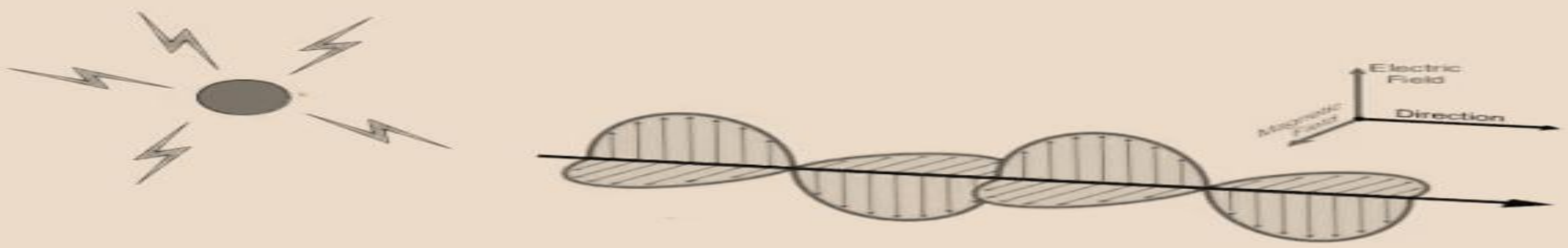
EMC, EMI In Electrical Installation

Seminar On Federations Of Myanmar Engineering Societies

19 May 2026, 1 ~ 4 pm



Tint Swe [Electrical Engineer]

Why Need Electromagnetic Compatibility – EMC?

What is Electromagnetic Interference ~ EMI?

- **Electromagnetic interference is the electromagnetic disturbance affecting the performance of a device.**
- **Most sources of EMI are another electronic device or electrical system, but there are cases when EMI can have an environmental source, such as an electrical storm, a power surge, electrostatic discharge (ESD) or solar radiation.**
- **The fundamental issue arises from the interaction between electromagnetic fields generated by electrical currents and nearby conductors or electronic circuits. These interactions can occur through various coupling mechanisms, including conductive, inductive, capacitive, and radiative pathways.**
- **All electrical conductors generate magnetic fields proportional to the distance between them.**

Why Need Electromagnetic Compatibility – EMC?

What Are The Source Of Electromagnetic Interference - EMI?

- **Switching devices for inductive loads,**
- **Electric motors,**
- **Fluorescent lighting,**
- **Welding machines,**
- **Computers,**
- **Rectifiers,**
- **Choppers,**
- **Frequency converters/regulators,**
- **Lifts,**
- **Transformers,**
- **Switchgear,**
- **Power distribution busbars, and so on. . .**

EMC-Electromagnetic Compatibility

- EMC or electromagnetic Compatibility ~ capability, is a requirement for electrical devices and installations.
- Without compatibility, emissions from one can interfere with the performance of another.
- Stringent guidelines and regulations exist in each country to ensure the devices, components or installations on the market adhere to acceptable parameters for both emissions (that could affect other devices) and immunity (to protect itself against emissions from other devices.)

Again ! What is EMC?

Electromagnetic compatibility is required because all electric devices or installations influence each other when interconnected or close to each other. EMC is a measure of a device‘s ability to operate as intended in a shared operating environment without affecting the operability of other equipment in the same environment.

Myanmar National Building Code 2025

- **5B.4.1.1 The design and planning of an electrical wiring installation shall take into consideration,**

[some or all of the following:]

- a) the type of supply, occupancy, envisaged load and the earthing arrangement available;
- b) the atmospheric condition, such as cooling air temperature, moisture or such other conditions
- which are likely to affect the installation adversely;
- c) the possible presence of inflammable or explosive dust, vapour or gas;
- d) the degree of electrical and mechanical protection necessary;
- e) the importance of continuity of service including the possible need for standby supply;
- f) the probability of need for modification or future extension;
- g) the probable operation and maintenance cost taking into account the electricity supply tariffs
- available;
- h) the relative cost of various alternative methods;
- **i) the need for radio and telecommunication interference suppression;**
- j) ease of maintenance;
- k) safety aspects;
- l) energy conservation
- m) the importance of proper discrimination between protective devices for continuity of supply
- and limited isolation of only the affected portion; and
- n) reliable and sustainable electricity supply

Many EMC Related Codes in IEC:

- IEC 61 000-2-5: 1 995, Electromagnetic compatibility (EMC) – Part 2: Environment – Section 5:

  Classification of electromagnetic environments – Basic EMC publication
- IEC 61 000-6-1 , Electromagnetic compatibility (EMC) – Part 6-1: Generic standards – Immunity

  for residential, commercial and light-industrial environments

  IEC 61 000-6-2, Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity for industrial environments

  IEC 61 000-6-3, Electromagnetic compatibility (EMC) – Part 6-3: Generic standards – Emission

standard for residential, commercial and light-industrial environments

  IEC 61 000-6-4, Electromagnetic compatibility (EMC) – Part 6-4: Generic standards – Emission

- standard for industrial environments
- IEC 60364-4-44, Low voltage Electrical Installations-Protection against voltage disturbances and electromagnetic disturbances;

EMI, EMC In Electrical Installation

- Unit Of EMI , Decibels(dB); to express the intensity of Electromagnetic signals.
  - Deci - - -, Bel = 1/10 Bel
  - A unit to measure **power**
  - Also the Logarithmic scale
- To measure the electric field: vole per meter(V/m)
- To Measure the magnetic field: Ampere per meter(A/m)

Gain = A = 10 log (Po / Pi) dB — Eqn. 1

$A = 10 \log (V2^2/V1^2) = 20 \log (V2/V1)$

Reference Value to Voltage, Current and Power.

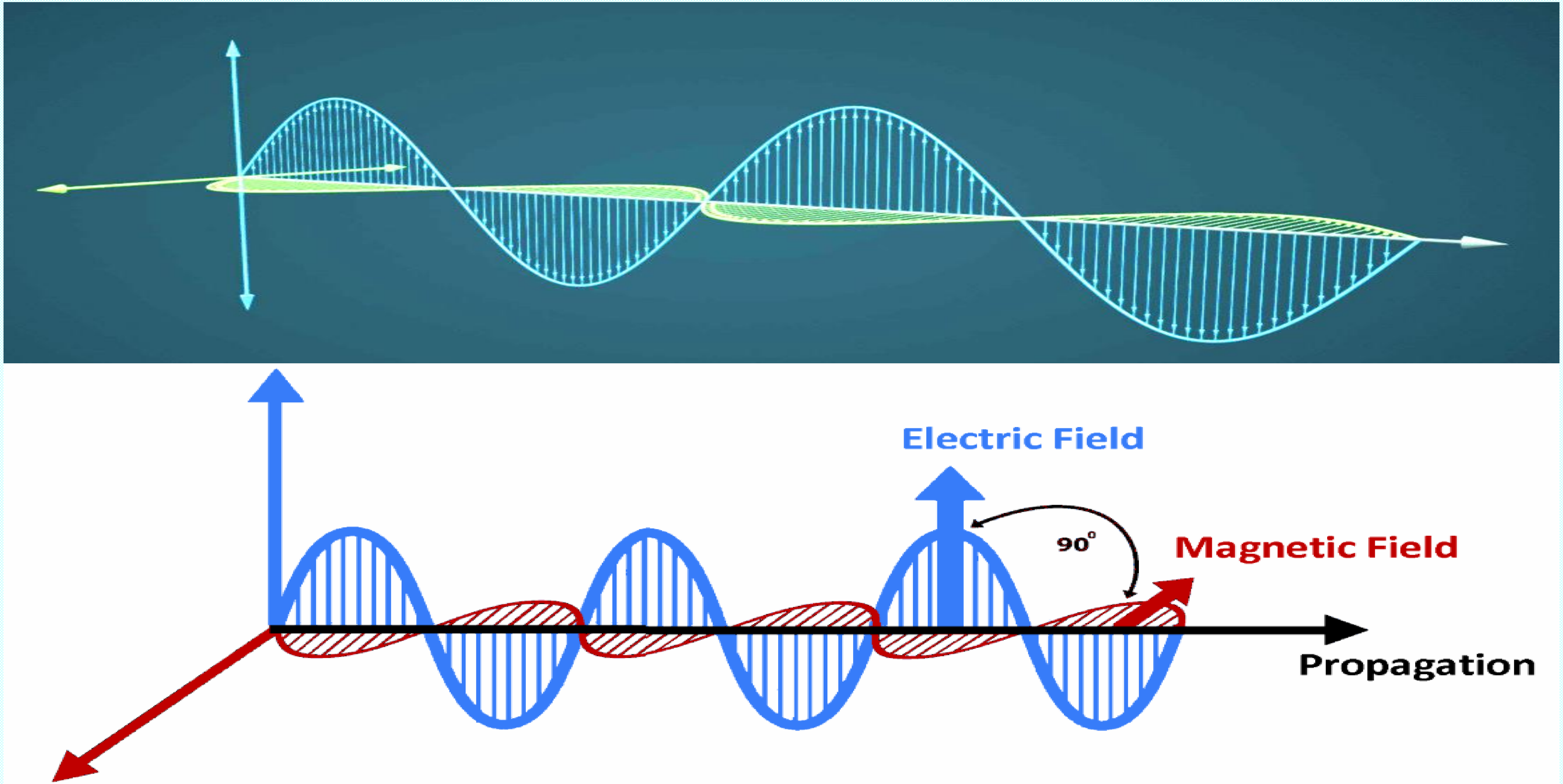
20 log (100 / 1) = 20 × 2 = 40 dBμV[E-field]

20 log (10/1) = 20 × 1 = 20 dBA

20 log (10,000,000/1) = 20 × 7 = 140 dBμA[H-field]

EMI, EMC In Electrical Installation

- Electromagnetic Wave In Shape:



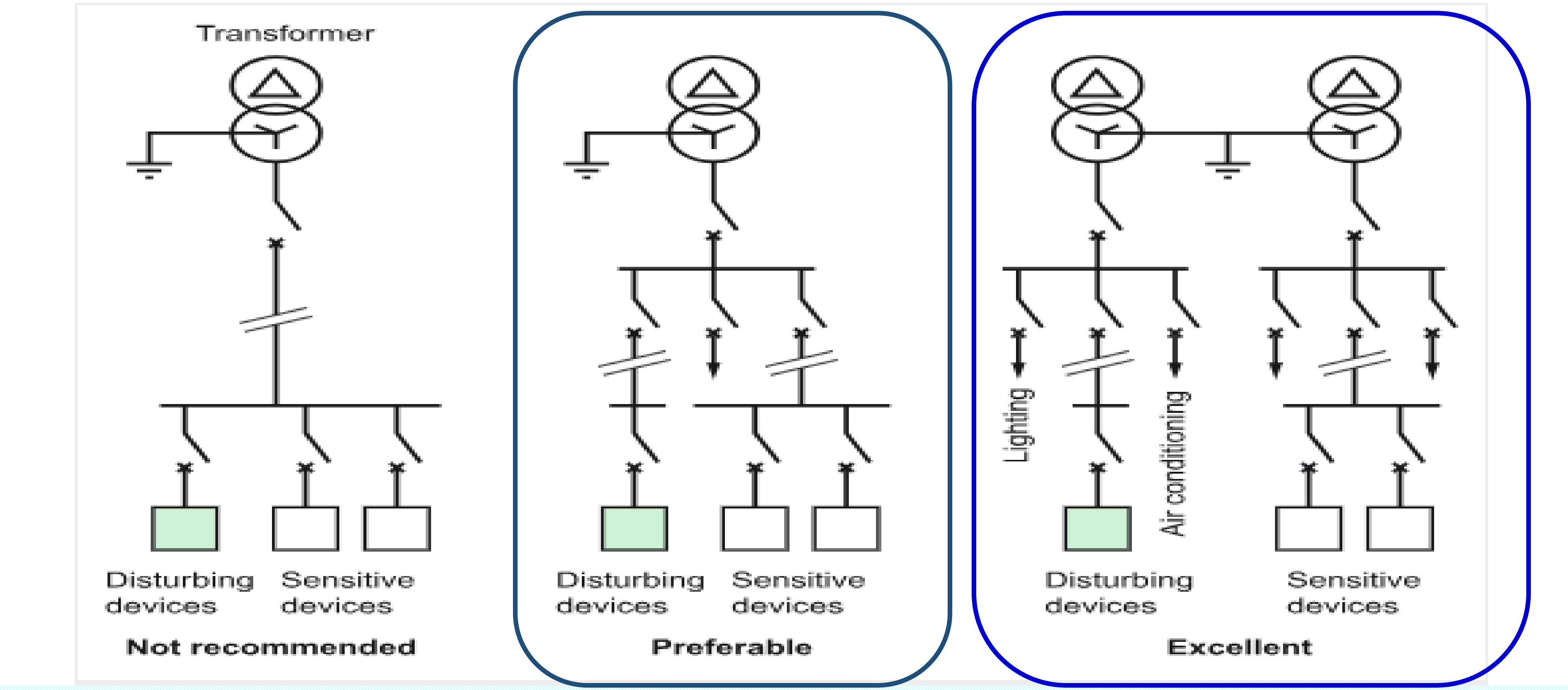
ElectroMagnetic Compatibility (EMC)

1. **EMC Behavior of different electrical distribution architecture**
2. **EMC – Earthing principles and structures**
3. **EMC implementation**
4. **EMC – Coupling mechanisms and counter-measures**
5. **Wiring recommendations**
6. **Contractual EMC**
7. **Real Life Experience**
8. **Example of Testing, and Document in EMC**

1. EMC Behavior of different electrical distribution architecture

Best and Basic Way to Install The Supply To Sensitive Equipment:

- **Sensitive Equipment distribution shall be supplied by dedicated transformer in a TN-S system.**



Mitigation Of Electromagnetic Compatibility(EMC)

1. EMC Behavior of different electrical distribution architecturing

- TN-S Earthing System can minimize the EMC problems for installations comprising information-technology equipment , including telecom equipment.

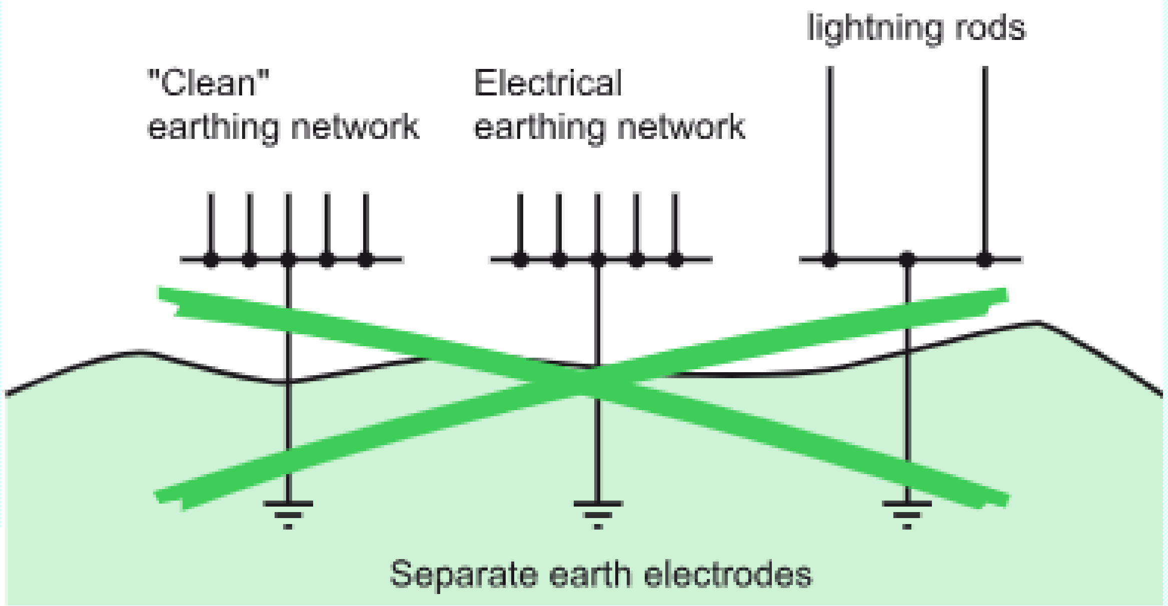
	Earthing System			
	TT	TN-S	IT	TNC
Safety Of Peoples	Yes	Yes	Yes	Yes
	RCD to be installed	Continuity of PE conductor must run along the L,N .		
Safety Of Property	Yes	Poor	Yes	Poor
	Medium earth fault current, <10A	High earth fault current, (<1kA)	Low earth-fault current	High earth fault current, (>1kA)
Availability Of Energ	Good	Good	Excellence	Good
EMC Performance	Good	Excellence	Poor, to avoid	Poor
	Risk of overvoltages	Good equipotential situation	Risk of overvoltages	Neutral and PE are combined
	Equipotential problems, Need to manage devices with high leakage currents	Need to manage devices with high leakage currents	Common-mode filters and surge arrestors must handle the phase- to-phase voltages	50/60 Hz and harmonics currents circulate in the earthing and grounding structures
		High ground- currents (transient disturbances)	RCDs subject to nuisance tripping if common-mode capacitors are present	High ground-fault currents (transient disturbances)

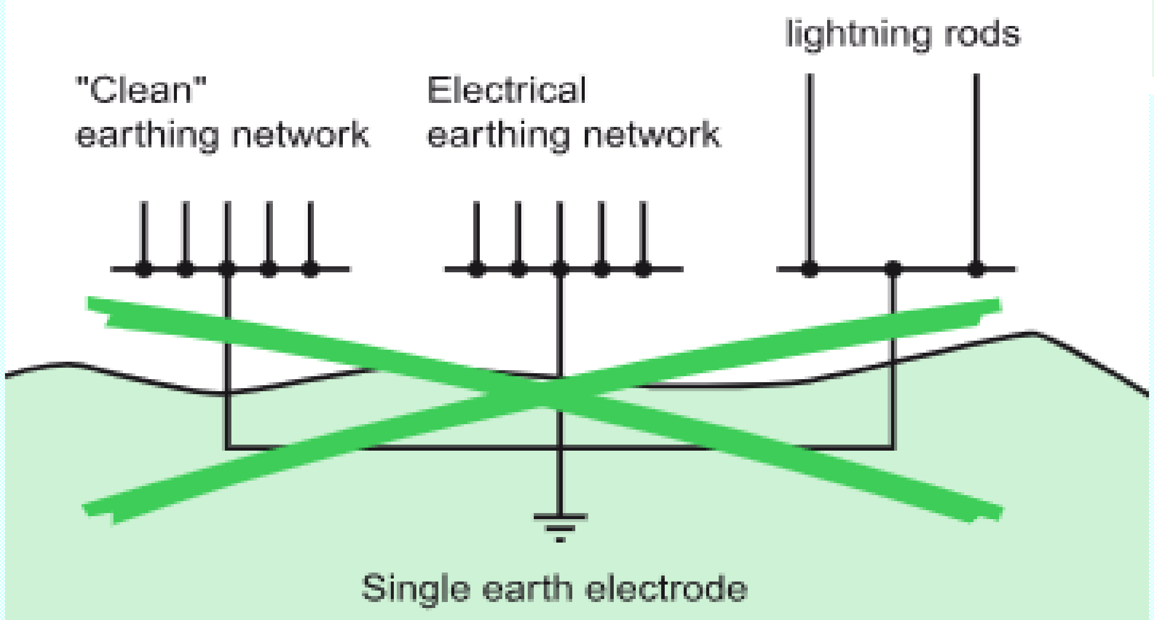
2. EMC – Earthing principles and structures

Mitigation Of Electromagnetic Compatibility(EMC)

Earthing network, which to specially design to fulfil several functions. Earthing can be independent or operate together to meet the ;

1. Safety of persons from electrical hazard,
2. Equipment protection from electrical hazard,
3. Equipment reliable quality,
4. EMC performance

