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**Shielding and bonding for cables between
buildings**

Recommendation ITU-T K.73

ITU-T



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Shielding and bonding for cables between buildings

Summary

Bonding and earthing of telecommunication installations are done for reliability and personal safety reasons. The evolution of the power architecture of telecommunication systems has created new installation conditions for equipment. To cover these situations, bonding and earthing configurations need to be defined to ensure that adequate reliability and safety are maintained.

Recommendation ITU-T K.73 analyses the situation in which equipment connected together are installed in different buildings with different earthing and power feeding conditions.

This Recommendation also includes the installation requirements for equipment located in different buildings, which have the same earthing and feeding power conditions, to improve the shielding and bonding of telecommunication and power cables between buildings.

Other Recommendations dealing with bonding and earthing are Recommendation ITU-T K.27, Bonding configurations and earthing inside a telecommunication building, Recommendation ITU-T K.35, Bonding configurations and earthing at remote electronic sites and Recommendation ITU-T K.66, Protection of customer premises from overvoltages. These Recommendations do not cover how equipment installed in these different environments can be interconnected.

History

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Introduction

The equipment installed inside a building is generally connected to the earthing system of the building and can be also connected to other equipment inside or outside the building.

The outdoor mains distribution network serving a building can be a TN (TN-S or TN-C), TT or IT system; but the a.c. power distribution inside the building may be different depending on the customer's needs.

A d.c. power distribution inside a building can be an "isolated d.c. return" system or a "d.c. return common" system.

To cover these different distribution situations, bonding and earthing configurations need to be defined to ensure that adequate reliability and safety are maintained. This Recommendation has the following objectives:

- 1) contribute to safety by reducing potential differences between telecommunication equipment units and earthed systems;
- 2) mitigate damage caused by lightning and other surges on the mains and telecommunication cables;
- 3) allow rapid de-energization of power lines that accidentally contact telecommunication equipment or cables, thereby reducing hazards and damage;
- 4) provide paths to divert to earth the surge currents entering the premises on cable screens;
- 5) provide a low-resistance circuit to earth for systems that use signalling with earth return.

This Recommendation requires the connection to the main earthing terminal of the following elements:

- both ends of metallic cable screens, if high unbalanced currents are expected due to different earthing potentials. Precautions should be taken to limit such currents;
- conductive parts of entry, distribution and termination points, including metallic cabinets, covers and other metallic parts of the cable management system.

In this Recommendation, the term "different earthing and power feeding conditions" means that each building is fed by an outdoor mains distribution and the earthing systems of each building are not intentionally connected, regardless of both the distance or power feeding conditions.

In this Recommendation, the term "same earthing and power feeding conditions" means that there is only one outdoor mains distribution and only one earthing system for all buildings.

Recommendation ITU-T K.73

Shielding and bonding for cables between buildings

1 Scope

This Recommendation provides bonding configurations and earthing for telecommunication equipment installed inside different buildings in the following cases:

- 1) buildings with different earthing and power feeding conditions;
- 2) buildings with the same earthing and power feeding conditions.

This Recommendation:

- is intended to facilitate the internet working between different equipment (interconnected by metallic links);
- can be used for new installations and, if possible, for the expansion and replacement of existing installations;
- is not intended to replace national regulations on bonding and earthing.

The user should refer to [ITU-T K.27] for bonding configurations and earthing inside the telecommunication building; to [ITU-T K.35] for bonding configurations and earthing at remote sites; to [ITU-T K.66] for bonding and earthing of telecommunication installations inside a customer's premises.

Bonding requirements between a building and an adjacent tower are outside the scope of this Recommendation.

NOTE – In this case, the user should refer to [b-ITU-T K.47], [b-ITU-T K.56] and [ITU-T K.71].

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T K.27] Recommendation ITU-T K.27 (2015), *Bonding configurations and earthing inside a telecommunication building*.

[ITU-T K.35] Recommendation ITU-T K.35 (2018), *Bonding configurations and earthing at remote electronic sites*.

[ITU-T K.66] Recommendation ITU-T K.66 (2019), *Protection of customer premises from overvoltages*.

