preferred distance between colour strips should be less than 1,200 mm.

NOTE 3 For cable management system which transverse different compartments, rooms, etc. of an installation, there should be at least two colour coded strips on the cable management system for each compartment, rooms, etc.

6.7.9 COP 95, requirement for colour coding of cables and conductors

All cables and conductors shall be identified by colour in accordance with Table 14 only. The cable colour code shall follow any changes in the regulation/circular/directive from regulatory authority.

Table 14 – Colour coding of cables and conductors

Type of electrical installation	Colour code (Malaysia practice)	BS 7671 18th Edition
Single Phase electrical installation		
Phase	Red	Brown
Neutral	Black	Blue
Protective earthing and equipotential bonding	Green	Green or Green with Yellow Stripe
Functional earthing	Green	Cream
Three Phase electrical installation		
Single phase circuit		
Phase	Red / Yellow / Blue	Brown
Neutral	Black	Blue
Protective earthing and equipotential bonding	Green	Green or Green with Yellow stripe
Functional earthing	Green	Cream
Three phase circuit		
L1 or Red phase	Red	Brown
L2 or Yellow phase	Yellow	Black

L3 or Blue phase	Blue	Grey
Neutral	Black	Blue
Protective earthing and equipotential bonding	Green	Green or Green with Yellow Stripe
Functional earthing	Green	Cream

NOTE 1 All the above cable colour code shall be applicable to single core PVC cable & multicore PVC cable.

NOTE 2 Single core PVC/PVC cable & XLPE/PVC cable without colour coded jacket and coloured black shall be colour coded at the terminations by colour cable lug boots of equivalent. For surface wiring, cable colour coding strip such as colour heat shrink strips or equivalent of at least 50 mm wide should be placed at regular intervals along the cables or conductors. The maximum intervals between two colour heat shrink strips should be less than 1,200 mm.

NOTE 3 Bare conductors such as busbars should be colour coded with coloured heat shrink tube. The preferred method is 100 % coverage. If this coverage is not practicable, colour coding strip such as colour heat shrink strips or equivalent of at least 50 mm wide should be placed at regular intervals along the cables or conductors. The maximum intervals between two colour heat shrink strips should be less than 1,200 mm.

NOTE 4 For cables and conductors which transverse different compartments, rooms, etc. there should be at least two-colour coded strips on the cables and conductors for each compartment, room, etc.

6.7.10 COP 96, as-built documentation

Every completed installation shall have the as-built electrical single line diagrams and earthing arrangements, maintenance manuals including electrical equipment kept in secure area and made easily accessible to qualified electricians for safety in operation and maintenance. This as-built documentation shall be endorsed by a professional electrical engineer who inspects the installation. There shall be at least two (2) sets of as-built documentation, one of the copies shall be kept by owner of the installation. Additionally, a durable as-built electrical single line diagrams shall be made available in each of the distribution board.

6.8 Special installation

6.8.1 COP 97, requirements for special installations or locations – Bathroom area

Socket outlet is allowed at least 2.5 m away from water outlet (outside Zone 2 – refer to in IEC 60364:7:701) with a dedicated 10 mA RCD.

6.8.2 COP 98, requirements for special installations or locations - Locations containing a swimming and fountain

Socket outlets are allowed at least 2 m away from water source (outside Zone 1 – refer to IEC 60364:7:702) with a dedicated 10 mA RCD.

6.8.3 COP 99, requirements for special installations or locations – Gas outlet

SSO outlet shall be 200 mm away LPG gas.

6.8.4 COP 100, requirements for special installations or locations – Solar photovoltaic

The outgoing circuit to the solar photovoltaic installation shall be protected with a RCD Type B. For the solar photovoltaic installation itself, the installation refers to MS 1837 and IEC 60364:7:712.

6.8.5 COP 101, requirements for special installations or locations – External lighting and outdoor installation

All outdoor installation shall be at least:

a) armoured cable;

b) all termination shall be in proper weatherproof junction box (IP66); and

c) for incoming supply from supply authority using underground cable, shall be mechanically protected, overcurrent protective device shall be provided after the metering panel in armoured cable or in conduit.