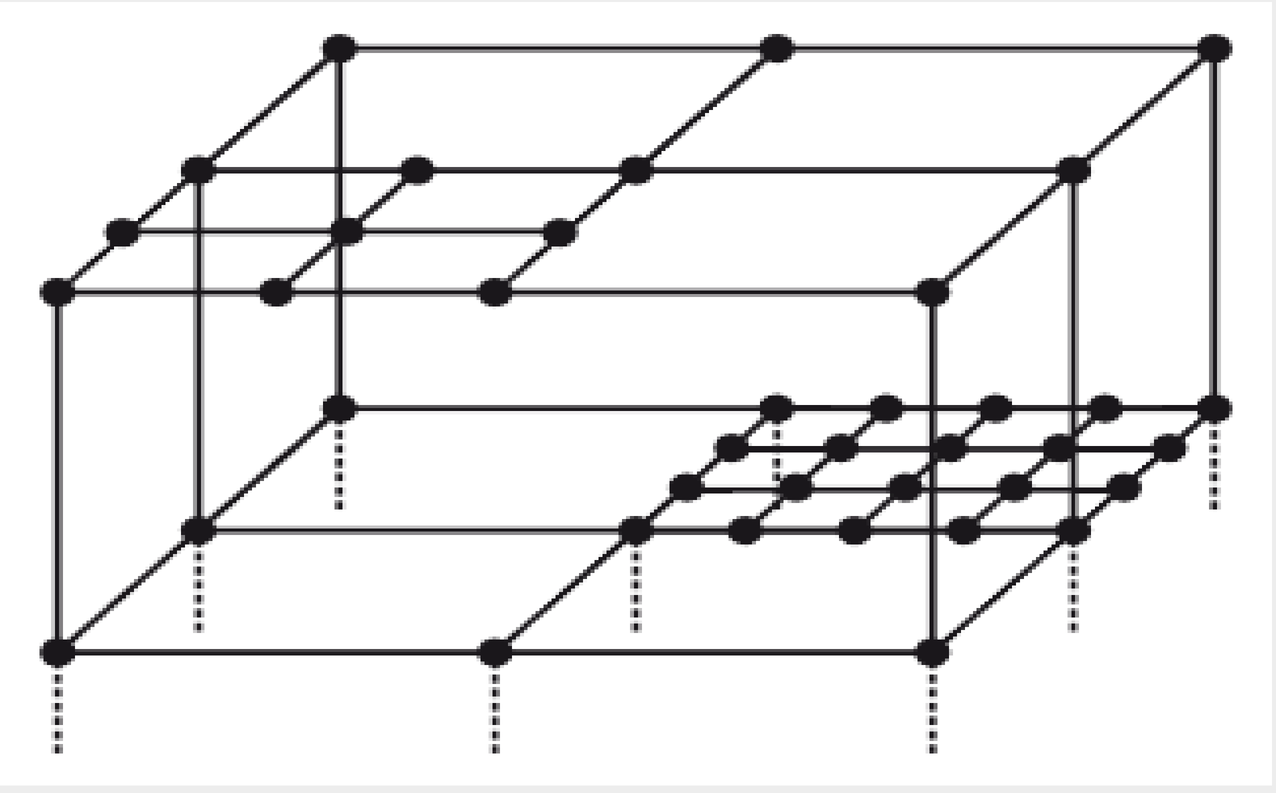


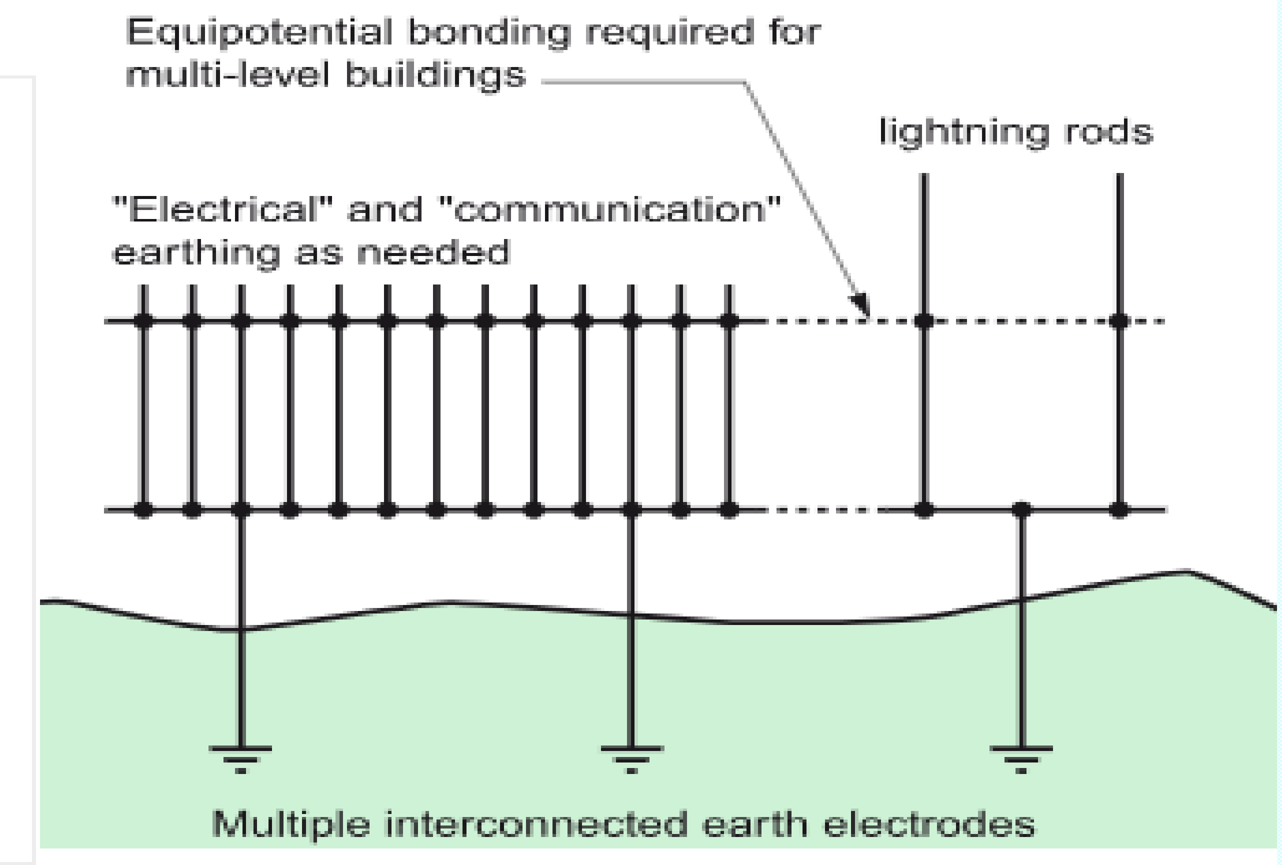


- Single earth electrode and
- Separate earth electrodes are not recommendable in EMC

2. EMC – Earthing principles and structures

- The multi electrodes and earthing network is generally advised to use for safety and EMC.
- Especially in multi-level building, more than one earth bonding to apply,
- Equipotential bonding , Electrical and communication earthing, as earth meshes and bonded several point between Levels,





2. EMC – Earthing principles and structures

- It is now recognised that independent, dedicated earth electrodes, each serving a separate earthing network, are a solution that is not acceptable in terms of EMC, and a serious safety hazard. In certain countries, the national building codes forbid such systems.
- A separate "clean" earthing for electronics , a "dirty" earthing network for energy is not recommended in view of obtaining correct EMC,
- A single electrode is used if a lightning strike, a fault current or HF disturbances, transient currents will flow in the installation, transient voltages result in failures or damage to the installation.

If proper installation and maintenance implemented, this approach may be fine at power frequencies, but not suitable for EMC purposes and recommended for general use.

For professional and industrial installations, a equipotential and common bonding network may be useful to ensure better EMC performance with respect to:

- Digital systems and new technologies
- Compliance with the EMC essential requirements of Directive 2004/108/EC(emission and immunity)
- The wide number of electrical applications

But does not remove the need for Protective Conductors.

3. EMC – Mitigation of Electromagnetic Interference

A. Equipotential bonding inside and outside the building:

- Safety
- EMC

EMI is the unwanted electromagnetic noise that disrupts electronic devices, while EMC ensures devices operate correctly without causing or being affected by such interference.

It is recommended to interconnect the earthing networks of buildings that have shared cable connections. Interconnection of the earthing networks must take ,as the earthing-network must be as meshed as possible.

3. EMC Implementation– Mitigation of Electromagnetic Interference(EMI)

B. Improving Equipotemtial bonding conditions:

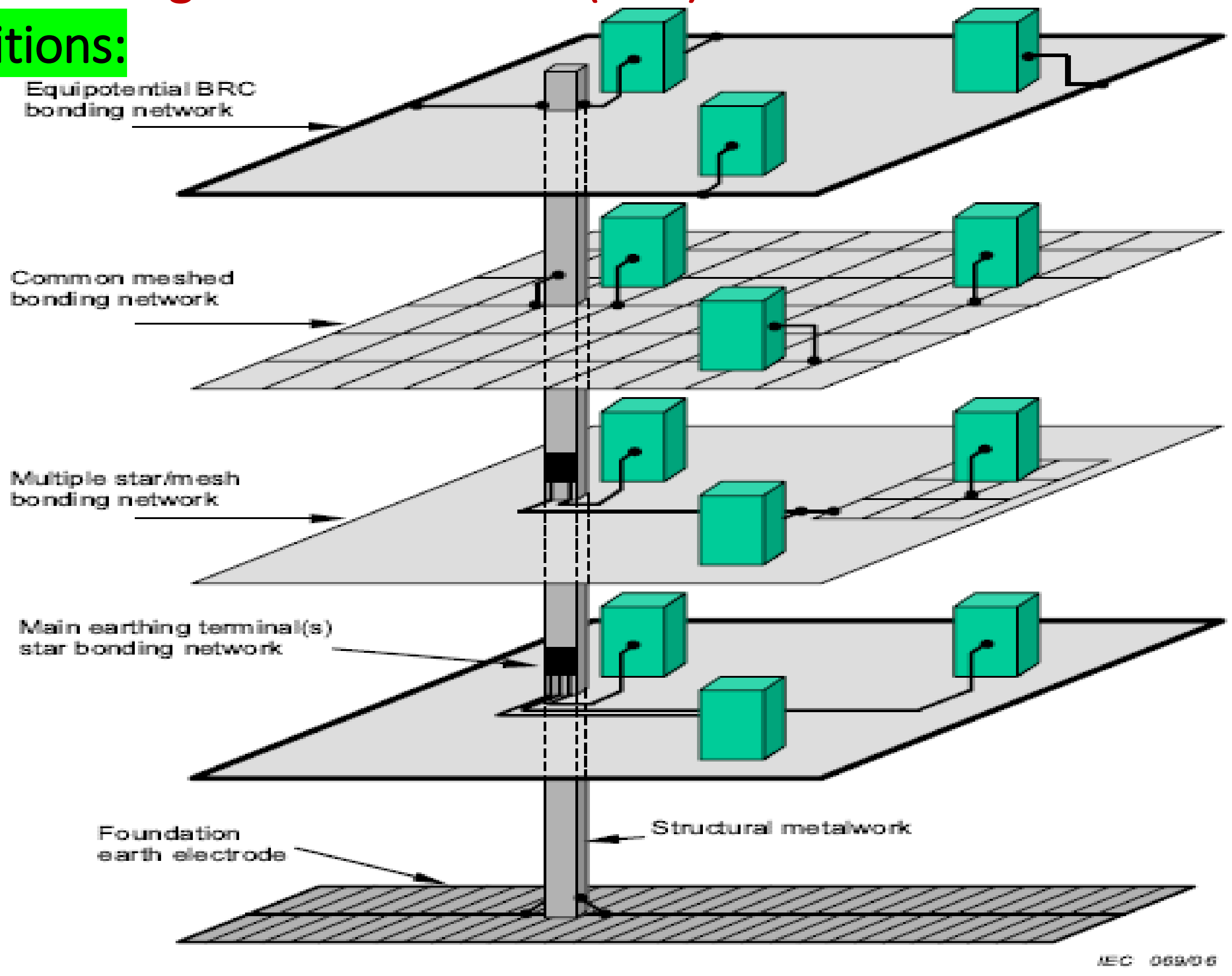
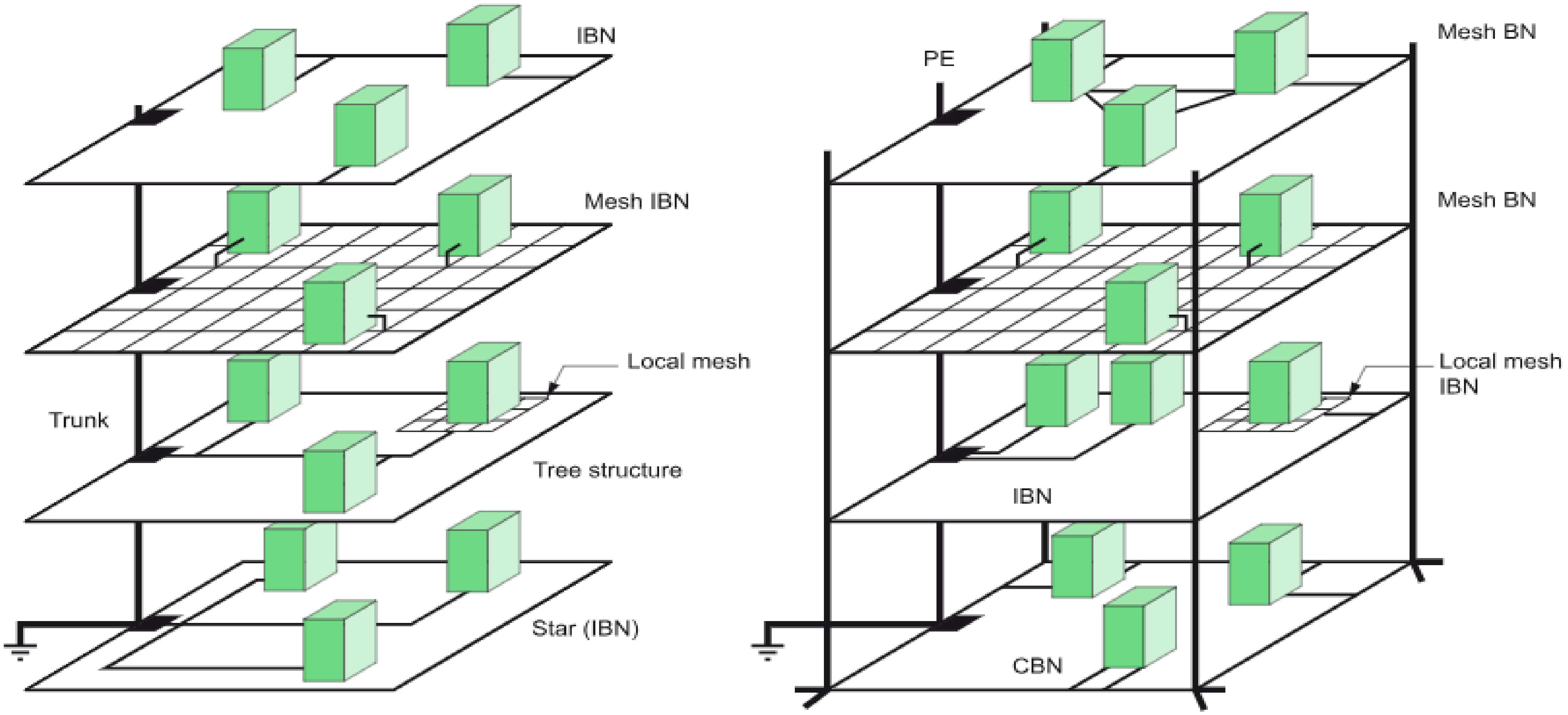


Figure 44.R16 – Example of equipotential bonding networks in structures without lightning protection systems

B. Improving Equipotemtial bonding conditions:

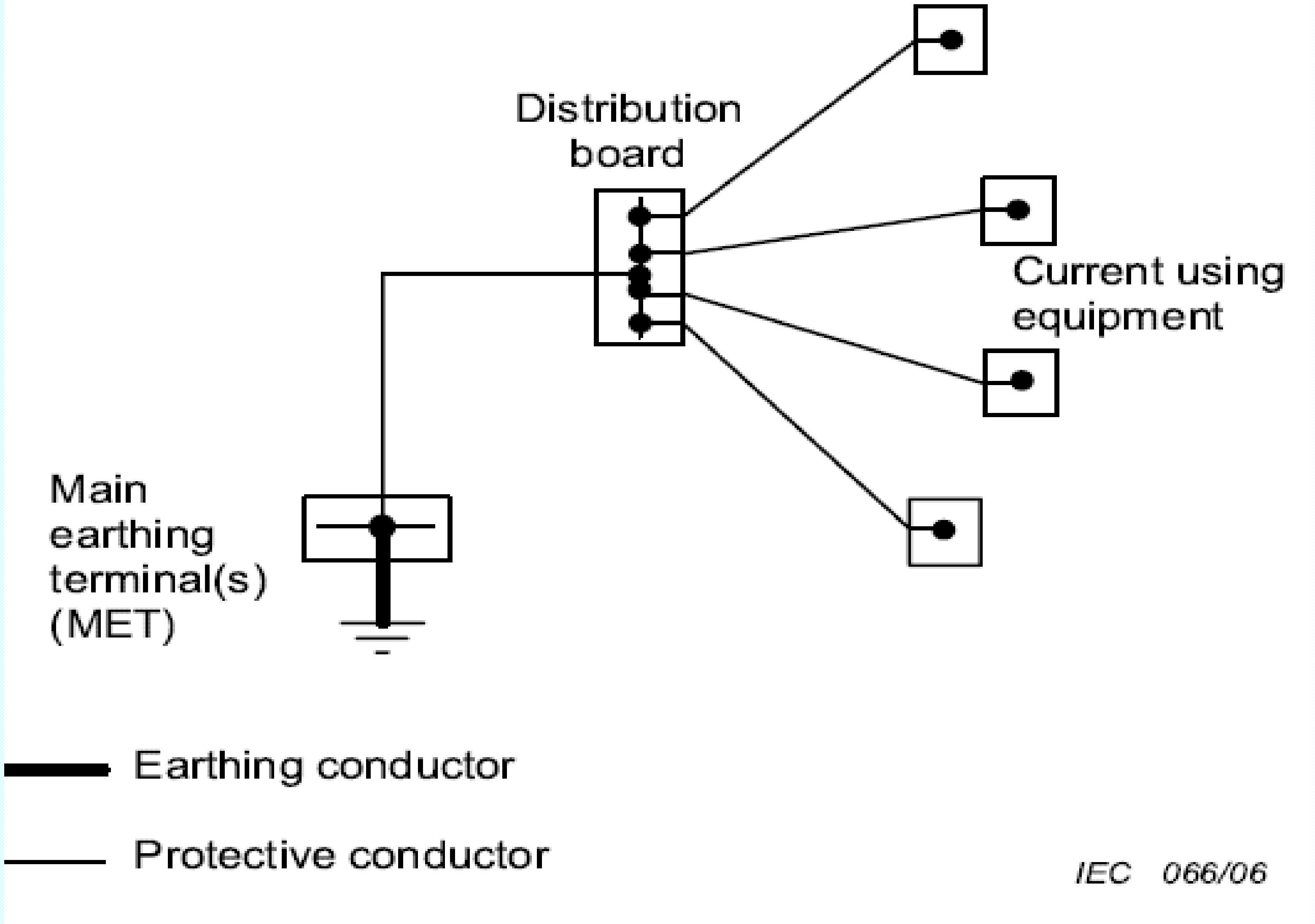


BN: Bonding network
CBN: Common bonding network
IBN: Isolated bonding network

3. EMC Implementation– Mitigation of Electromagnetic Interference(EMI)

B. Improving Equipotemtial bonding conditions:

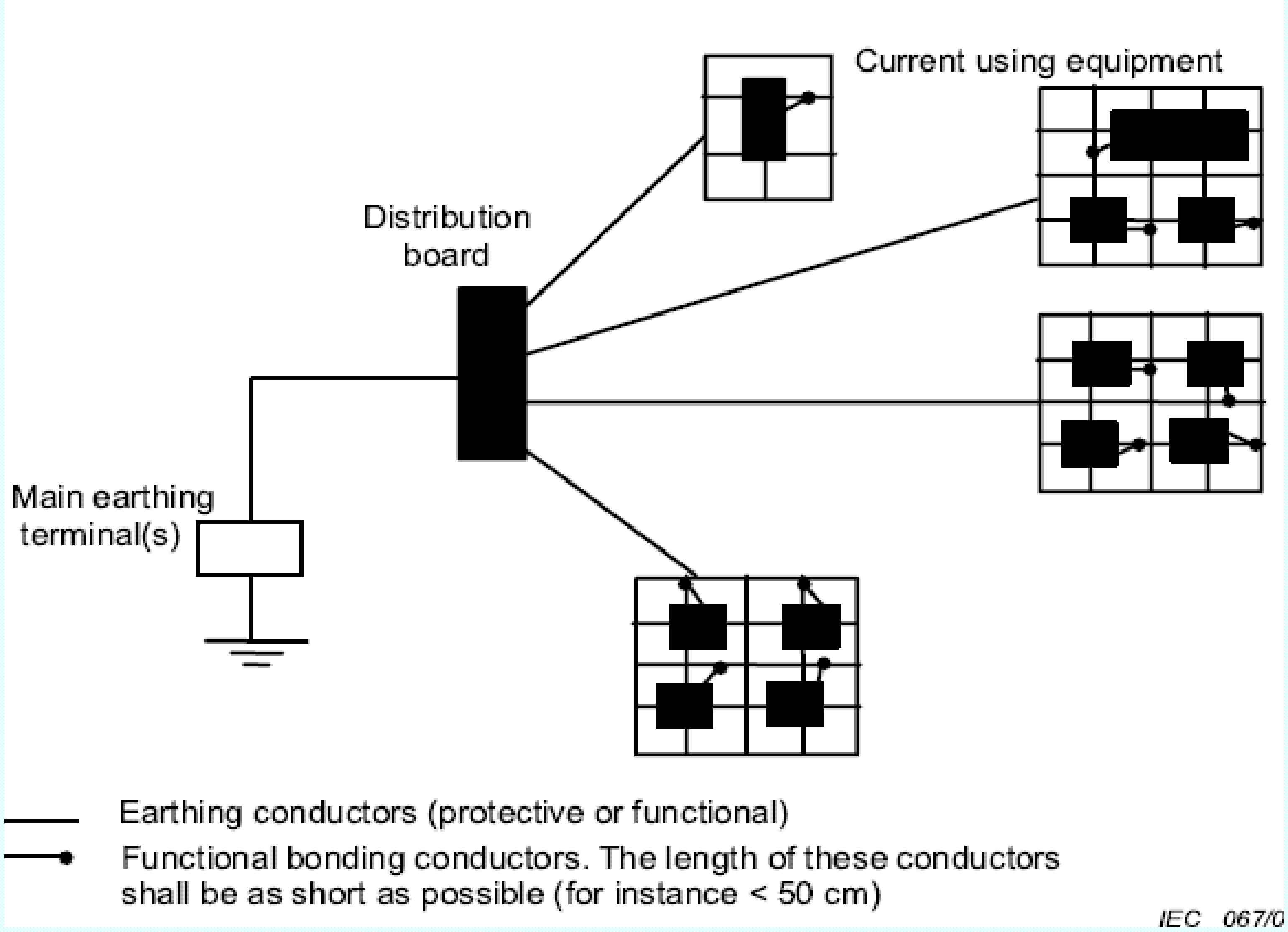
- Protective Conductors in Star Network,