[ITU-T K.71] Recommendation ITU-T K.71 (2011), *Protection of customer antenna installations*.

[EN 50174 series] EN 50174, *Information technology – Cabling installation*.

[EN 50174-2] EN 50174-2 (2018), *Information technology – Cabling installation – Part 2: Installation planning and practices inside buildings*.

[EN 50174-3] EN 50174-3 (2013), *Information technology – Cabling installation – Part 3: Installation planning and practices outside buildings*.

[EN 50310]	EN 50310 (2016), <i>Telecommunications bonding networks for buildings and other structures</i> .
[IEC 62305-1]	IEC 62305-1 (2010), <i>Protection against lightning – Part 1: General principles</i> .
[IEC 62305-2]	IEC 62305-2 (2010), <i>Protection against lightning – Part 2: Risk management</i> .
[IEC 62305-3]	IEC 62305-3 (2010), <i>Protection against lightning – Part 3: Physical damage to structures and life hazard</i> .
[ISO/IEC 30129]	ISO/IEC 30129 (2015), <i>Information technology – Telecommunications bonding networks for buildings and other structures</i> .

3 Definitions

In this Recommendation, the [b-IEC 60050] earthing definitions are used. The definitions of [ITU-T K.27] for bonding configurations and earthing are also used.

3.1 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.1.1 bonding terminal: This is a terminal provided to allow easy connection of bonding conductors at the entry point of services. The bonding terminal is connected to a MET or to an EBB.

3.1.2 functional earth: A functional earth (FE) is used for the purpose of allowing the intended signalling function of telecommunication equipment to be fulfilled. The signalling function may include signalling with earth return.

3.1.3 parallel bonding conductor: This is a bonding conductor that is parallel to the cable.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

EBB Equipotential Bonding Bar

EPR Earth Potential Rise

FE Functional Earth

MET Main Earthing Terminal

PBC Parallel Bonding Conductor

PE Protective Conductor

RCD Residual Current Device

SPD Surge Protective Device

5 Description of the problem

Equipment and persons in a building are exposed to externally produced energy because conductive services such as telecommunication lines, power lines, antenna leads, waveguides, earthing conductors and metallic pipes penetrate the shell of the building. The penetration of conducted energy is mitigated by interconnecting all of these conductors at their entry points with low-impedance bonding conductors or voltage-limiting devices referred to the main earthing terminal.

The building should be provided with a main earthing terminal, located as close as possible to the a.c. power and telecommunication cable entrance facilities. In order to minimize surge currents and voltages in the building, the shields of all cables entering the building shall be bonded to the main

earthing terminal, preferably directly or by means of monitoring the current interrupters. Arresters or capacitors may be used for this connection, if required by corrosion considerations.

In the case of connection between equipment installed in different buildings, the current could flow on the cable screen laid for the connection between the equipment due to the potential difference between the earthing systems of the buildings.

The current can cause damage to the cable and/or to the equipment, and injury to the people.

5.1 a.c. current (for different main distribution systems)

The main distribution network can service the building by a TN (TN-S or TN-C), TT or IT system; the a.c. power distribution inside the building can be different from the one that depends on the demands of the customer. A TN-S earthing system is recommended and is specified in some standards [EN 50174 series] and [EN 50310].

If the different earthing systems of different buildings which are connected by means of a cable screen, the following situations have to be considered:

- current on the cable screen in case of power fault between the different buildings;
- transferred potential.

The same situation has to be considered in the case of different buildings with the same earthing system.

The following aspects should be considered:

- power, I/O, etc., links between buildings (existing or future ones);
- safety of those involved with the connecting or disconnecting of cables between buildings for provisioning, repair or maintenance;
- failure of the fault protection systems (RCDs, insulation monitoring devices, etc.);
- the quantity and types of other cables interconnecting different buildings (in the whole life of the buildings to avoid any later risk);
- if people decide in one building to modify the earthing system without consulting any involved people in the other buildings (for example, if the buildings have different owners or if those knowledgeable about the earthing systems are not available).

5.2 Lightning current

If the lightning flash strikes a building, a part of the lightning current flows through the cable screen and that can cause damage to the cable, to the equipment and to the people.