6.8.6 COP 102, requirements for special installations or locations – EV charger

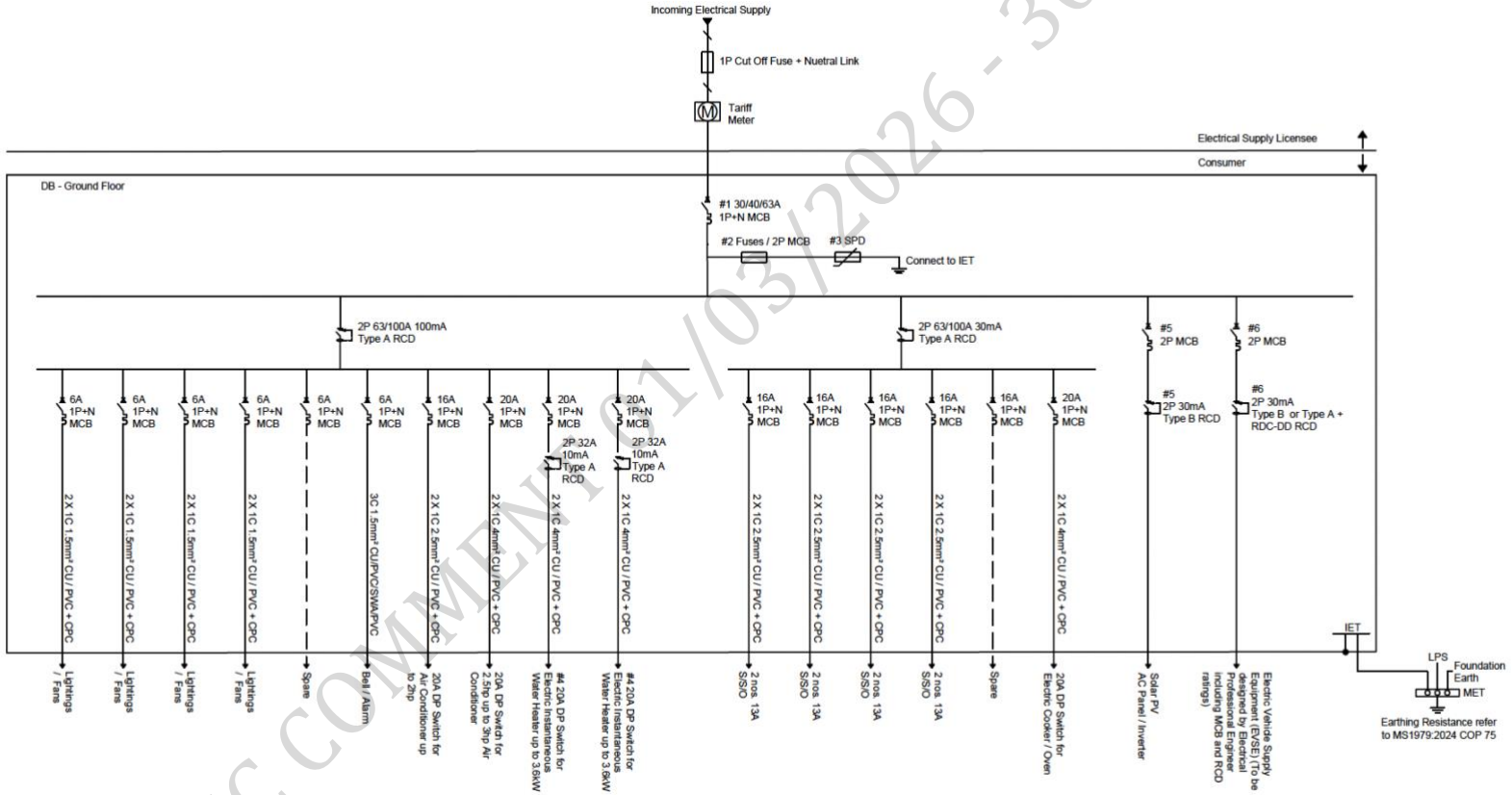
All EV charging connecting point shall be protected with an RCD Type A with Residual Direct Current Detecting Device (RDC-DD) (built-in or external type) or RCD Type B. For the EV charger installation itself, the installation refers to IEC 60364:7:722.

6.8.7 COP 103, requirements for special installations or locations – Electric fence

Electric fence installation shall be protected with RCD of not more than 30 mA and comply to local regulatory requirements and IEC 60335-2-76. The electric fence shall have a separate earthing system from electrical earthing system. A distance of at least 10 m shall be maintained between the energizer earth electrode and any other earthing system connected parts such as the power supply system protective earth or other types of earthing system.

Annex A
(informative)

Basic single line schematic diagram for single phase incoming distribution board



Key

MCB	Miniature Circuit Breaker	MET	Main Earthing Terminal
SPD	Surge Protection Device	LPS	Lightning Protection System
IET	Intermediate Earthing Terminal	RCD-DD	Residual Direct Current Detecting Device

NOTE This Single Line Diagram only serves as guide. Total Connected Loads (TCL), Maximum Demand (MD) and cable sizing is designed by electrical professional engineer.

#1, #2, #5 and #6 Current ratings of MCB, fuse and RCD to be designed by electrical professional engineer to comply with relevant MS and IEC standards.

#3 SPD design and specifications shall comply to MS IEC 61643, MS IEC 62305 and MS IEC 60264.