3. EMC Implementation– Mitigation of Electromagnetic Interference(EMI)

B. Improving Equipotemtial bonding conditions:

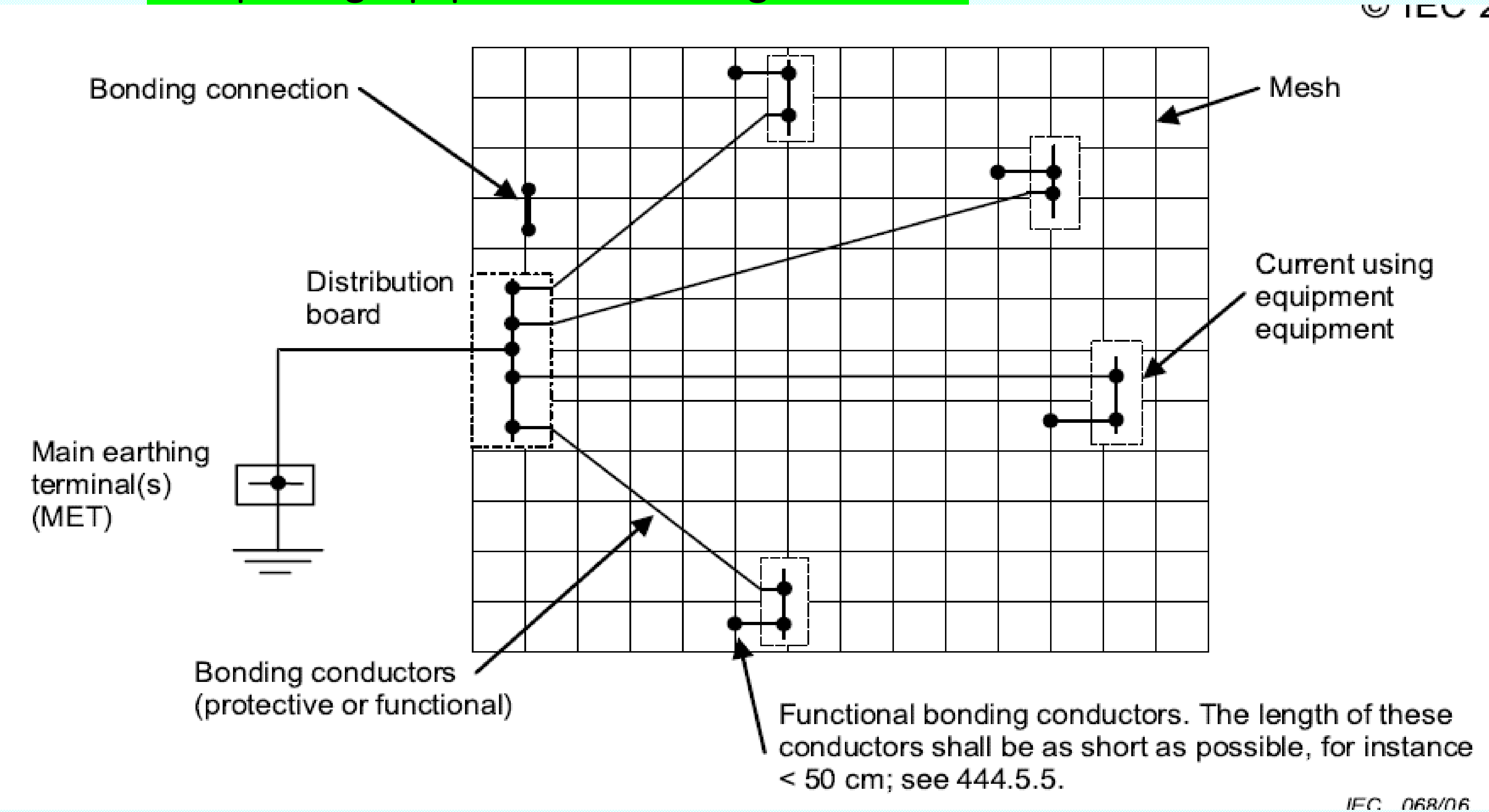
- Protective Conductors in multiple mesh bonding Star Network,



3. EMC Implementation– Mitigation of Electromagnetic Interference(EMI)

B. Improving Equipotemtial bonding conditions:

Common multiple mesh bonding Star Network,



Mitigation Of Electromagnetic Compatibility(EMC)

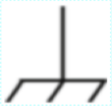
3. EMC Implementation– Mitigation of Electromagnetic Interference(EMI)

B. Improving Equipotemtial bonding conditions: GROUNDING SYMBOLs

1. Grounding/Earthing

2. Function Grounding/Earthing

3. Protective earth/ground



4. Frame or Chassis Bonding

5. Equipotential of equipment for same potential ,earth terminal

6. Do Not connect to protective earth/ground

7.Class II equipment wit Double insulation,

3. EMC Implementation– Mitigation of Electromagnetic Interference(EMI)

B. Improving Equipotemtial bonding conditions:

- Bonding Network

The length of connections between a structural element and the bonding network does not exceed 50 centimetres and an additional connection should be installed in parallel at a certain distance from the first.

If it is possible, to use a single 50 cm conductor or two parallel conductors one meter long, installed at a minimum distance from one another (at least 50 cm) to reduce the mutual inductance between the two conductors. Even the profile of bonding conductors is not important, but a flat profile is preferable. The conductor should also be as short as possible.

- Parallel earthing conductor (PEC)

The parallel earthing conductor must be designed to handle high currents when it is used for protection against lightning or for the return of high fault currents.

When cable shielding is used as a parallel earthing conductor, it cannot handle such high currents and the solution is to run the cable along metal structural elements or cableways which then act as other parallel earthing conductors for the entire cable.

Bonding conductors may be metal strips, and flat braids are preferable (skin effect) because a round conductor has a higher impedance than a flat conductor with the same cross section. Where possible, the length to width ratio should not exceed 5.

3. EMC Implementation– Mitigation of Electromagnetic Interference(EMI)

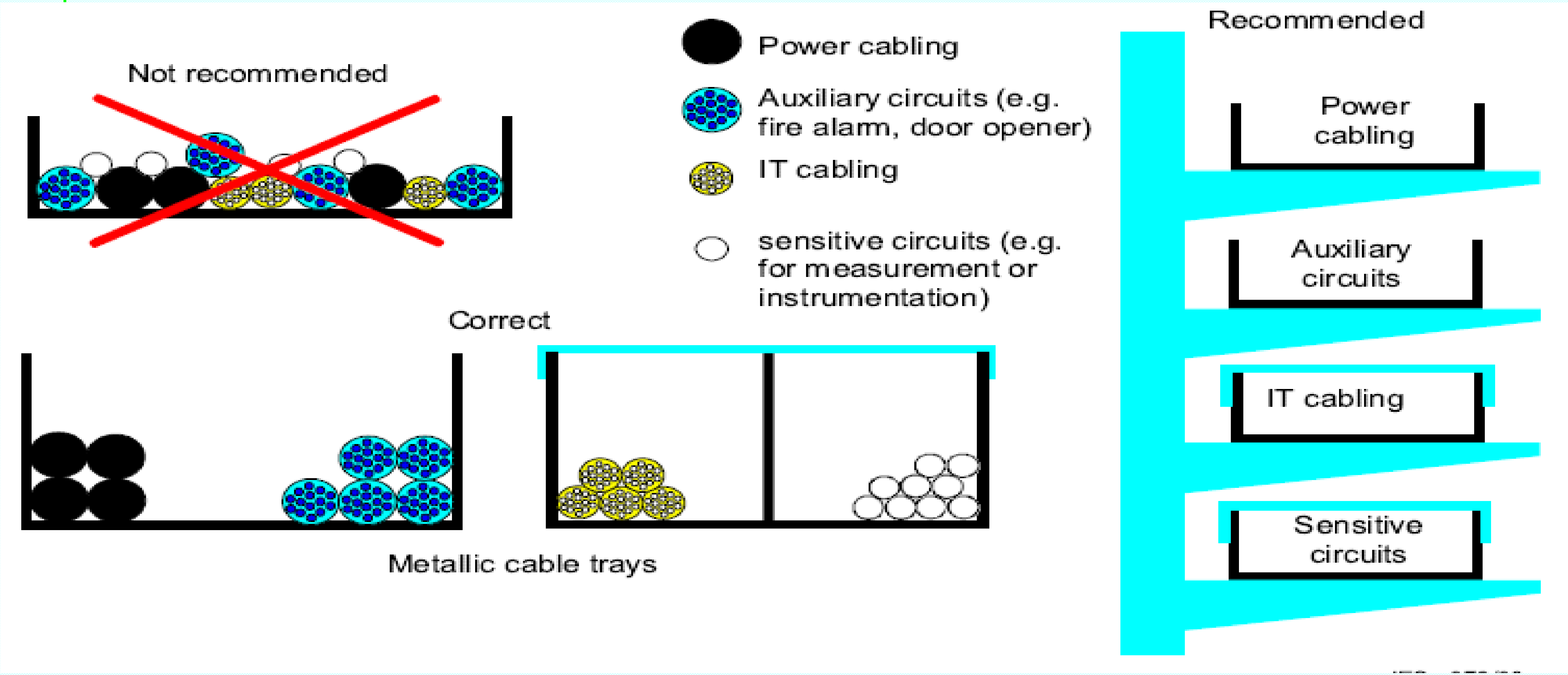
C. Separating cables:

- The physical separation of high and low-current cables is very important for EMC, particularly if low-current cables are not shielded or the shielding is not connected to the exposed conductive parts (ECPs). The sensitivity of electronic equipment is in large part determined by the accompanying cable system.
- If there is no separation (different types of cables in separate cableways, minimum distance between high and low-current cables, types of cableways, etc.), electromagnetic coupling is at its maximum. Under these conditions, electronic equipment is sensitive to EMC disturbances flowing in the affected cables.
- Use of busbar trunking systems such as Canalis or busbar ducts for high power ratings is strongly advised. The levels of radiated magnetic fields using these types of trunking systems is 10 to 20 times lower than standard cables or conductors.

Mitigation Of Electromagnetic Compatibility(EMC)

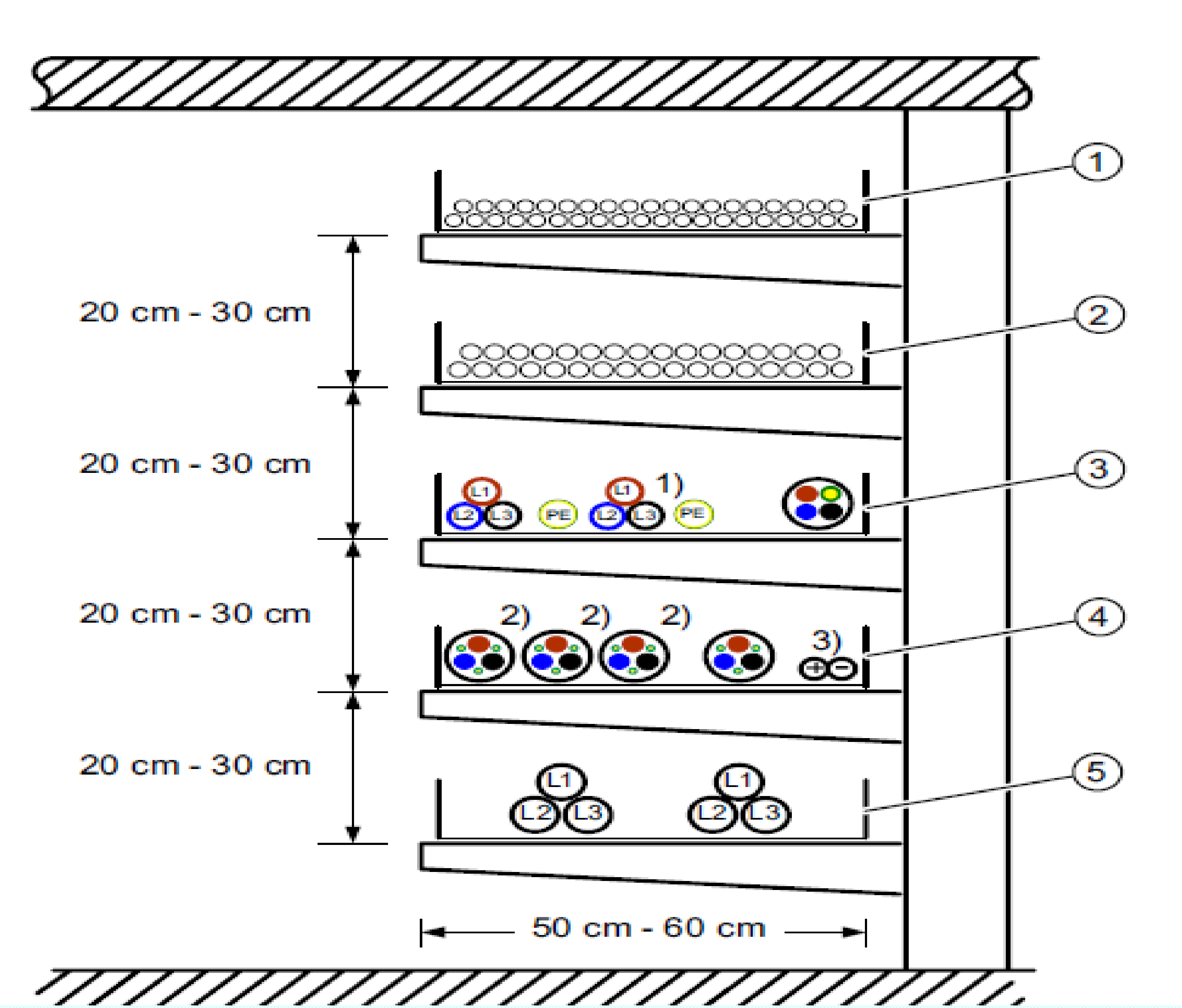
3. EMC Implementation– Mitigation of Electromagnetic Interference(EMI)

C. Separating cables:



3. EMC Implementation– Mitigation of Electromagnetic Interference(EMI)

C. Separating cables:



3. EMC Implementation– Mitigation of Electromagnetic Interference(EMI)

D. Raised Floor:

- The screening effect of a raised floor, equipotentiality.
- If the contact between the support brackets is faulty to add an equipotential mesh.
- To ensure effective electrical connections between the metal pedestals. Small spring clips are available on the market to connect the metal pedestals to the equipotential mesh. A mesh 1.5 to 2 metres in size is suitable in most cases. The recommended cross-sectional area of the copper is 10 mm^2 or more. In general, a flat braid is used. To reduce the effects of corrosion, it is advised to use tin-plated copper.

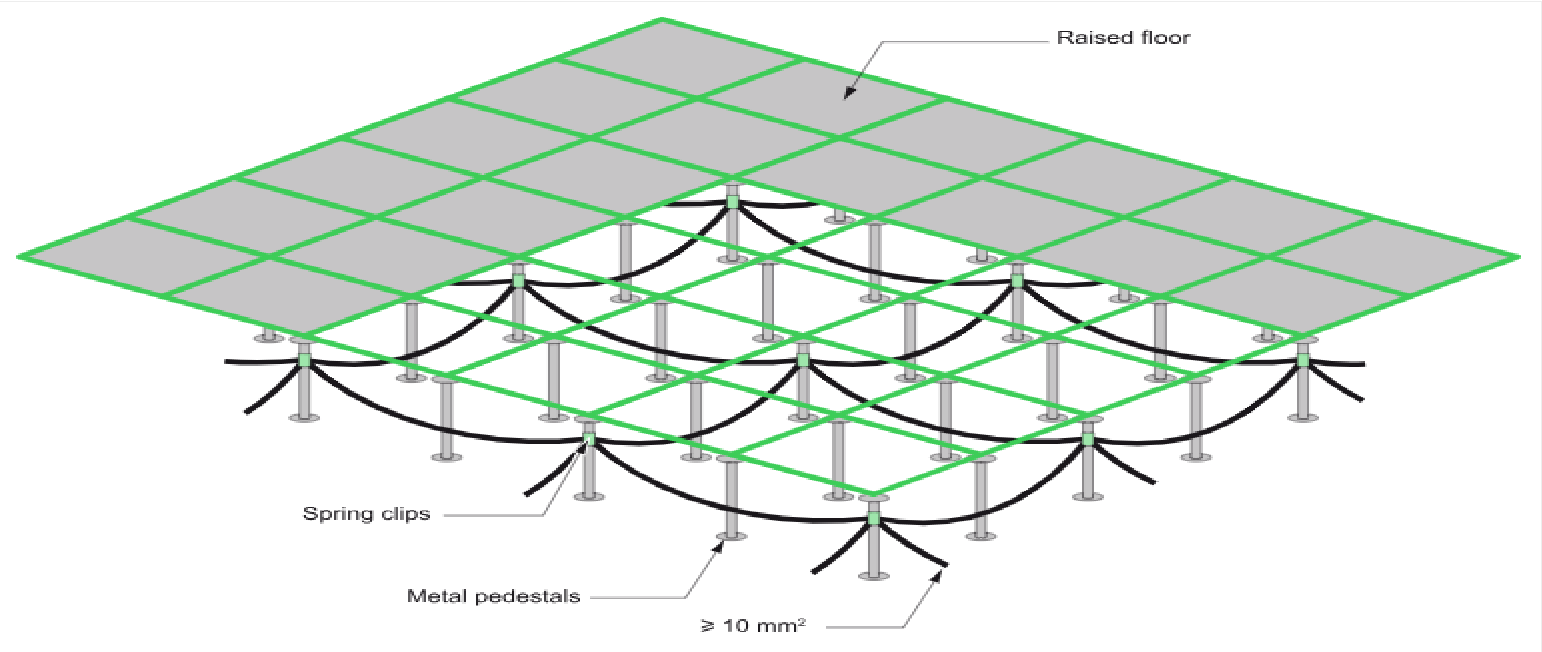


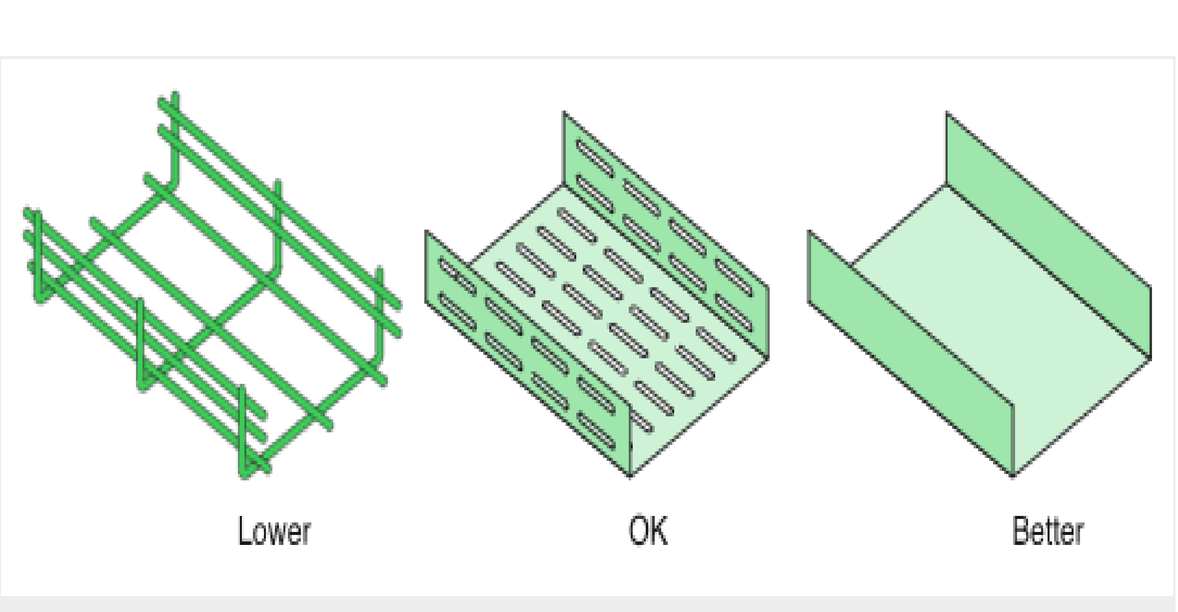
Fig. R8 – Raised floor implementation

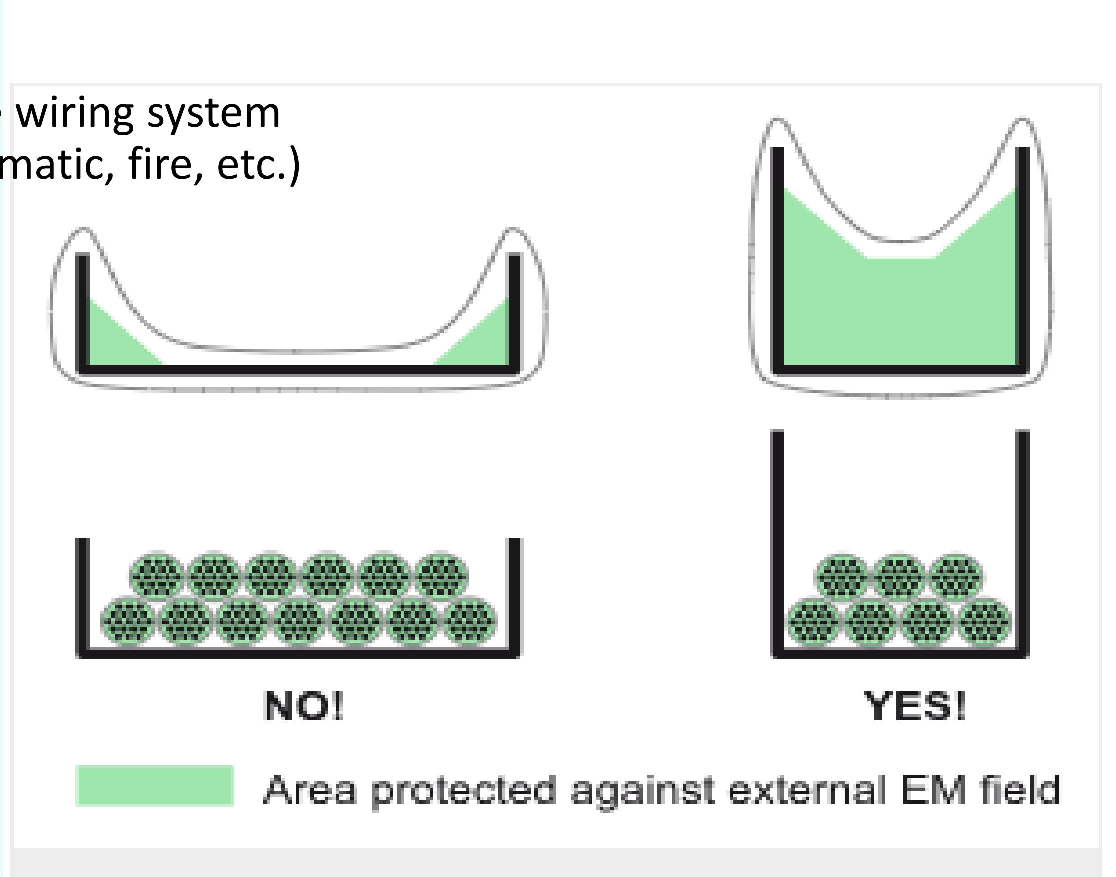
3. EMC Implementation– Mitigation of Electromagnetic Interference(EMI)