6 Solutions

6.1 Galvanic isolation

This solution consists of maintaining the cable screen isolated from the earthing system; in this case, the cable covering shall be able to bear the potential difference between the cable screen and the earthing system produced both by fault or by lightning.

NOTE – If the insulation level of the cable covering cannot withstand the expected lightning overvoltage, an appropriate SPD shall be placed across the screen and the earth.

In some situations, the cable screen could be bonded to the earthing system at one end and could be maintained insulated at the other end. In this situation, the end of the non-earthed cable has to be protected against direct contact, and a label/mark sign shall be used to indicate that a potential electrical shock risk exists (protection of people).

6.2 Parallel bonding conductor (PBC)

This solution consists of installing a bonding conductor that is laid in parallel to the cable.

The purpose of a parallel bonding conductor is to reduce the current flowing on the cable screen in case of potential differences between METs.

The parallel bonding conductor should be designed to withstand a large current when it is used as a lightning protection, or as a power fault current return [b-IEC 60364-5-54]. Generally, the cable screen cannot act as a parallel bonding conductor because it is not designed to cope with a large current.

The section of the PBC should be chosen in such a way that the magnitude of the current that will flow through the cable screen cannot produce damage to the cable or people.

7 Responsibility

If the telecommunication equipment between two buildings belongs to a network operator, the network operator is responsible for the installation of the PBC (if necessary).

The network operator has the incumbency of informing the building owner of such a planned installation, and of obtaining the owner's agreement.

The building owner who rents the house to the network operator has the incumbency to permit the network operator to install the PBC.

If the telecommunication equipment between two buildings belongs to a private person (such as ADSL modem and computer), it is not recommended to connect the cable between the two buildings, as it may cause some safety or electrical problems.

8 Bonding between buildings under different earthing and power feeding conditions

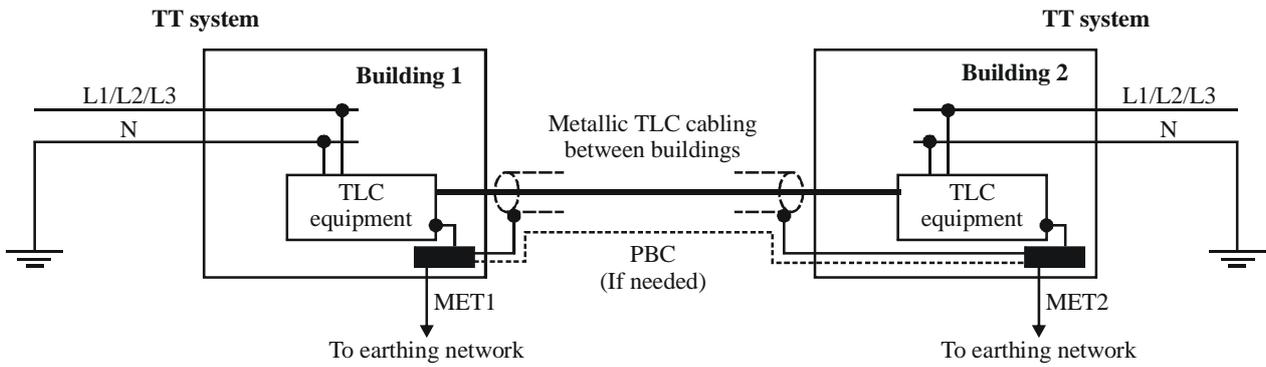
Each building is fed by an outdoor mains distribution of type TT, TN (S or C) or IT, and the bonding and earthing of each building comply with [ITU-T K.66], [ITU-T K.35] and national regulations.

At the entrance of each building, the connection between the cable screen and the MET is requested.

Measurement is required in order to access the possible current flowing between the two METs.