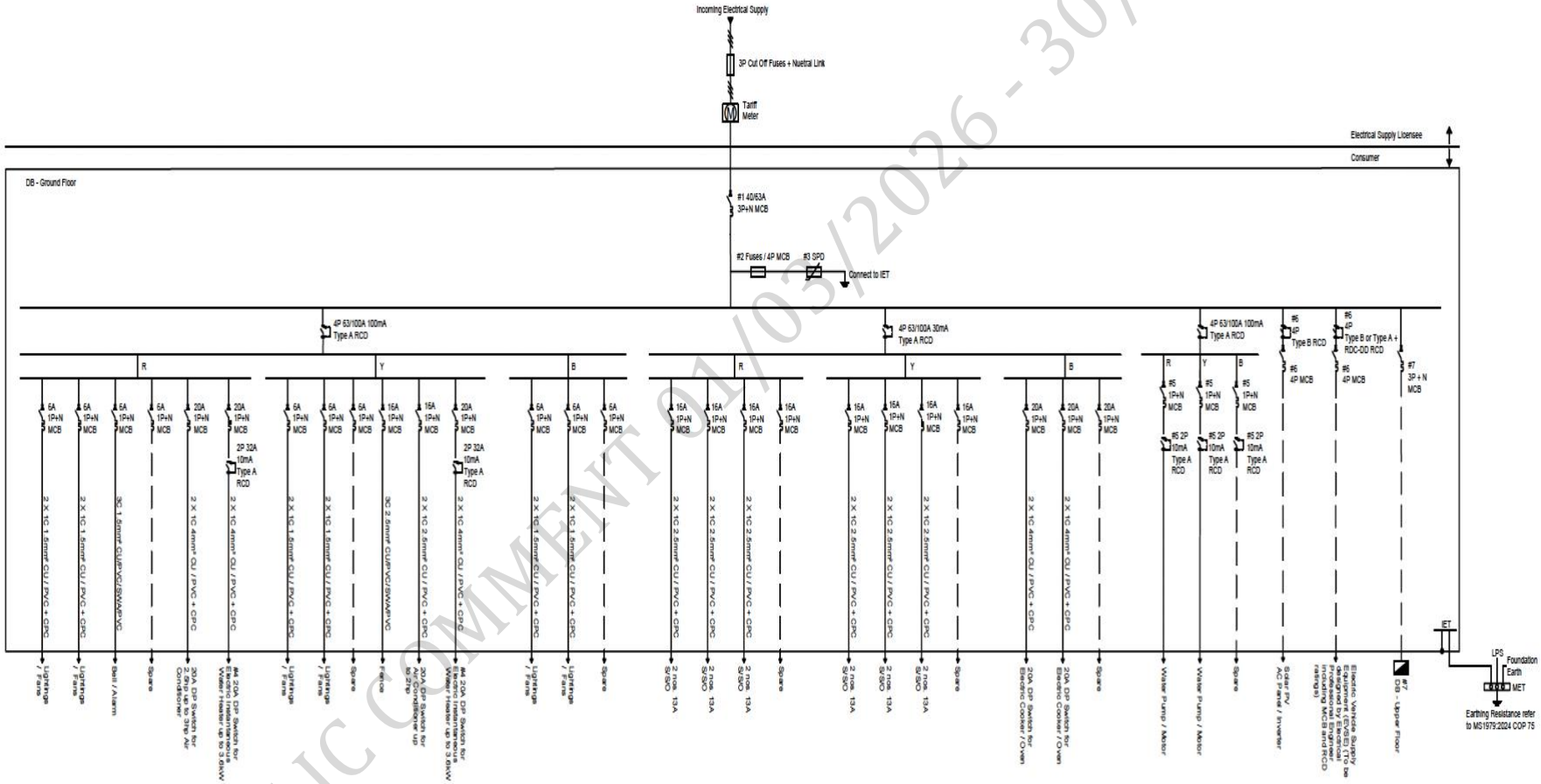
#4 For electric instantaneous water heater more than 3.6 kW, electrical professional engineer shall check available spare capacity of declared MD. and to size current ratings of MCB, RCD and cable based on relevant MS and IEC standards.

Figure A.1 – Basic single line schematic diagram for single phase incoming distribution board

S

Annex B
(informative)

Basic single line schematic diagram for three phase incoming distribution board



Key

MCB	Miniature Circuit Breaker	MET	Main Earthing Terminal
SPD	Surge Protection Device	LPS	Lightning Protection System
IET	Intermediate Earthing Terminal	RCD-DD	Residual Direct Current Detecting Device

NOTE This Single Line Diagram only serves as guide. Total Connected Loads (TCL), Maximum Demand (MD) and cable sizing is designed by electrical professional engineer.

#1, #2, #5 and #6 Current ratings of MCB, fuse and RCD to be designed by electrical professional engineer to comply with relevant MS and IEC standards.

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#4 For electric instantaneous water heater more than 3.6 kW, electrical professional engineer shall check available spare capacity of declared MD. and to size current ratings of MCB, RCD and cable based on relevant MS and IEC standards.

Figure B.1 – Basic single line schematic diagram for three phase incoming distribution board

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