E. Cable Running:

Selection of materials and their shape depends on the following criteria:

- Severity of the EM environment along cableways (proximity of sources of conducted or radiated EM disturbances)
- Authorised level of conducted and radiated emissions
- Type of cables (shielded?, twisted?, optical fibre?)
- EMI withstand capacity of the equipment connected to the wiring system
- Other environmental constraints (chemical, mechanical, climatic, fire, etc.)
- Future extensions planned for the wiring system



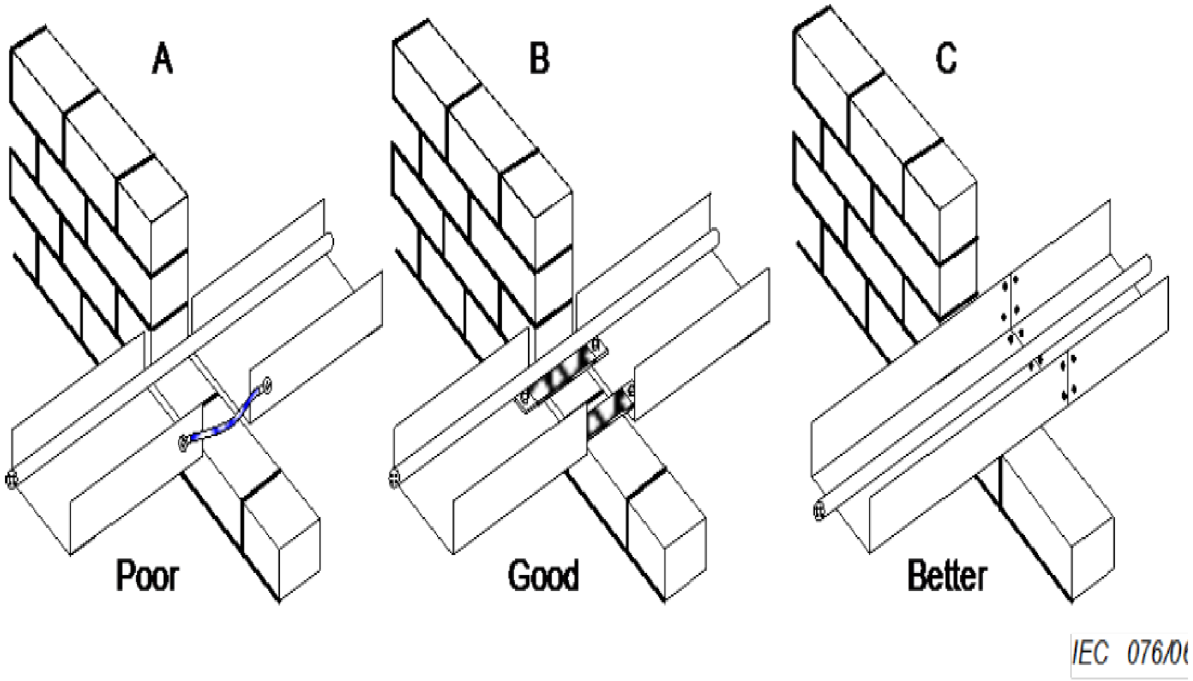


3. EMC Implementation– Mitigation of Electromagnetic Interference(EMI)

E. Cable Running:

Non-metal cableways are suitable in the following cases:

- A continuous, low-level EM environment
- A wiring system with a low emission level
- Situations where metal cableways should be avoided (chemical environment)
- Systems using optical fibres



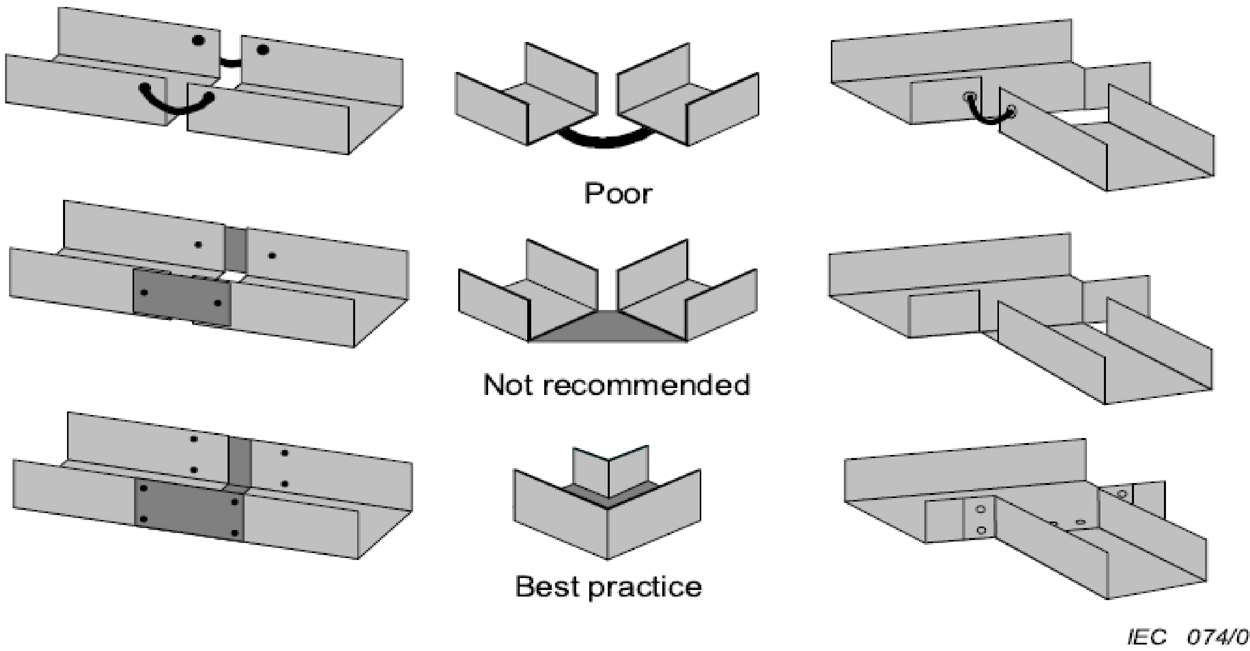


Figure 44.R20 – Continuity of metallic system components

3. EMC Implementation– Mitigation of Electromagnetic Interference(EMI)

E. Cable Running:

- When a metal cableway is made up of a number of short sections, care is required to ensure continuity by correctly bonding the different parts. The parts should preferably be welded along all edges. Riveted, bolted or screwed connections are authorised as long as the contact surfaces conduct current (no paint or insulating coatings) and are protected against corrosion. Tightening torques must be observed to ensure correct pressure for the electrical contact between two parts.

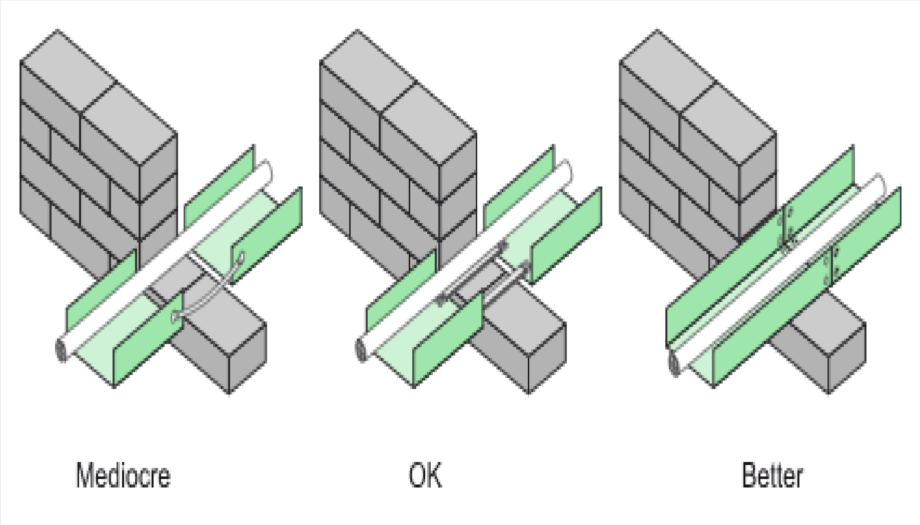


Fig. R14 – Recommendation for metal cableways assembly to pass through a wall

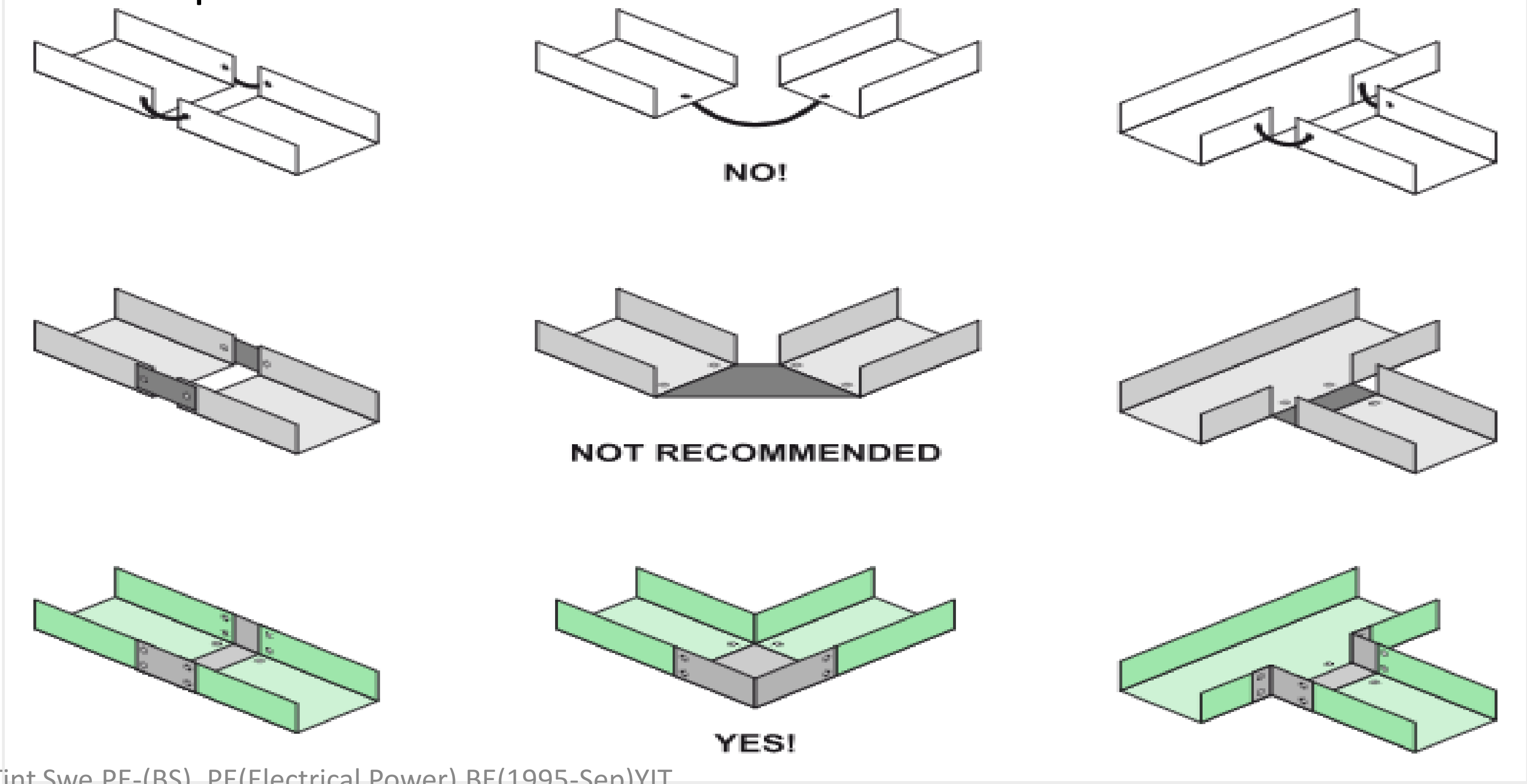


Fig. R13 – Metal cableways assembly

3. EMC Implementation– Mitigation of Electromagnetic Interference(EMI)

F. BUS Way

- **The design of busbar trunking with tightly spaced conductors in a metal enclosure helps to considerably reduce radiated electromagnetic fields.**
- **The electromagnetic field characteristics of busbar trunking are well defined and measurements show that they are far below potentially dangerous levels (see Fig. R16).**
- **In specific cases, where particularly low values are required (computer rooms, medical rooms, some offi ces), it is important to minimize the magnetic induction generated by power cables.**

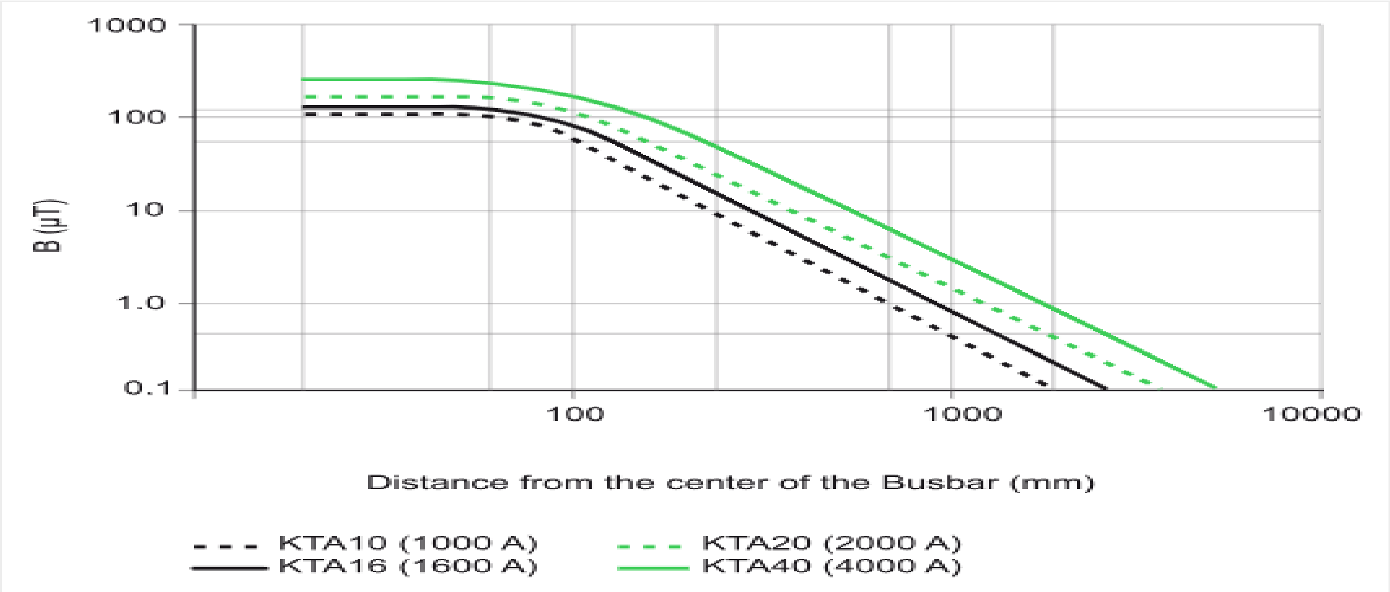


Fig. R16 – Canalis busbar trunking system data

3. EMC Implementation– Mitigation of Electromagnetic Interference(EMI)

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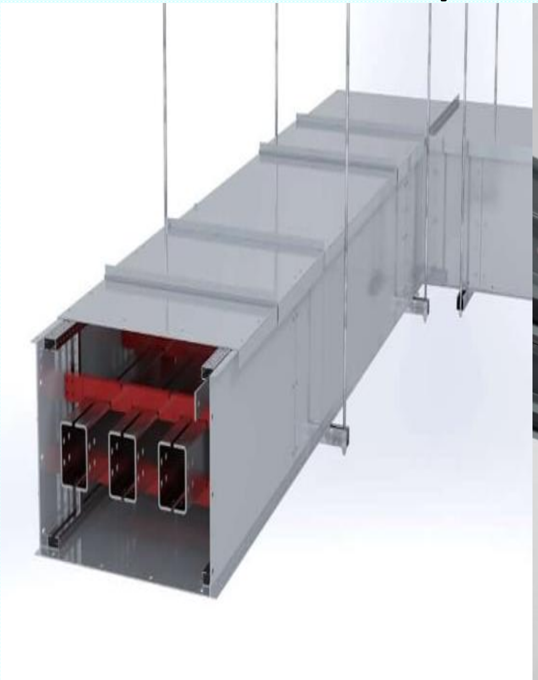
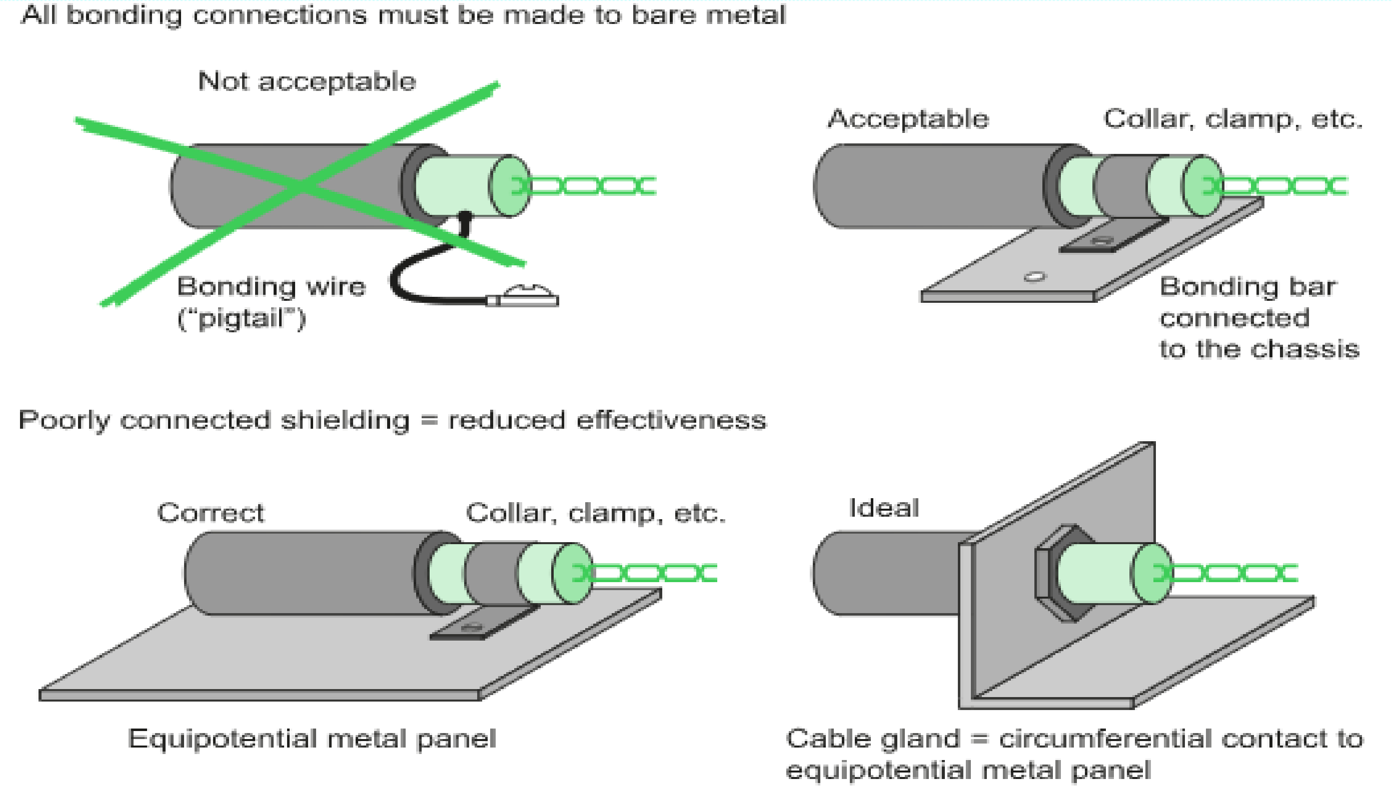


Mitigation Of Electromagnetic Compatibility(EMC)

3. EMC Implementation– Mitigation of Electromagnetic Interference(EMI)

G. Implementation Of Shielded Cables:

- The shielded cable connects equipment located in the same equipotential bonding area, the shielding must be connected to the exposed conductive parts (ECP) at both ends.