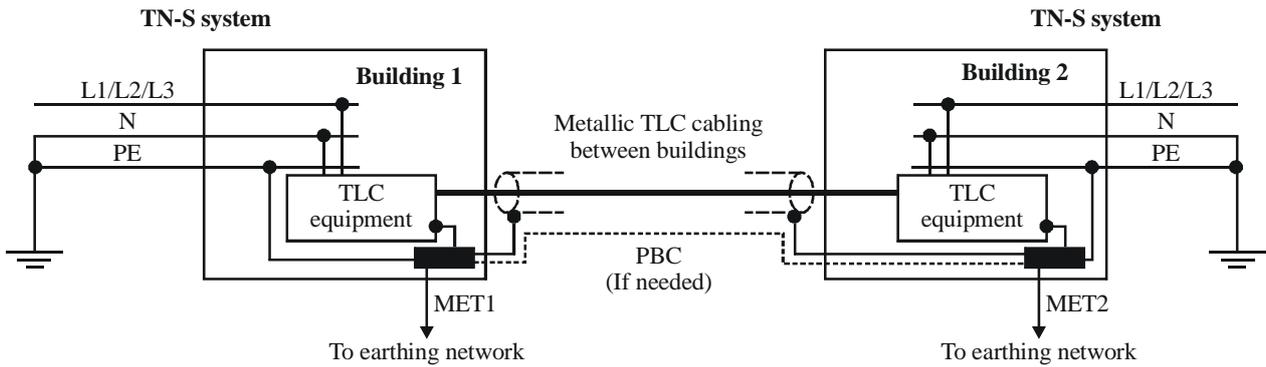
As for each building, the power feeding conditions are different; during a fault condition, a potential difference between the earthing systems of the buildings can occur. In this case, if the current through the cable screen is unacceptable, a parallel bonding conductor (PBC) should be routed closely to the cable.

Figures 1 to 10 represent the possible configurations of the bonding between buildings with different earthing and power feeding conditions in which all the equipment are class I equipment (if some equipment is class II equipment, the following considerations are also valid).



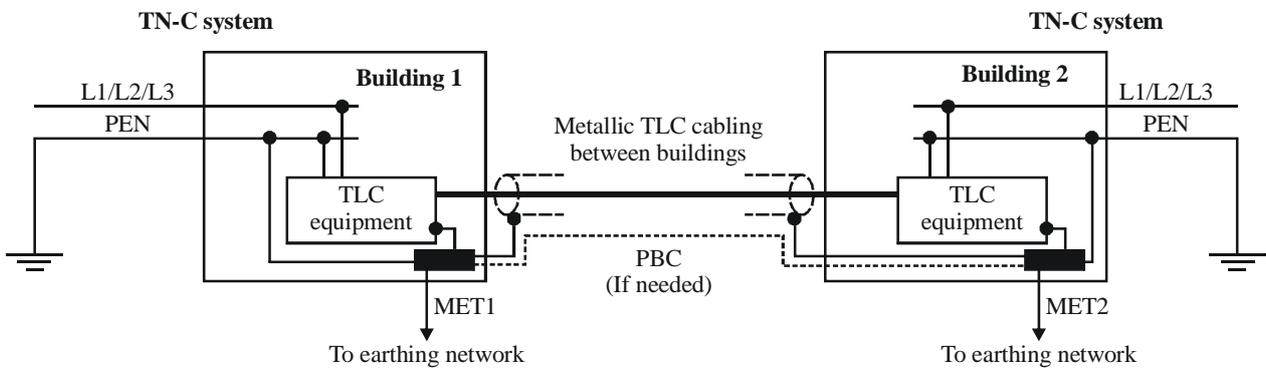
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Figure 1 – Metallic cabling between buildings fed by TT system