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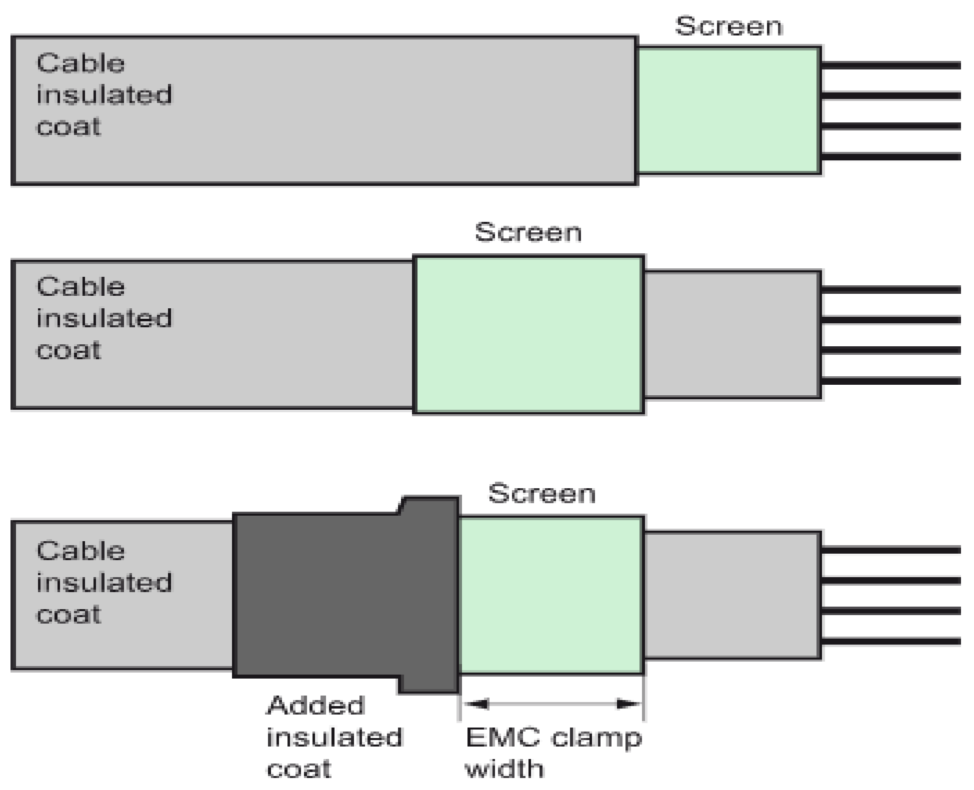


Fig. R18 – recommended screen preparation

G. Implementation Of Shielded Cables:

- **If the connected equipment is not in the same equipotential bonding area, there are a number of possibilities;**
  - **Connection at only one end to the ECPs is dangerous. If an insulation fault occurs, the voltage in the shielding can be fatal for an operator or destroy equipment. In addition, at high frequencies, the shielding is not effective.**
  - A parallel earthing conductor (PEC) must be run next to the shielded cable. The size of the PEC depends on the short-circuit current in the given part of the installation. It is clear that if the installation has a well meshed earthing network, this problem does not arise.

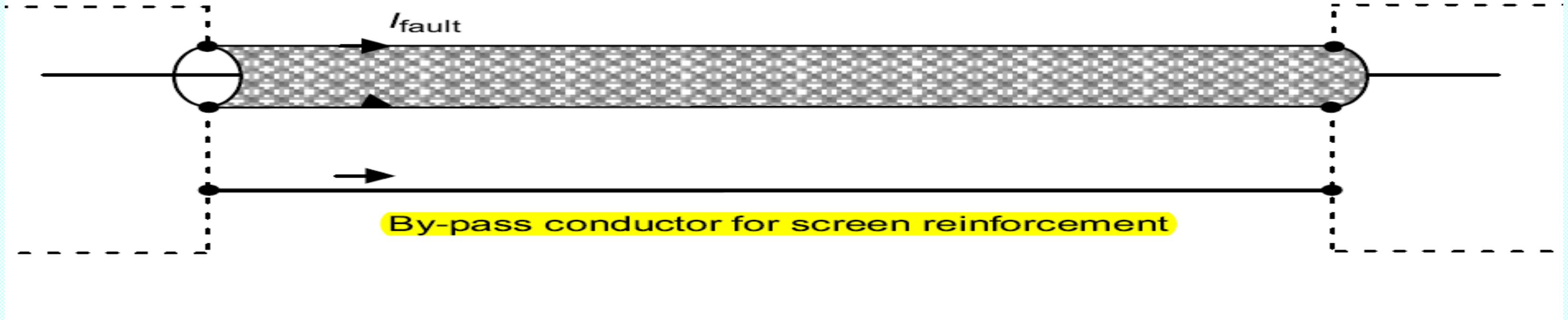
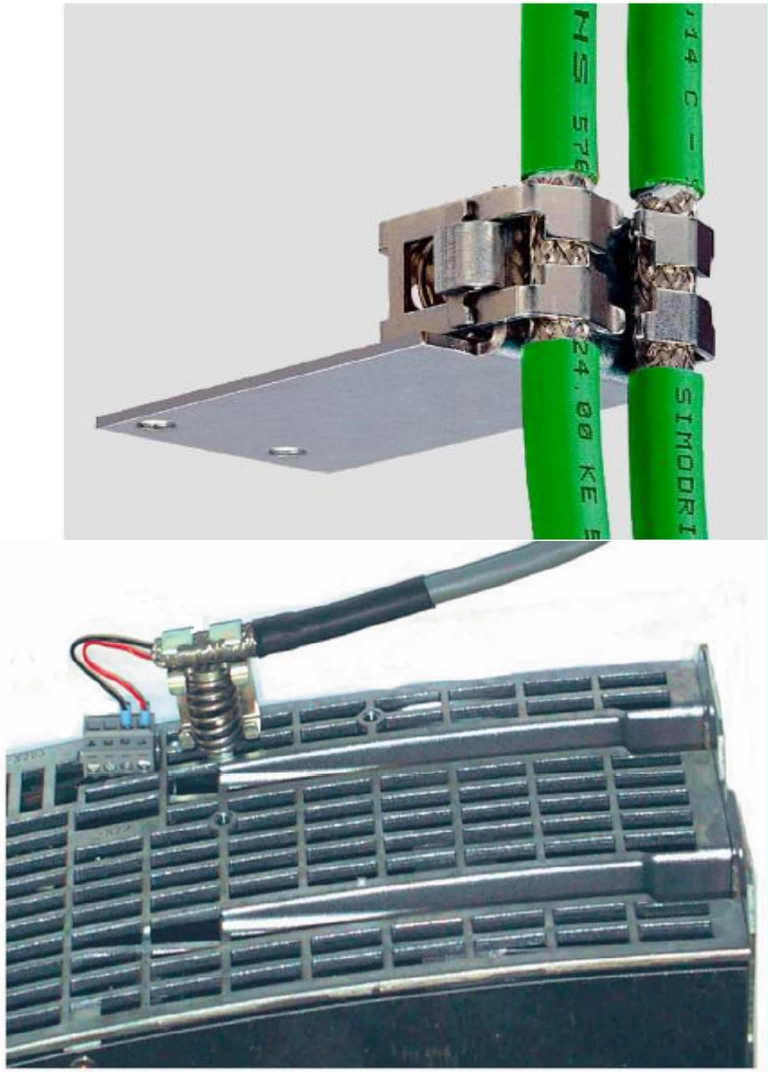


Figure 44.R1 – By-pass conductor for screen reinforcement to provide a common equipotential bonding system

Examples of shield connections



H. Communication Network:

- The category of the different cables shall be the same,
- Cables and connections of different categories the resultant performance will be determined lowest performing component,
- The Terminal Outlets (TO) could be used to earth the screen terminations

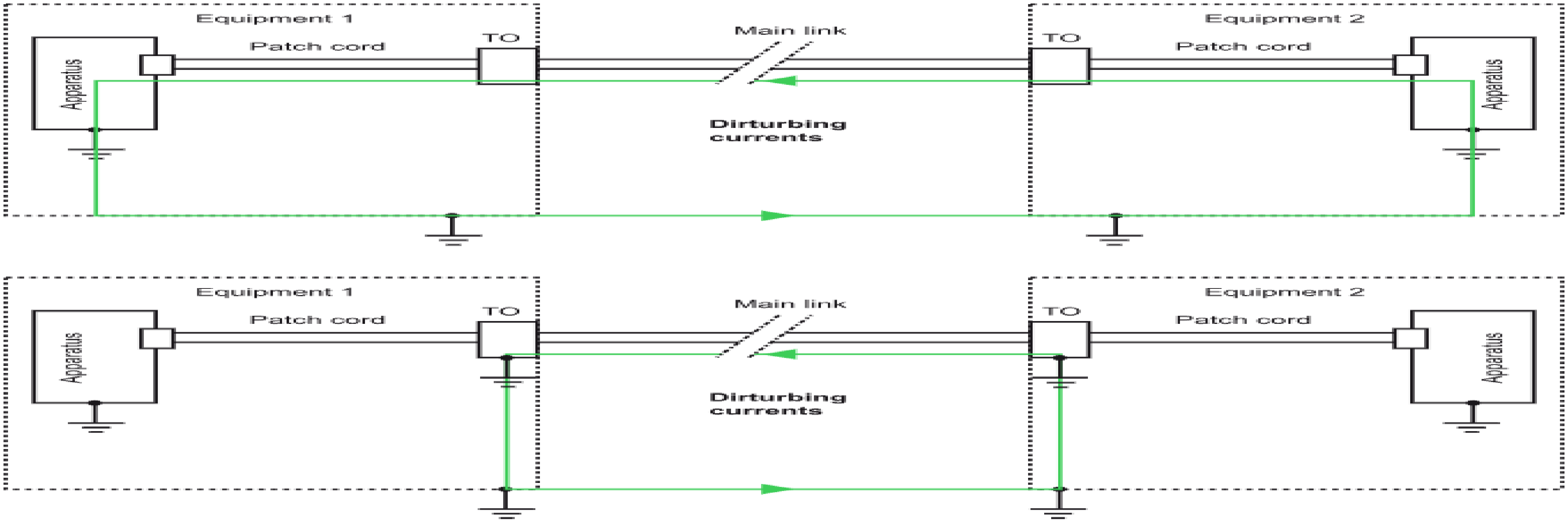


Fig. R19 – How to reduce disturbing currents loop

3. EMC Implementation– Mitigation of Electromagnetic Interference(EMI)

H. Communication Network:

- The use of TN-S earthing system and well equipotential installation minimize this issue.
- The use of Surge Protective Device (SPD) installed in Common Mode and/or Differential Mode is recommended.
- To avoid electrical safety issue, the optical fiber link should not have any metallic parts.

Protection against coils disturbances

AC and mostly DC Coils (relay, contactor, actuator, etc.) are very disturbing sources.

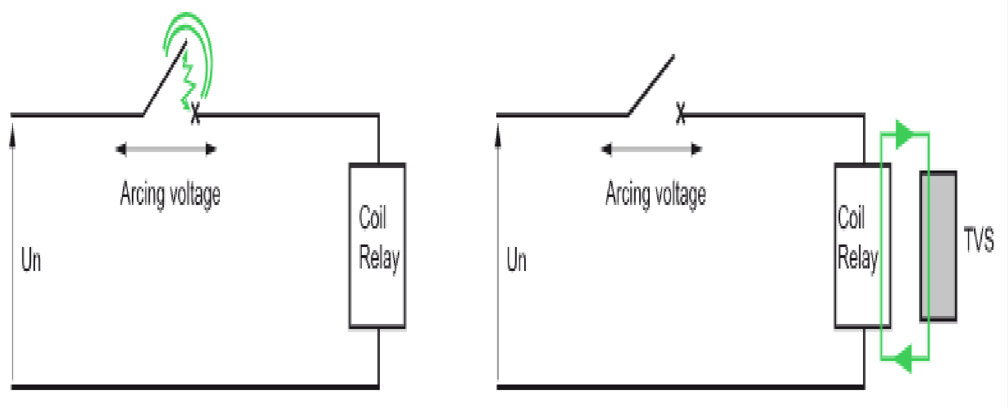


Fig. R20 – TVS reduces the arcing voltage

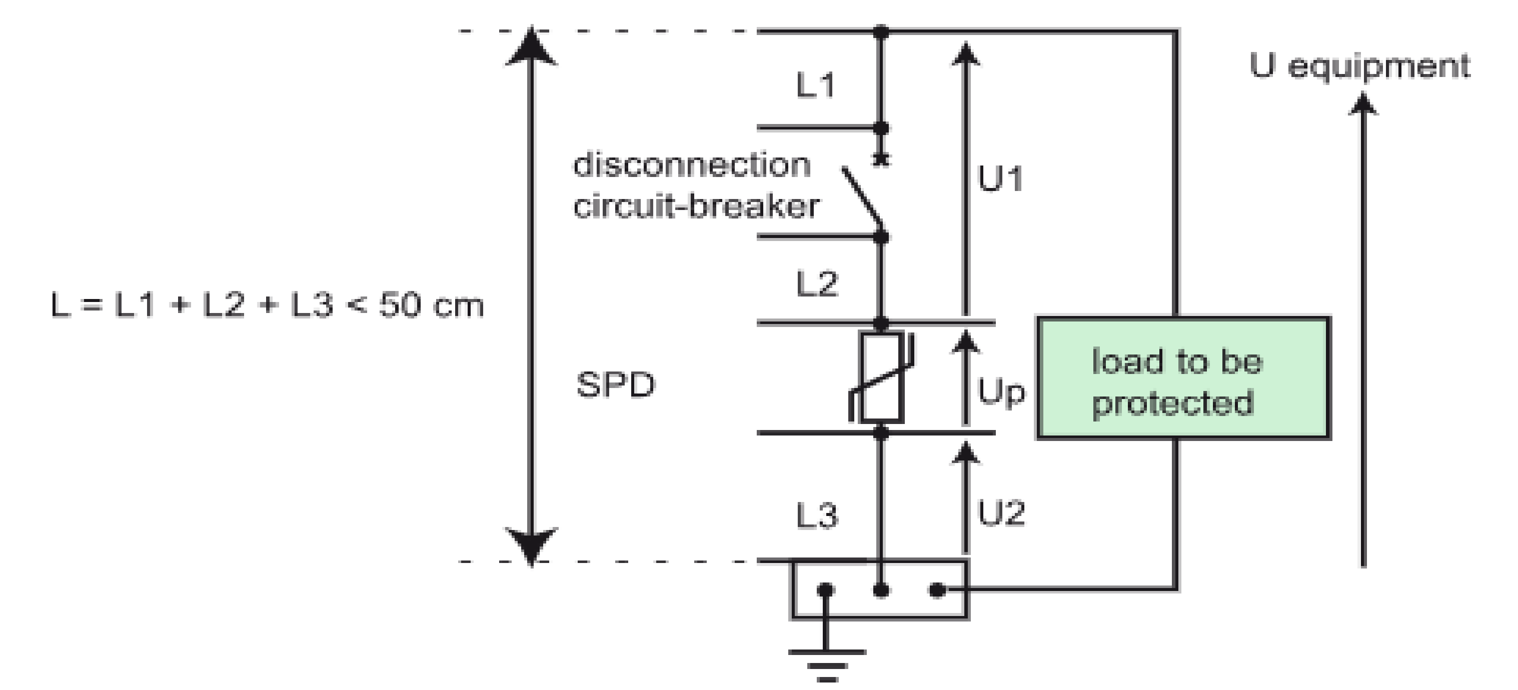
Fig. R21 – TVS table information

Symbol	Transient Voltage Suppression type	For AC	For DC	Overvoltage limitation	Contact fall time
	R-C network	Y	Y	2 to 3 . Un	1 to 2 times the standard time
	Metal Oxide Varistor	Y	Y	< 3 . Un	1.1 to 1.5 times the standard time
	Transient Voltage Suppression Diode Bidirectional	Y	Y	< 2. Un	1.1 to 1.5 times the standard time
	Transient Voltage Suppression Diode Directional	N	Y	Un + 0.7 V	3 to 10 times the standard time
	Free wheeling diode	N	Y	Un + 0.7 V	3 to 10 times the standard time
	Resistor	Y	Y	< 4 . Un	1.5 to 2.5 times the standard time

3. EMC Implementation– Mitigation of Electromagnetic Interference(EMI)

I. Implementation Of Surge Arresters

- The Electromagnetic Interference arise from ,such as the Lightning, Switchgear operation, High Tension faults shall consider the implementation of surge arresters (surge protective devices).
- The total length of SPD connections to the network and the earth terminal block should not exceed 50 cm.
- Minimum cable size for SPD Type 2= 4sqmm, and Type 1 = 16 sqmm,

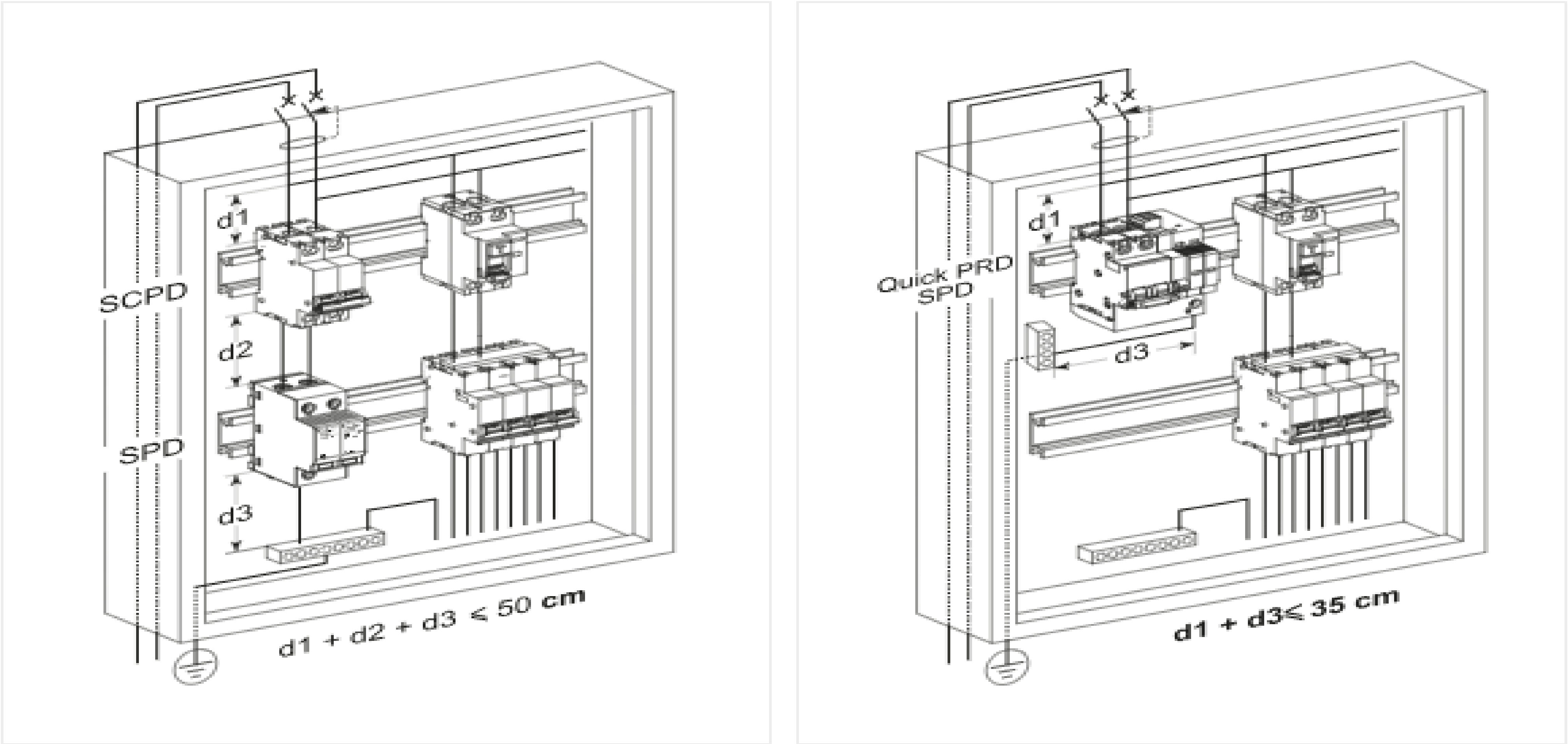


3. EMC Implementation– Mitigation of Electromagnetic Interference(EMI)

I. Implementation Of Surge Arresters

❖ Cabling Rule Of Surge Protection Device: RULE 1

Fig. J42 – SPD with separate or integrated external SCPD



I. Implementation Of Surge Arresters

❖ Cabling Rule Of Surge Protection Device: RULE 2

The conductors of protected outgoing feeders:

- should be connected to the terminals of the external SCPD or the SPD;
- should be separated physically from the polluted incoming conductors.

They are located to the right of the terminals of the SPD and the SCPD (see **Figure J43**).

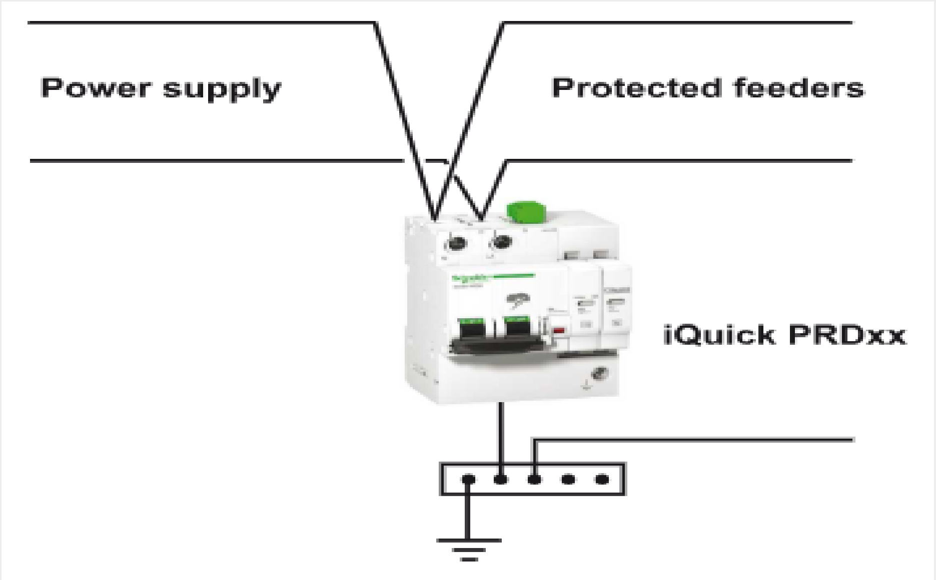
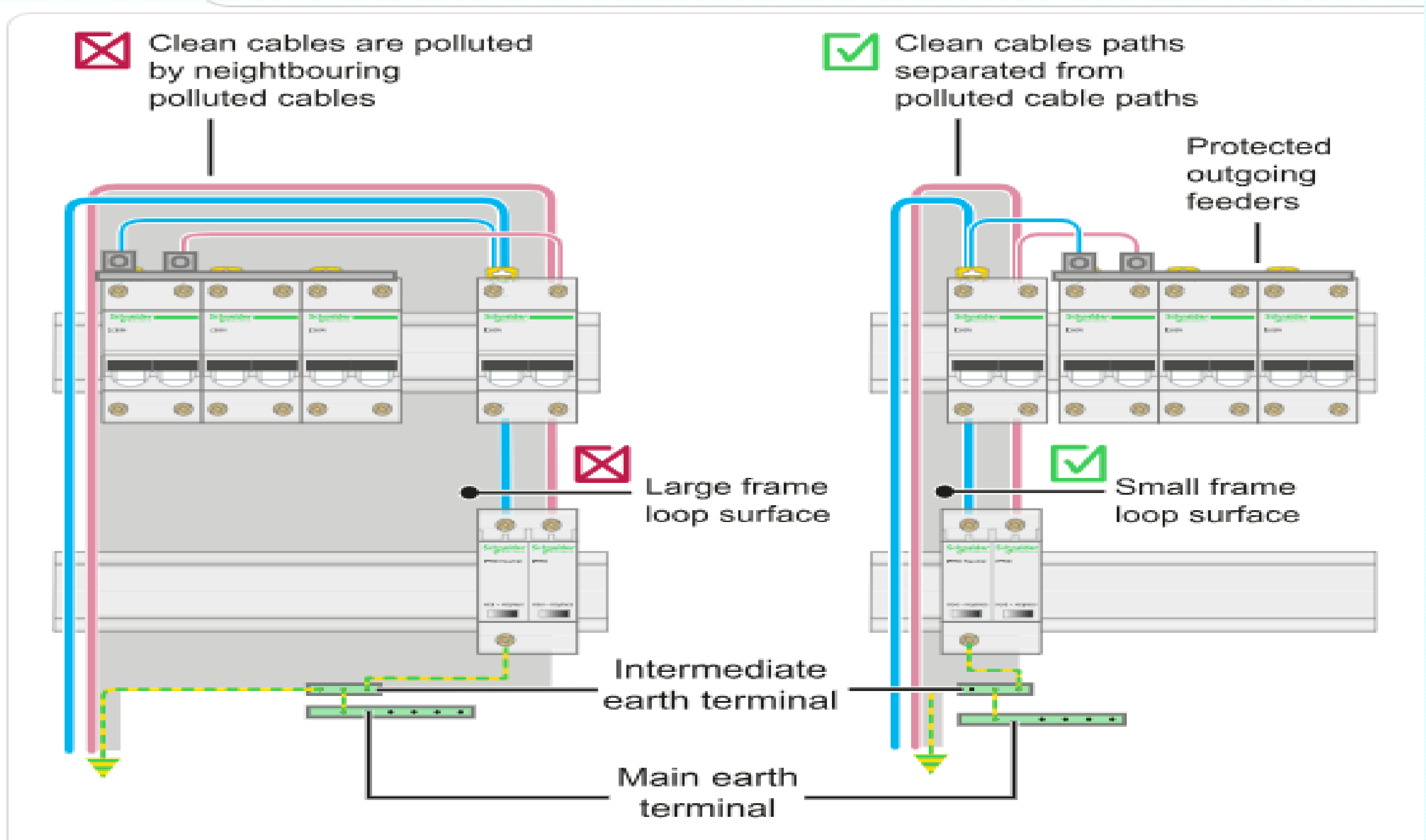


Fig. J43 – The connections of protected outgoing feeders are to the right of the SPD terminals

3. EMC Implementation– Mitigation of Electromagnetic Interference(EMI)

I. Implementation Of Surge Arresters

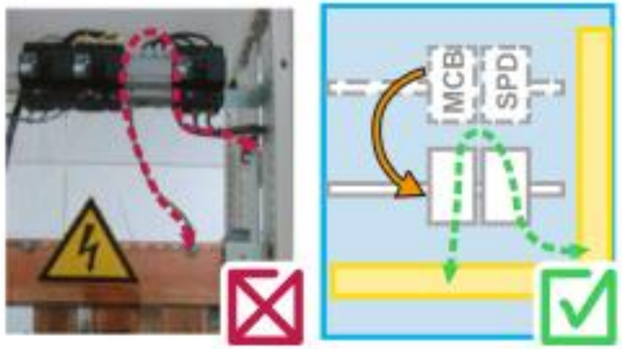
- Cabling rules (3,) incoming feeder phase, neutral and protection (PE) conductors run one beside another in order to reduce the loop surface.
- Cabling rule (4), incoming conductors of the SPD should be remote from the protected outgoing conductors to avoid coupling,



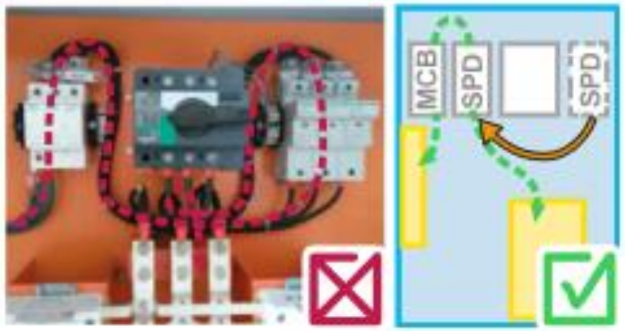
3. EMC Implementation– Mitigation of Electromagnetic Interference(EMI)

I. Implementation Of Surge Arresters

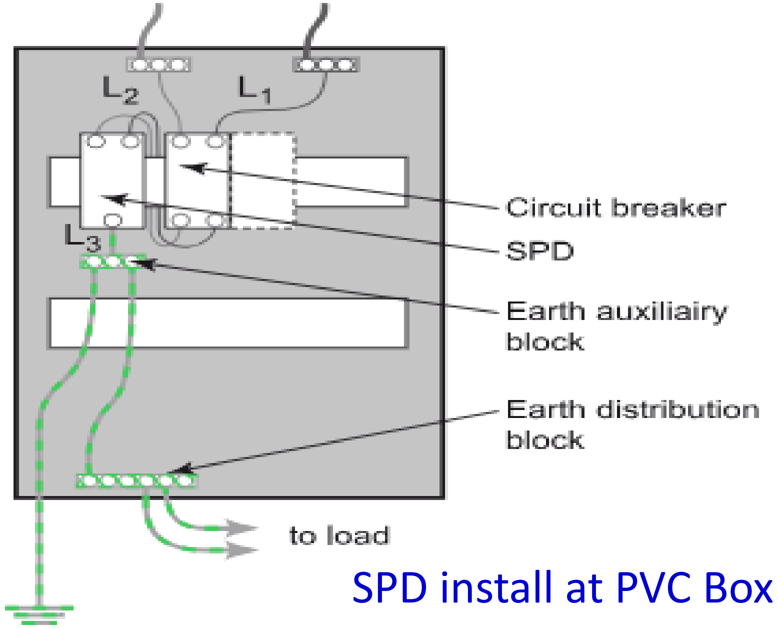
- Connection of Surge Protection Device
  - Connection in Plastic enclosure
  - Connection in Metallic enclosure
  - Conductor size



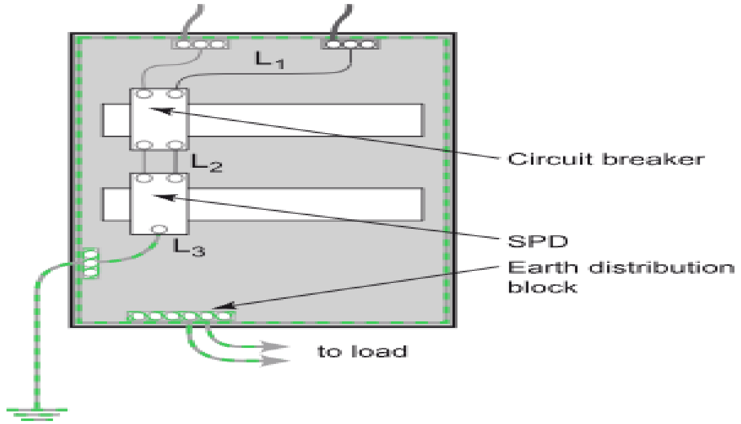
Example 1: Equipment installation design should be done in accordance **to installation rules: cables length shall be less than 50 cm.**



Exemple 2 : Positioning of devices should be linked to **installation rules: reduce length of cables < 50 cm and keep the loop area rule of reducing impact of magnetic fields created by lightning current.**



SPD install at PVC Box



SPD install at metal Box, body earth to do

3. EMC Implementation– Mitigation of Electromagnetic Interference(EMI)

J. Cabinet Cabling

Each cabinet must be equipped with an earthing bar or a ground reference metal sheet. All shielded cables and external protection circuits must be connected to this point. Anyone of the cabinet metal sheets or the DIN rail can be used as the ground reference.
Plastic cabinets are not recommended. In this case, the DIN rail must be used as ground reference.

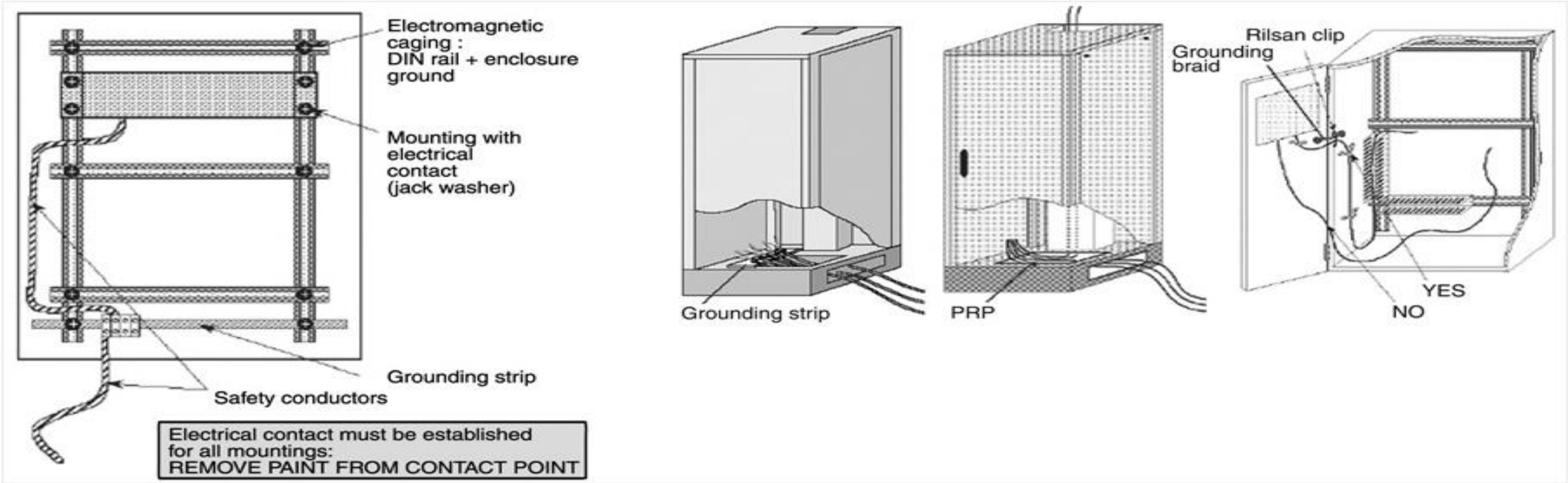
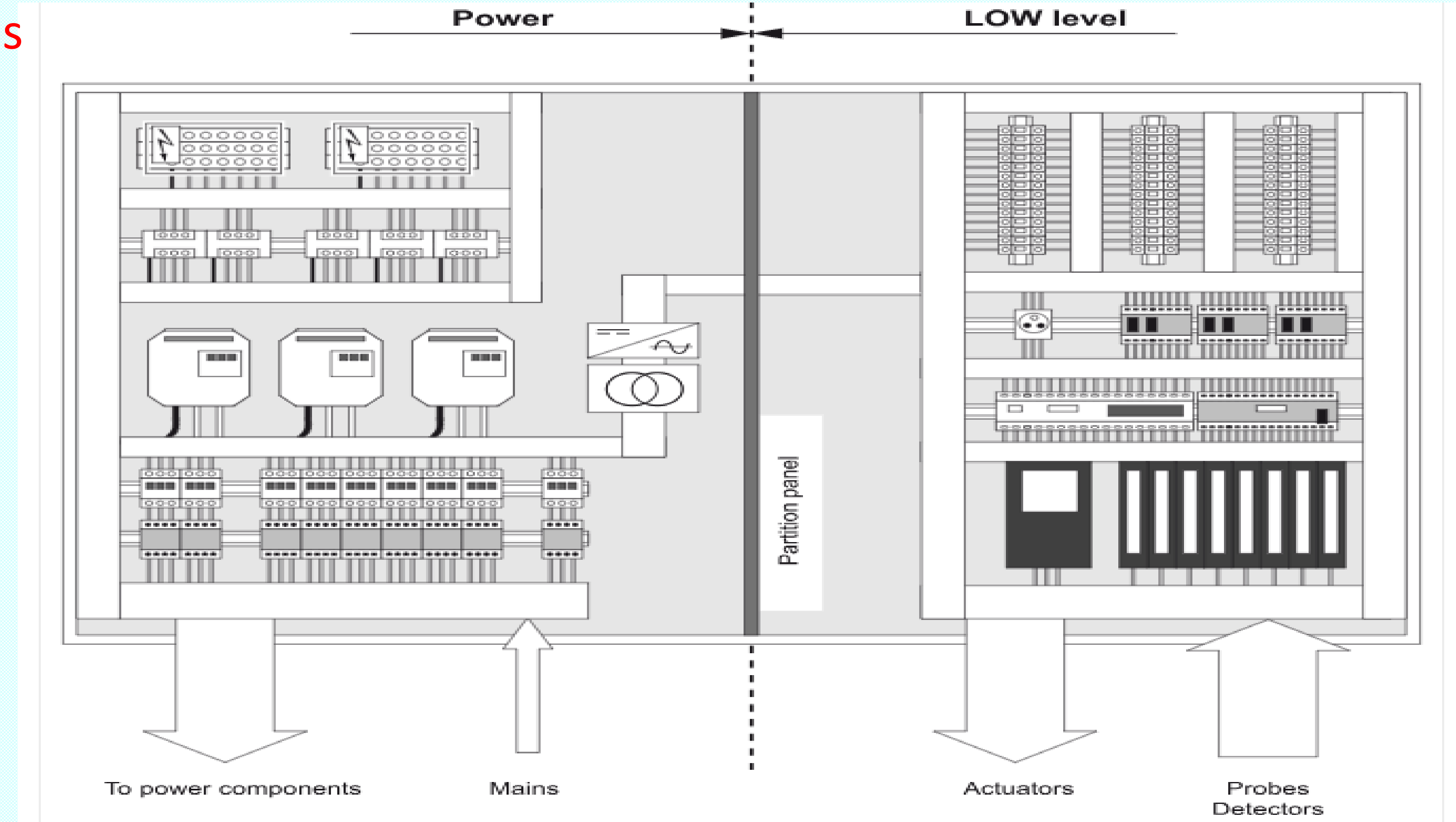


Fig. R22 – Grounding and bonding examples

J. Cabinet Cabling

- Non metallic environment. cabinet are not recommended for EMC purposes.
- Non magnetic metals (e.g. aluminum, stainless steel) are more efficient for high frequencies



J. Cabinet Cabling

- To protect electronics equipment against low frequency magnetic field, it is recommended to use (galvanized) steel cabinets.
- Power and low level apparatus shall be physically separated and cables segregation and distances between power and sensitive cables shall also be respected as shown on the figures below.

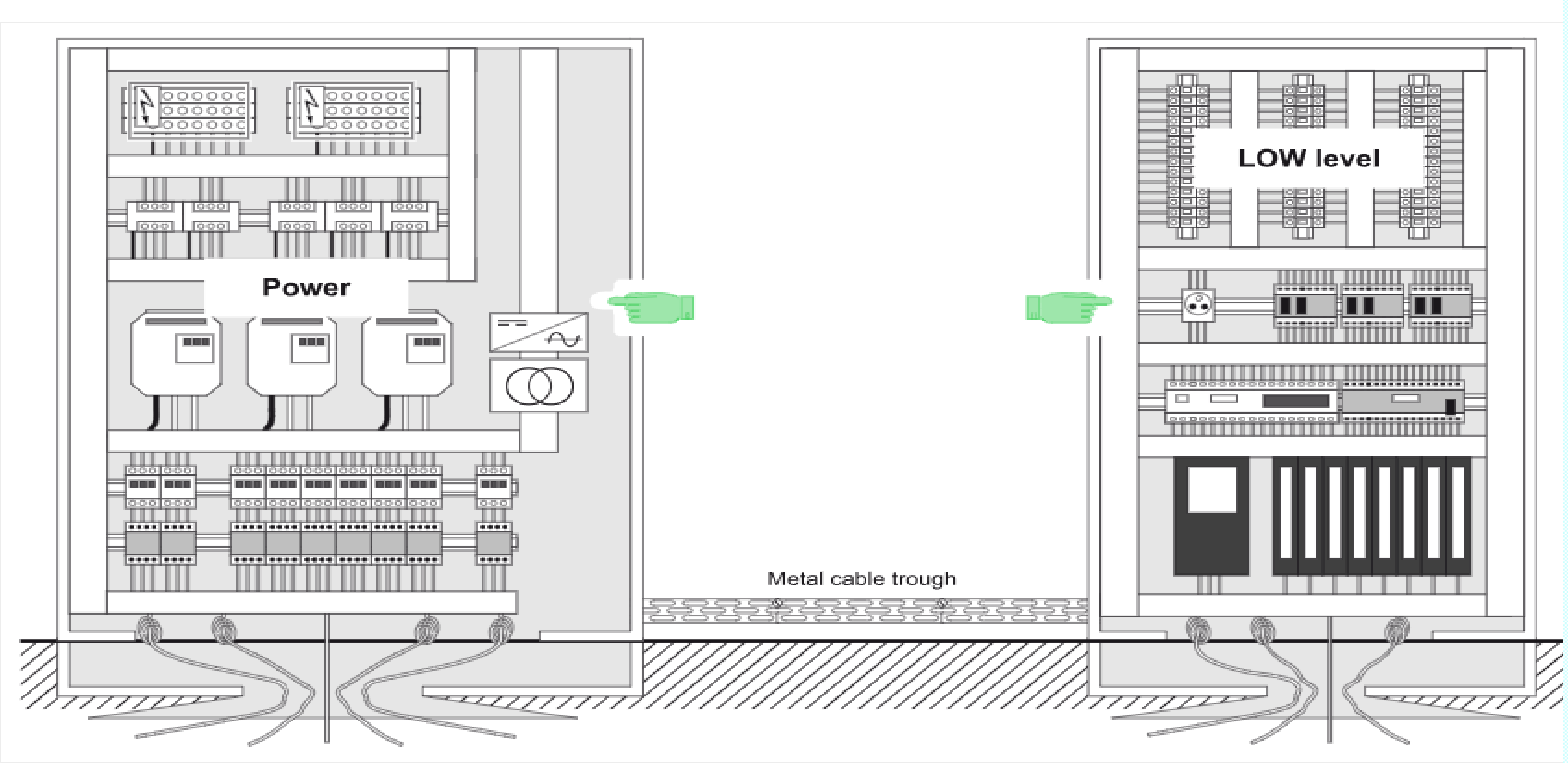
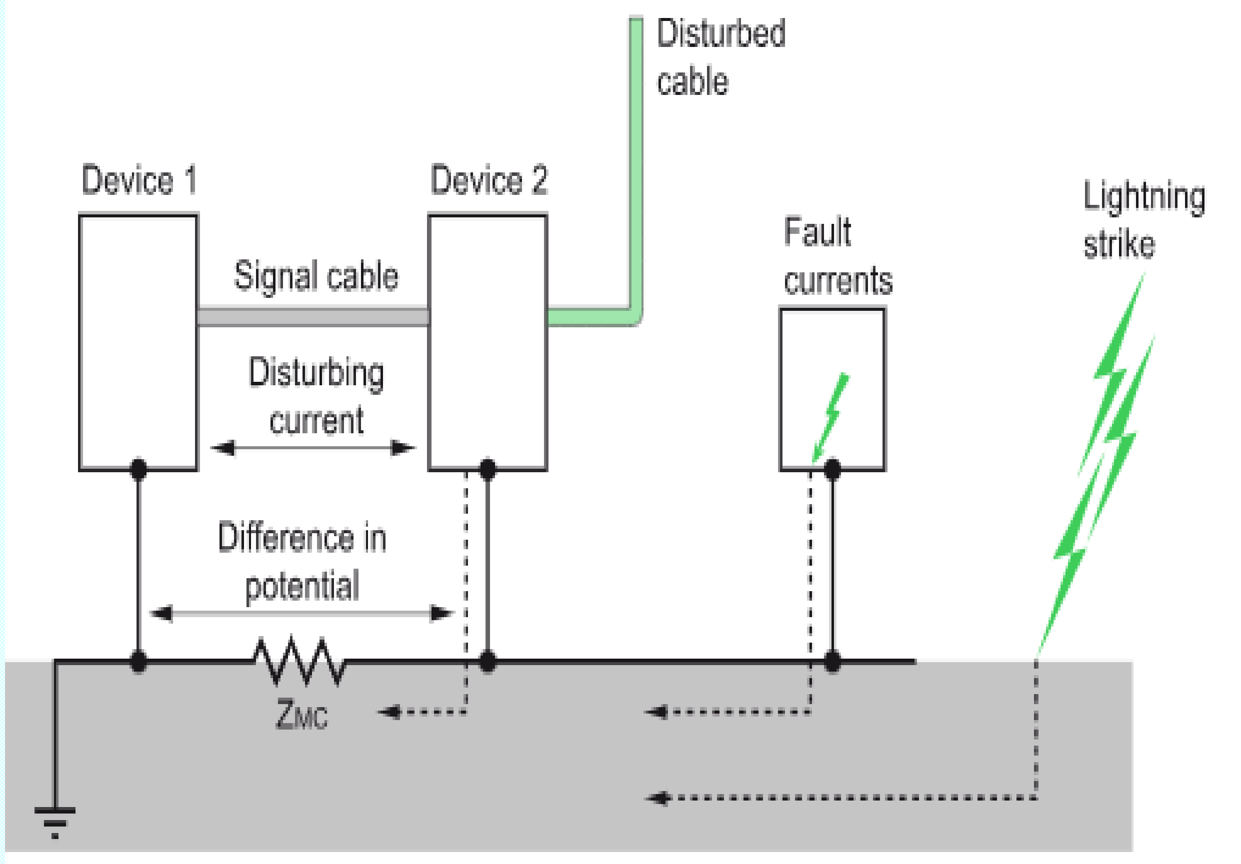