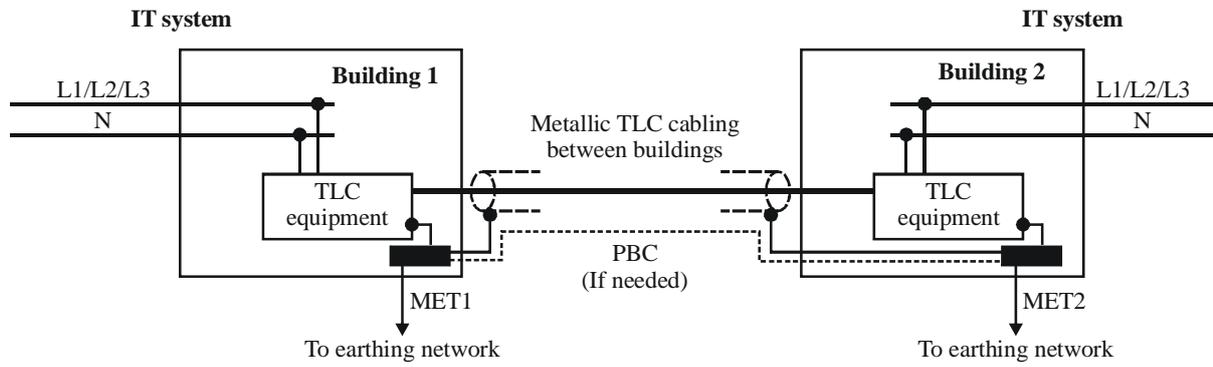
K.73(08)_F02

Figure 2 – Metallic cabling between buildings fed by TN-S system



K.73(08)_F03

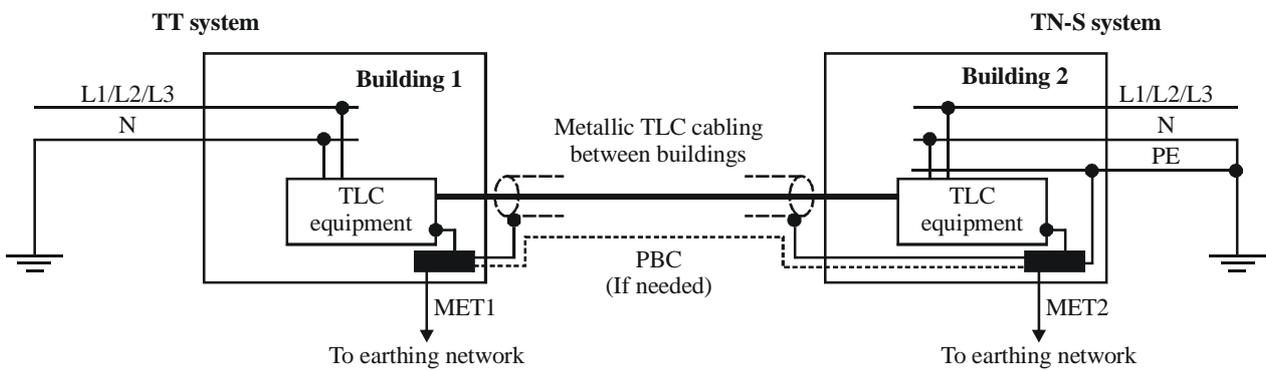
Figure 3 – Metallic cabling between buildings fed by TN-C system



K.73(08)_F04

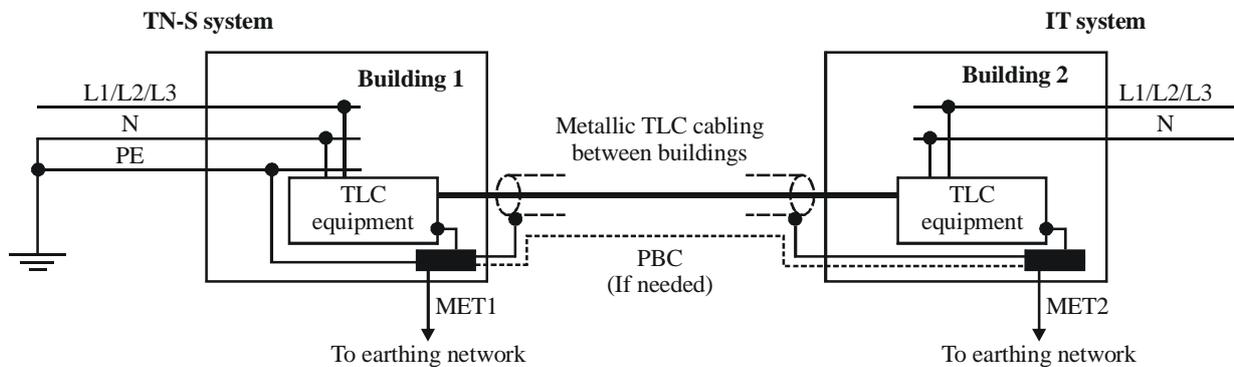
NOTE – Additional measures may be necessary if the cable screen and/or PBC conductor are disconnected from MET1 or MET2 (see clause 6.1).