Fig. R27 – Correct EMC design inside two separate cabinets

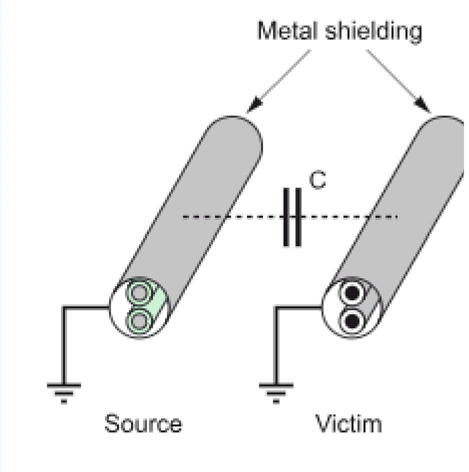
COMMON MODE-IMPEDENCE Coupling

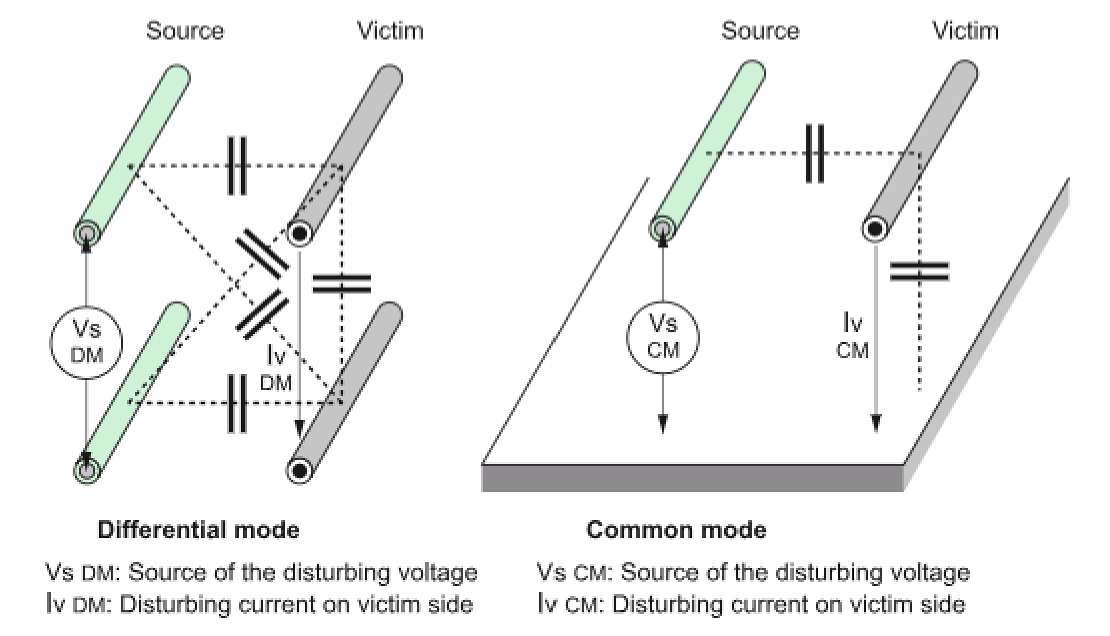
- Two or more devices are interconnected by the power supply and communication cables. When external currents (lightning, fault currents, disturbances) flow via these common-mode impedances, an undesirable voltage appears.
- This stray voltage can disturb low-level or fast electronic circuits.
- Common-mode impedances must as low as possible.
  - Reduce impedances:
  - Mesh the common references,
  - Use short cables or flat braids
  - Install functional equipotential bonding
  - Add CMI Filter.



CAPACITIVE COUPLING :

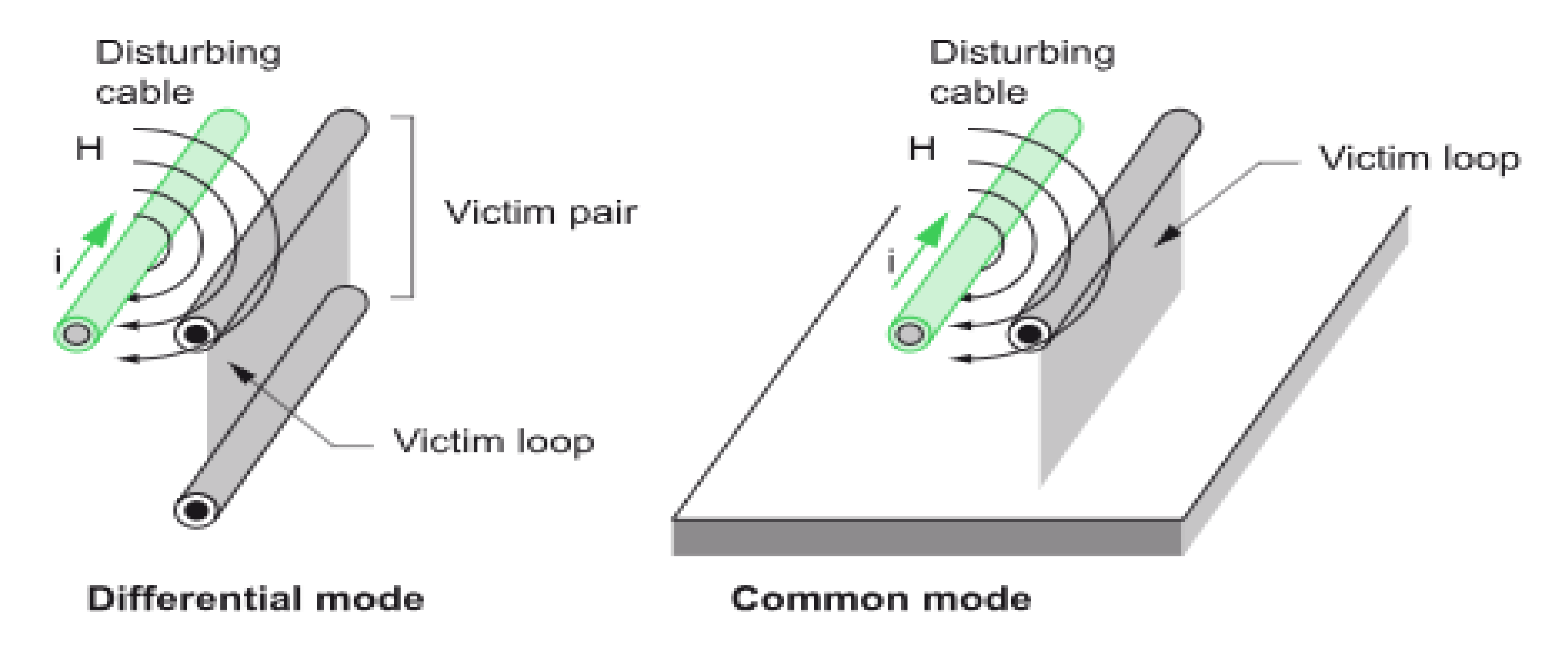
- Capacitive coupling increases with voltage vibration di/dt, some facts are:
- frequency
- proximity of the EMI emitter to the victim and the paralleling length cables,
- height of the cables with respect to a ground referencing plane
- input impedance of the victim circuit (a high input impedance , more vulnerable)
- insulation of the victim cable,





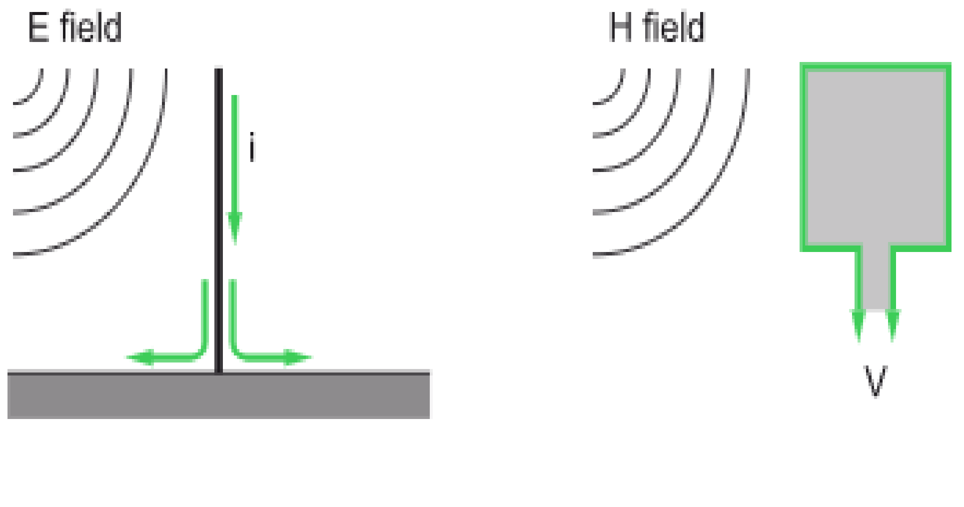
Inductive Coupling :

- Inductive coupling increases with:
  - The frequency
  - The proximity of the disturber to the victim and the length of the parallel cables,
  - The height of the cables with respect to a ground referencing plane,
  - The load impedance of the disturbing circuit.

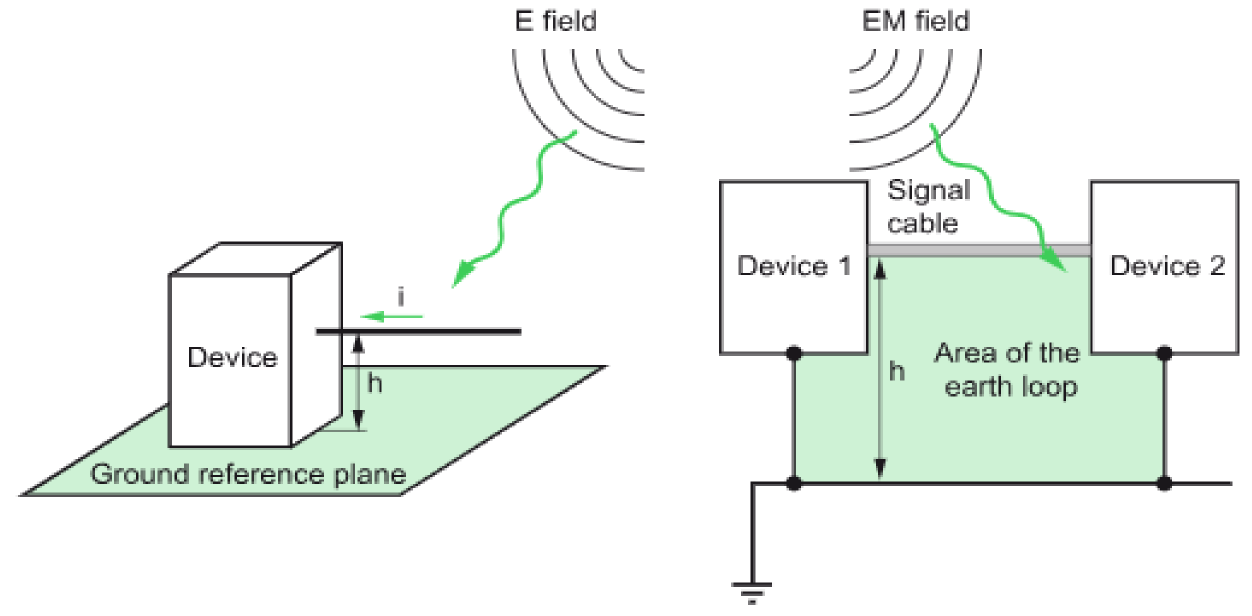


Radiated Coupling :

- An electromagnetic field comprises both an electrical field and a magnetic field. The electrical field (E field) and the magnetic field (H field) are coupled in wiring systems via the wires and loops, where variable electrical field, a current is generated in the cable. This is also called is called field-to-cable coupling.
- when a variable magnetic field flows through a loop, it creates a counter electromotive force that produces a voltage between the two ends of the loop. This phenomenon is called field-to-loop coupling.



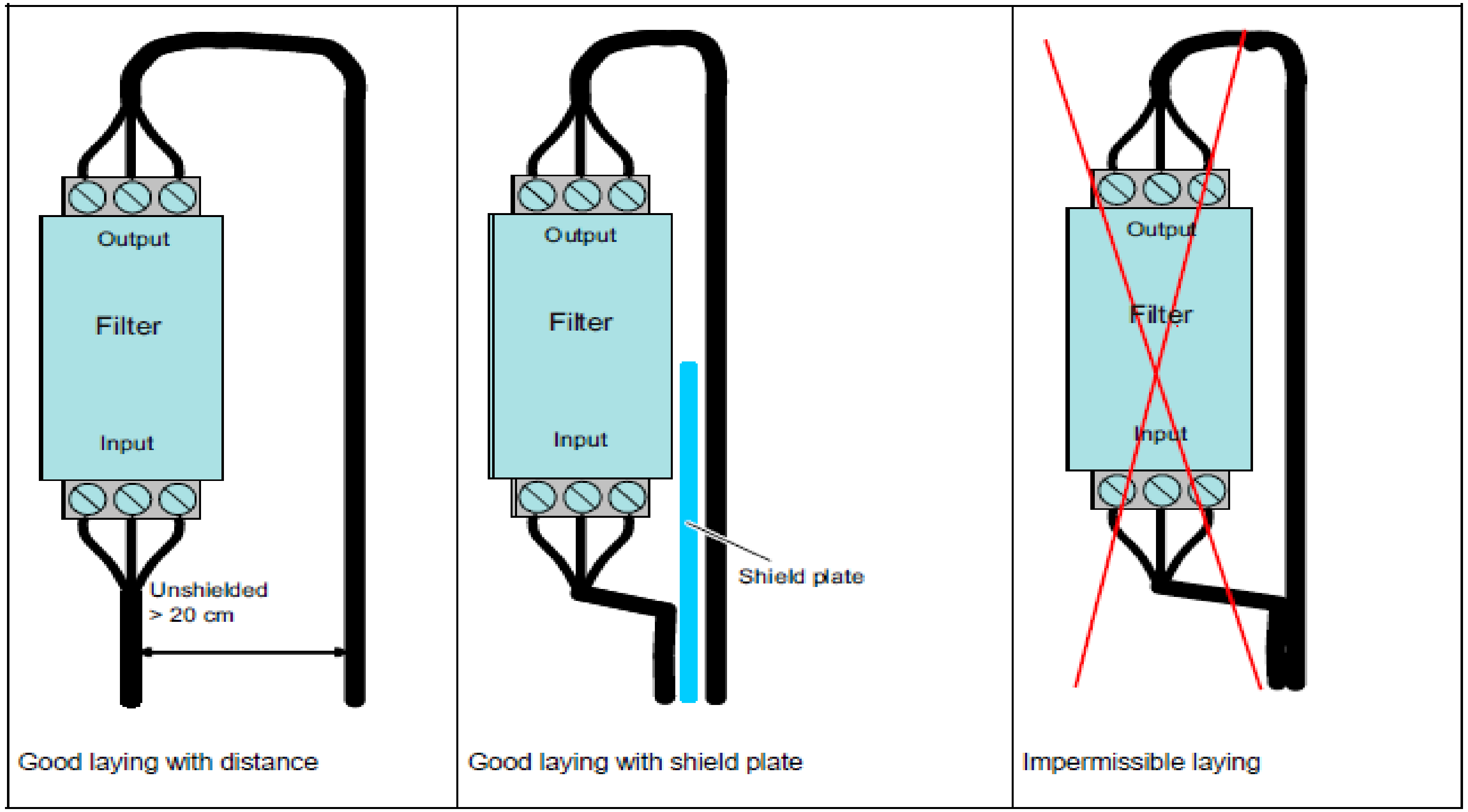
Field-to-cable coupling Field-to-loop coupling



Example of field-to-cable coupling Example of field-to-loop coupling

WIRING Recommendations:

- **Incoming cables and filters to filter outgoing cables must always be installed separately.**
- **Filtered and unfiltered cables must never be laid together.**



It is recommended that the power cables are laid shielded starting at the control cabinet inlet.

WIRING Recommendations:

Correct bundling: Incorrect bundling:

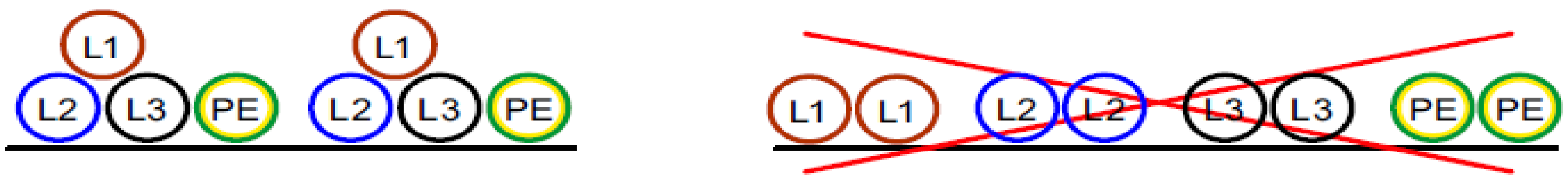


Figure 3-5 Bundling of cables

When more than one motor cable is routed in parallel, note that each individual motor cable must contain all three conductors of the three-phase system. This helps to minimize the magnetic leakage fields and thus also the magnetic interference of other loads.

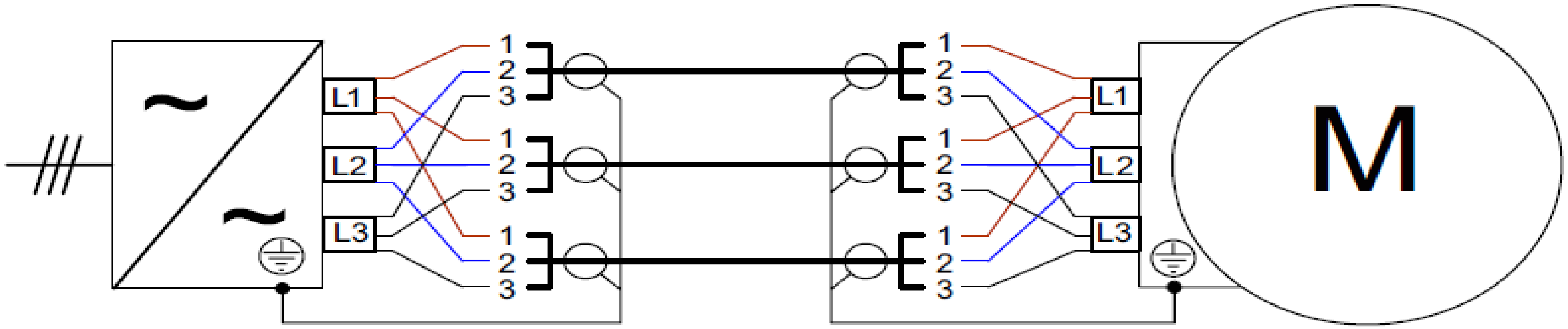


Figure 3-6 Example of three motor cables routed in parallel

Mitigation Of Electromagnetic Compatibility(EMC)

WIRING Recommendations:Cable Arrangement/Management/Bundling/ cable configuration

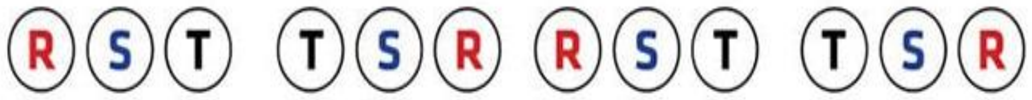


Figure 3: Systems fed on flat ground

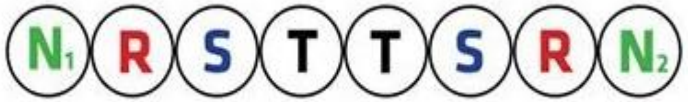


Figure 4: Systems fed on flat ground with 6 single core cables

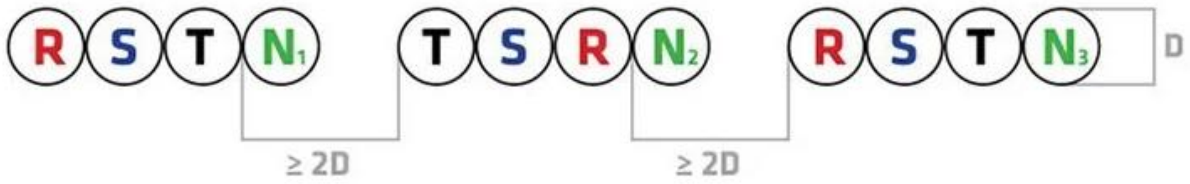


Figure 7: Systems fed on flat ground with 9 single core cables

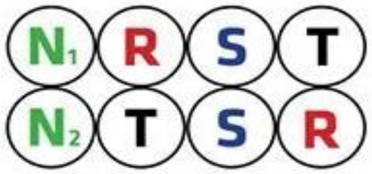


Figure 5: Systems fed with 6 single core cables in a row

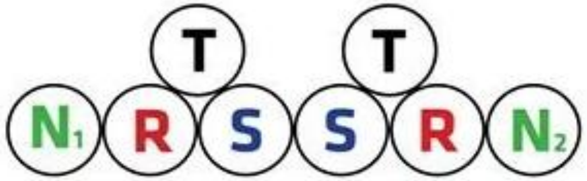


Figure 6: Systems fed with clover shaped 6 single core cables in a row

Some Types Of Cable Laying (single core without shield) in Phase Sequence Recommendations:

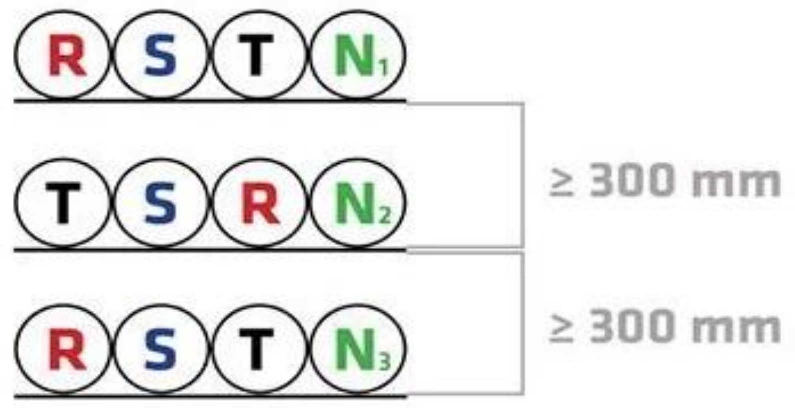


Figure 8: Systems fed with 9 single core cables in a row

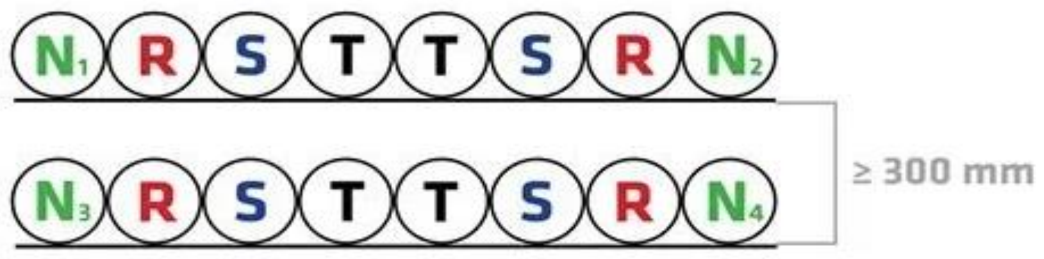


Figure 11: Systems fed with 12 single core cables in a row

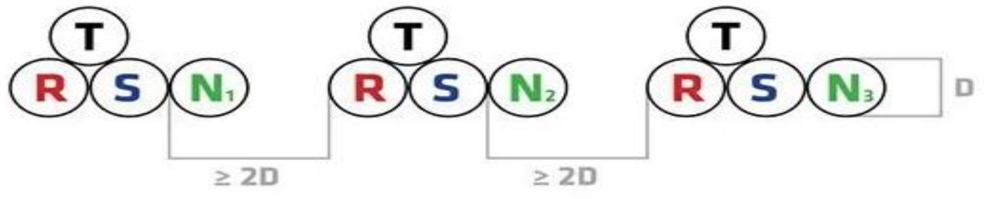


Figure 9: Systems fed with clover shaped 9 single core cables in a row

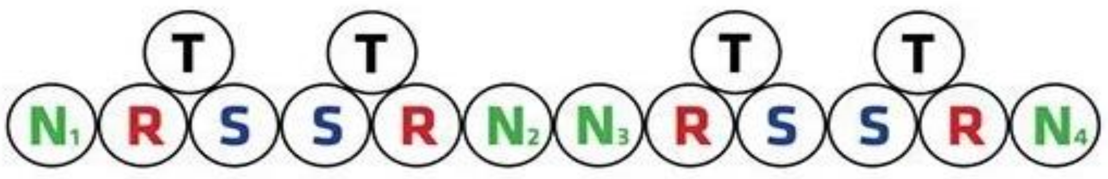


Figure 12: Systems fed with clover shaped 12 single core cables in a row

Figure 10: Systems fed on flat ground with 12 single core cables

Engr.Tint Swe,PE-(BS), PE(Electrical Power),BE(1995-Sep)YIT,
ME-ETM(Uni-SA),AFEO.Hons Member,AWE(JWS-Fed-MES

EMC In Contract of Electrical [Design,Supply and Install) Project :

- Electro-agnetic Compatibility / Quality Assurance
  - Electro-magnetic Compatibility
  - Quality Assurance
- General
  - System to be supplied shall be electromagnetically compatible with it's environmental ,
  - The electromagnetic environment includes emission from the "transit system, military installations, high voltage transmission, and distribution equipment, TV and radio broadcasting equipment telecommunication equipment and many types of domestic or public carried electrical equipment.

EMC In Contract of Electrical [Design,Supply and Install) Project :

- Electro-agnetic Compatibility / Quality Assurance
  - ALL equipment and systems shall neither interfere with nor be interfered by its electromagnetic environment.
  - Shall be comply to current EMC Standards, to ensure compliance with these standard and testing to demonstrate it.
  - Conducted (including transients), radiated, capacitively coupled, inductively coupled. And electrostatic interference , shall be considered.

- To Operate the EMC Procedure:
  - Exchage of EMC re;ated data , level of interfering emissions and susceptibility of all equipment.
  - Preparing ,Intergrated EMC tests documentation including tests programme, test specifications and test report,
  - Undertake of tests to verify EMC during commissioning of the system.

EMC In Contract of Electrical [Design,Supply and Install) Project :

- ❖EMC Technical Specification To Follow: Cabling
  - ❖ To produce EMC cabling constraints document detailing, All cable used shall be adequately protected against external interference, Protective measure includes EMI filters to apply.
  - ❖A safe separation from potential interfering source,
  - ❖The earthing system shall prevent longitudinal voltage that could cause touch potential hazard.

- ❖EMC Technical Specification To Follow:
  - ❖Bonding
  - ❖EMI Suppression and shield
  - ❖Radiated Immunity Levels; 20 V/m 80%AM in the frequency range 80 to 1000 MHz

EMC In Contract of Electrical [Design, Supply and Install) Project :

❖EMC Technical Specification To Follow: Test Report

a) Applicable standards
b) Equipment Tested
c) Equipment and cable configuration
d) Location of test site
e) List of test equipment
f) Unit of measurement
g) Measurement procedure
h) Reporting measurement data
i) General and special conditions
j) Summary of results
k) Required signatures
l) Test report appendices

EMC In Contract of Electrical [Design, Supply and Install) Project :

- EMC Deliverables:
  a) Final Design Stage
     1) Final EMI Risk Analysis Report
     2) EMC Test Plan & Specification for each sub-system
     3) EMC Compliance Matrix

  b) Manufacturing /Type Testing/Factory Testing Stage
     1) EMC Type Test Report

  c) Installation Stage
     1) Report on Site Constraints & Associated Corrective Measures

  d) Integrated Testing and Commissioning Stage
     1) Site Test Reports
     2) Technical Construction File(TCF) for equipment which cannot be tested.
     3) Overall Syatem EMC Summary Report

EMC In Contract of Electrical [Design, Supply and Install) Project :

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   3) Overall Syatem EMC Summary Report

EMC In Contract of Electrical [Design, Supply and Install) Project :

GUTHRIE GTS Since 1821

C975A - Supply and Installation of Electrical Services for Circle Line Extension

Inter-System Interface Verification Matrix (IVM) Guidance Note
This guidance note is prepared as a guideline to facilitate the completion of the attached Inter-System Interface Verification Matrix (IVM) template by System Wide Contractors (SWCs) interfacing with C1671A.
Legend for the column headings:
1. System / Equipment
a) RF Intentional Radiators – Refers to SWC's equipment (there could be more than one) that makes use of radio frequency during operation and prone to causing EMI on C1671A equipment. For instance, fixed or mobile radio equipment.
b) Non-Intentional Radiators – Refers to SWC's equipment (there could be more than one) that does not make use of radio frequency during operation but is prone to causing EMI on C1671B equipment. For instance, electrical equipment, laptop, PC etc.
c) Sensitive Equipment (Safety Critical) – Refers to SWC's equipment (there could be more than one) that is sensitive to EMI and will have adverse safety consequence. For instance, RF sensors, transducers etc.
d) Sensitive Equipment (Receiver Sensitive to RF) – Refers to SWC's equipment (there could be more than one) that is sensitive to RF interference but will not have adverse safety consequence. For instance, RF sensors, transducers etc.
e) List of equipment that does not meet the EMC standards and requirements outlined for the TWE and SWC itself in particular.

Page 1

Method Statement for Post-Delivery EMC Test

for

C975A – Supply and Installation of Electrical Services for Circle Line Extension

GUTHRIE GTS Since 1821

Confidential Business Information

Method Statement for Post Delivery EMC Test

TABLE OF CONTENTS

EMC In Contract of Electrical [Design, Supply and Install) Project :

COMMENT SHEET

DAR Title :SUBMISSION OF EMC Compliance Matrix

S/N	Dwg/Doc No	No.	Comments	Code	Response from C1673
		1.3	Appendix A, Item 2.8 & 4.8: The test method for IEC 61000-4-8 test is for investigation only not for certification testing. Please confirm that the LMCP and VSD are not sensitive to magnetic field.	2	Question to C1673 Is there any parts in LMCP/ VSD that are sensitive to magnetic field?
		1.5	Ref: Appendix A EMC Matrix Table, S/n 2 Please include the model of the MCC. Please check and confirm that the correct MCC model mentioned is used this project.	2	Question to C1673 Please check and confirm with the supplier that the correct MCC model is used for this project.
			Ref: Appendix A EMC Matrix Table, S/n 2.9 and 3.9 The justification column is not complete, please update.	2	C1673 to provide details on typical installation on site for port for process, measurement and control in respect to voltage damped oscillatory wave (pending). For MCC and VSD. • Is the input/output port in parallel with power cables? • Is it shielded cables for power/control? • Separated from power cables and in separate metallic and grounded trays?

Comment Code :

1: Minor	2: Moderate	3: Major

Circle Line Extension
Contract 975A – Supply and Installation of Electrical Services for Circle Line Extension
DESIGN SUBMISSION REVIEW

DAR No	: DAR/975A/MDS/0009/-	DS No	: DS/975A/MDS/0009/-
Reviewer	:	DS Status	: AC
Subject	: Submission of Method Statement for Post Delivery EMC Test		
File ref	: C975A/EM/D19.006.000/93/11/108/75768	Date	: 31 May 2011

Status : A - Accepted NA - Not accepted IN - Information Noted
AC - Accepted subject to comments S - Superseded

Comment Code : 1 - Minor 2 - Moderate 3 - Major

No	Drawing/ Document	Comments	Code	Remark (Response)
1.	GENERAL COMMENTS	In accordance with EN 50121-5, the performance criteria of Radiated Immunity test (IEC 61000-4-3) is "A". Please state this as the acceptance criteria for the post-delivery equipment test and comply accordingly.	2	Section 4 in latest submission has been updated.
		1) Table 2-1: EUT and Location in page 4-7: - Please include both LV MSB 1 & LV MSB 2 in the test schedule. 2) Table 4-1: Proximity Separation Distance: - Please include to test operator's TETRA	2	1) Table 2-1 in latest submission has been updated. 2) Table 4-1 in latest submission has been updated.
		Please confirm full compliance to LTA specifications.	2	Yes. We will comply with LTA's EMC requirements.
2.	MDS-09-	Are the equipment under test in item 2 complete? Does it include all equipment subject to EMC? Please include all equipment at Marina Bay Station too.	2	Update has been made to the EUT in the latest submission. As the equipment at both Marina Bay and Bayfront stations are similar, testing on equipment at Bayfront only is deemed adequate.
		Please plan and include all scheduled test date, locations and EUTs in this submission.	2	To C975A: Please set a date.
		The EUT locations only cover Bayfront Station. Please clarify what about Marina Bay station including Temporary Maintenance Facility?	2	Similar equipment are installed at both Marina Bay and Bayfront stations, thus testing on equipment at Bayfront only is deemed adequate.

Tint Swe (engineertintswe@gmail.com) is signed in

EMC In Contract of Electrical [Design, Supply and Install) Project :

Method Statement

Guide on cable installation for EMC clearan

Doc No: 1673/MS/ELE/010

Prepared By	Tint Swe	CM
	Name	Designation
Checked By	Bea Pang Chong	PM
	Name	Designation
Approved By	James Pang	PD
	Name	Designation

1 Purpose

GUTHRIE GTS

C975A - Supply and Installation of Electrical Services for Circle Line Extension

EMC FUNCTIONAL TEST AND INSTALLATION CHECKLIST

Project Title : C975A – Supply and Installation of Electrical Services for Circle Line Extension
Location : DB Room 6 - Concourse level
Date of Inspection : 4/08/2011
System/ Sub-system : Electrical Services /
Equipment Reference : DB Panels, PLCP
Equipment Description : SDB-BPT-C11, PLCP-BPT-01

Note:
1. *Please circle YES / NO upon site inspection.*
2. *If NO, REMARKS column to be completed with observation recorded or correction made.*
3. *A copy of this checklist shall be filed in the Project File.*

Part 1: Installation Check

ITEM	DESCRIPTION OF CHECKS	RESULT	REMARKS
1	Check that chassis/ enclosures are earthed. (Impedance ≤ 1Ω)	Yes / No	0.3Ω
2	Check chassis/ enclosures earthing point for contamination/ corrosion.	Yes / No	
3	Check that power cable is put on steel support to reduce capacitive and inductive coupling.	Yes / No	
4	Check that earthing cables connecting chassis/ enclosure to earthing point is at the shortest possible.	Yes / No	
5	Check that shielded twisted pair cable or equivalent is used for control and sensing cable.	Yes / No	
6	Check that screened cables are earthed to data earth or nearest earthing network conductor. (Impedance ≤ 1Ω)	Yes / No	NA (No Used Screen Cables)
7	Check screening earthing point for contamination/ corrosion.	Yes / No	NA (No Used Screen Cables)
8	Check that screened cables are bonded to data earth or nearest earthing network conductor at one end.	Yes / No	NA (No Used Screen Cables)
9	Check that screen cables are bonded 360º to the chassis/ enclosure termination points.	Yes / No	NA(No Used Screen Cables)
10	Check that cable or conductor used for bonding is at the shortest possible.	Yes / No	
11	Check that cable only cross over at right angle.	Yes / No	
12	Check that cables of different classification are not laid in same cable tray/trunk.	Yes / No	
13	Check separation distance between different cable classes. Reference can be made to table below.	Yes / No	

EMC In Contract of Electrical [Design, Supply and Install) Project :

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GTS
Since 1821

C975A - Supply and Installation of Electrical Services for Circle Line Extension

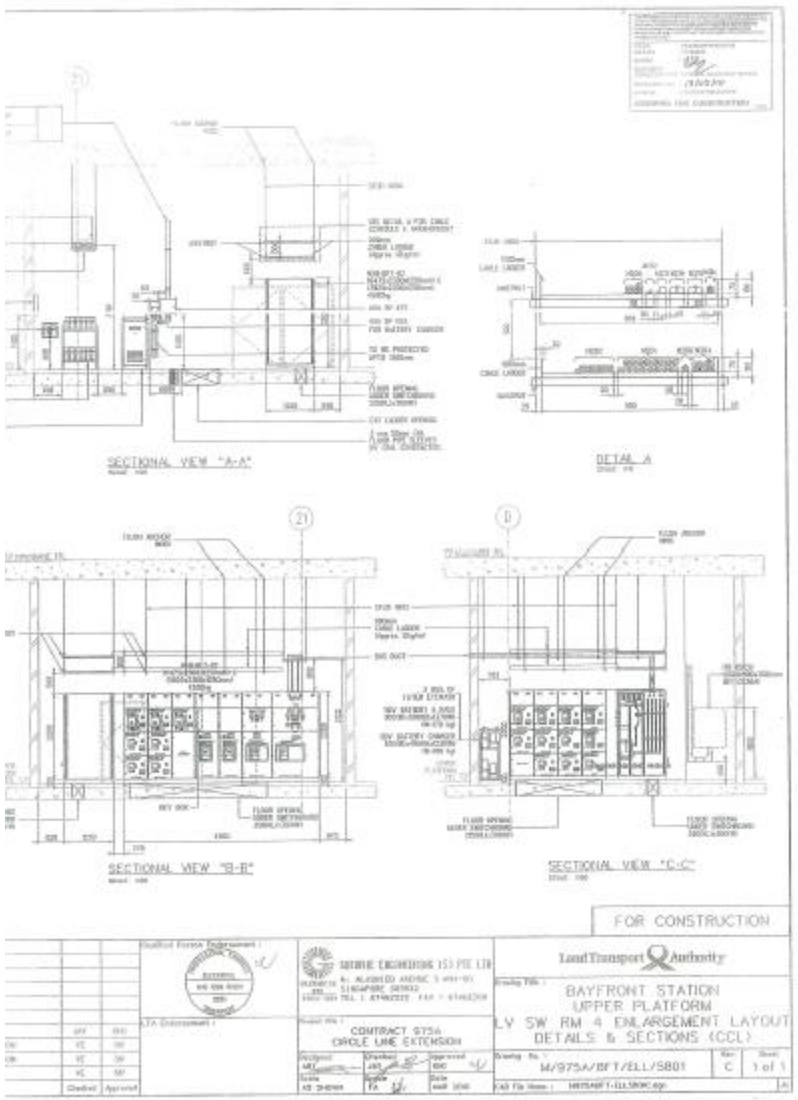
Reference for Cable Separation for Different Cable Class:

Minimum Cable Separation for U-shaped Metallic Conduit or Tray (in mm)						
Cable Class	1	2	3	4	5	6
1	0					
2	150	0				
3	450	300	0			
4	600	450	150	0		
5	1000*	600	300	150	0	
6	1000*	900	600	450	300	0

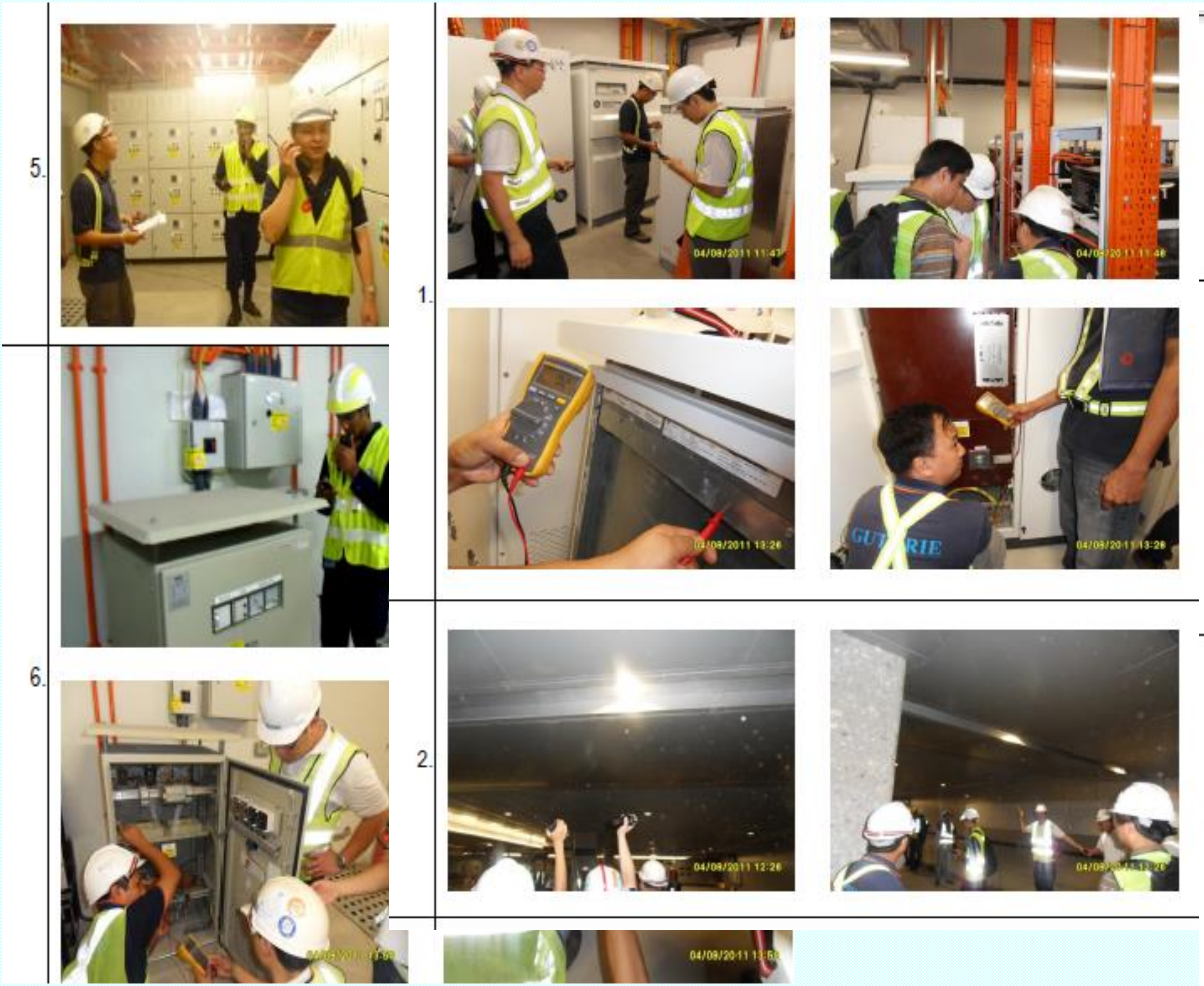
*- Class 1 cable should be run in covered metal duct.

Note:

All figures in the table are valid for cable run in parallel with U-shaped conduit or tray for up to 30m. For longer runs the figure shall be multiplied with factor L/30 in which L is in m.



EMC In Contract of Electrical [Design, Supply and Install) Project :



THANK YOU
Q & A

Seminar On Federations Of Myanmar Engineering Societies

19 May 2026, 1 ~ 4 pm