Figure 4 – Metallic cabling between buildings fed by IT system



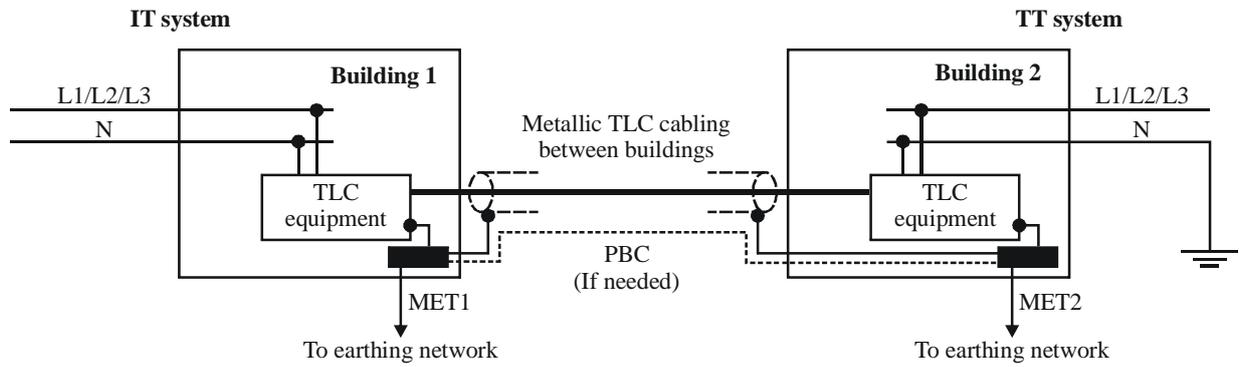
K.73(08)_F05

Figure 5 – Metallic cabling between buildings fed by TT and TN-S system



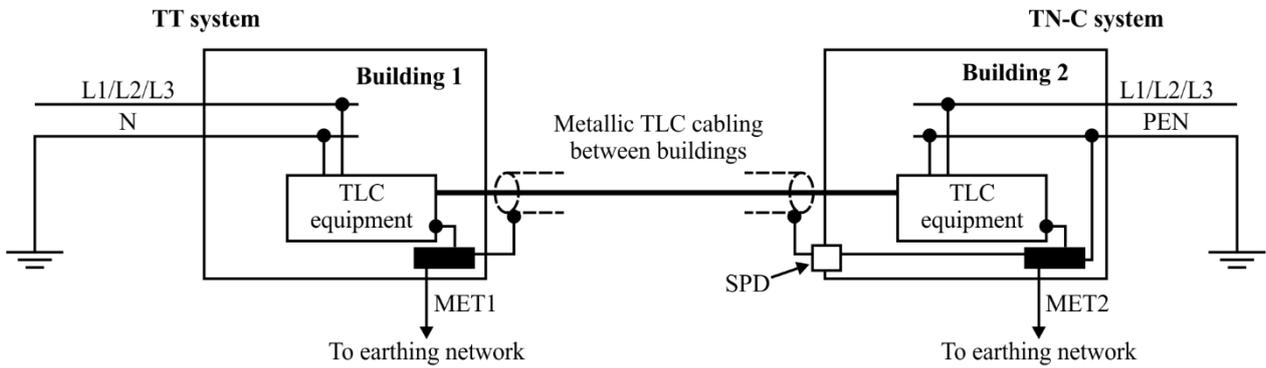
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Figure 6 – Metallic cabling between buildings fed by TN-S and IT system



K.73(08)_F07

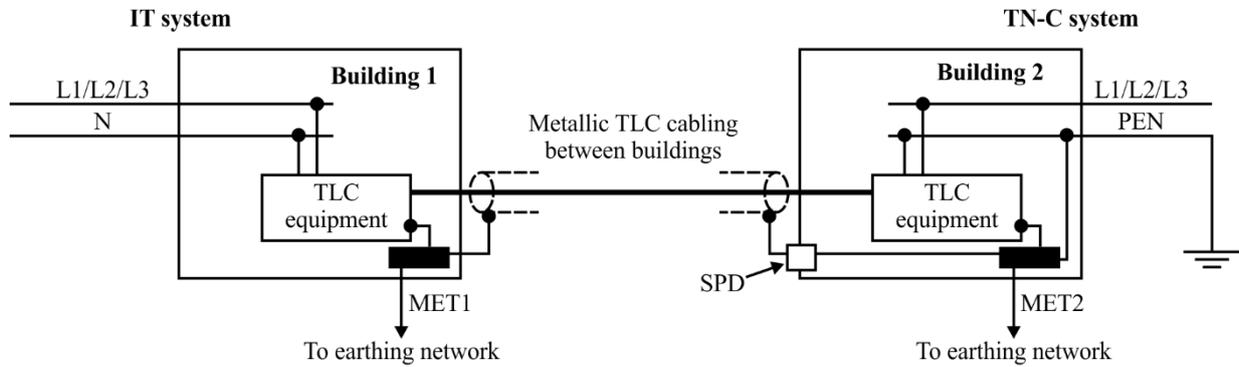
Figure 7 – Metallic cabling between buildings fed by IT and TT system



K.73(19)_F08

NOTE – An SPD shall be installed between the cable screen and MET1.

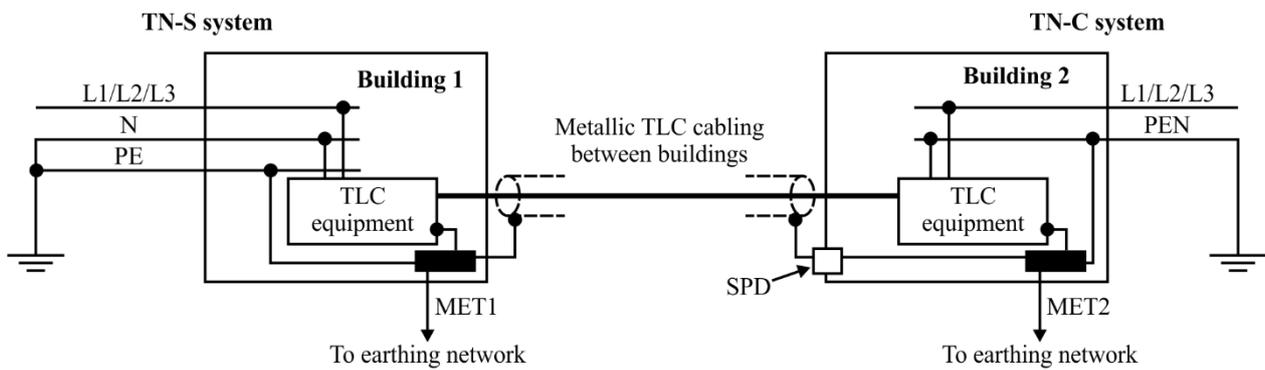
Figure 8 – Metallic cabling between buildings fed by TT and TN-C system



K.73(19)_F09

NOTE – An SPD shall be installed between the cable screen and MET1.

Figure 9 – Metallic cabling between buildings fed by IT and TN-C system



K.73(19)_F10

NOTE – According to [b-IEC 60364-1] connection between TN-S and TN-C shall be avoided. An SPD shall be installed between the cable screen and MET1.

Figure 10 – Metallic cabling between buildings fed by TN-S and TN-C system

8.1 Consideration in case of lightning flash on the building

If a lightning flash strikes a building, a part of the lightning current will flow on the cable screen; in this case, the installation of PBC should be designed according to [ITU-T K.71] and [IEC 62305-3].

For determining the probability of lightning flash to the building, a risk assessment should be performed according to [IEC 62305-2]. If the risk level is higher than the acceptable one, protection against lightning shall be performed according to [ITU-T K.66], [IEC 62305-1] and [IEC 62305-3].

9 Bonding between buildings under the same earthing and power feeding conditions

Some installations at the subscribers' premises may consist of several buildings, with the telecommunication cable from the public network entering the first building then continuing to the other buildings.

The outdoor mains distribution can be of type TT, TN (S or C) or IT, and the bonding and earthing of each building comply with [ITU-T K.66], [ITU-T K.35] and national regulations.

At the entrance of each building, the connection between the cable screen and MET is requested; in this way, the buildings are under the same earthing system and all metallic parts are connected to the MET of the relevant building. The potential difference between the different METs could be negligible and no current flowing on the cable screen is expected.

However, in addition to the connections between the MET and the earthing system, the bonding between MET should be useful; for this purpose, a parallel bonding conductor (PBC) should be routed closely to the cable (see Figure 11).

Metallic construction elements, or conduits, installed along the route of the cable, can also act as a parallel earthing conductor.

In general, the power cables enter the first building, then continue to the other building so that attention should be placed to minimizing interference to telecommunication cables.

In particular, if the telecommunication cable and the power cable share the same cable management system, buildings, voids or similar, the minimum distance between the telecommunication and power cables should be guaranteed [EN 50174-2] and [EN 50174-3].

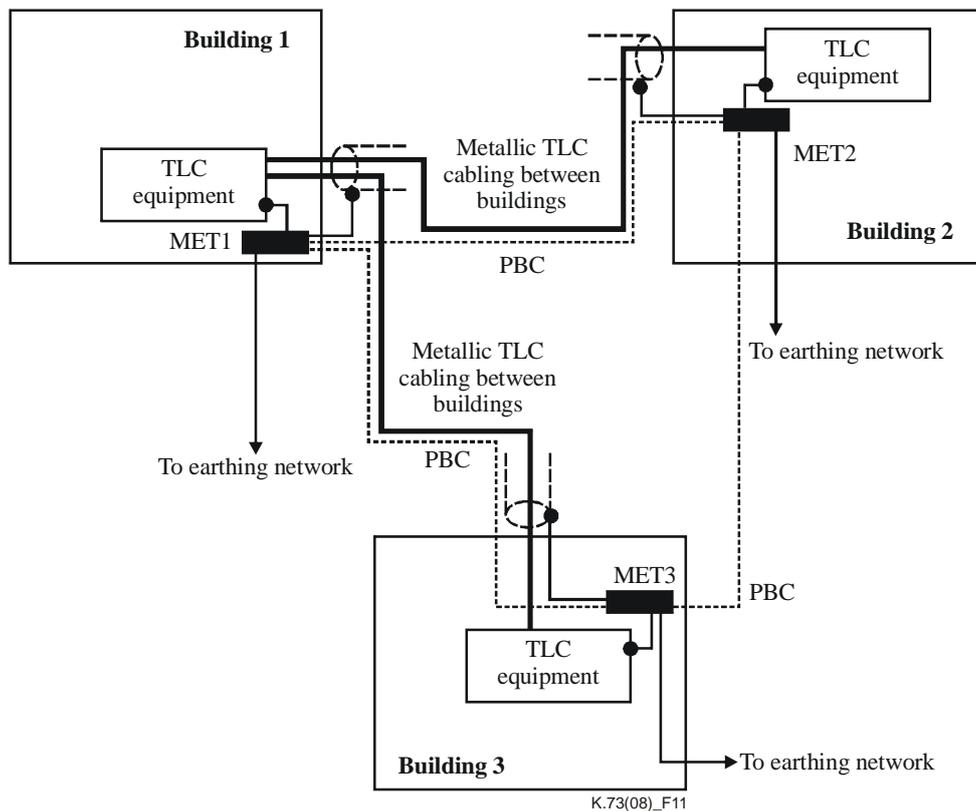


Figure 11 – Example of bonding between buildings under the same earthing and power feeding conditions

9.1 Consideration in cases of fault to ground in a low voltage (LV) power feeding

For whichever is the main distribution type (TT, IT or TN), in cases of fault to ground on class I equipment in one building, no damage to people in contact with the equipment in the other building occurs.

The current that can flow on the cable screen is generally negligible.

9.2 Consideration in cases of lightning flash on the building

If a lightning flash strikes a building, a part of the lightning current will flow on the cable screen; in this case, the installation of PBC should be designed according to [ITU-T K.71] and [IEC 62305-3].

For determining the probability of lightning flash to the building, a risk assessment should be performed according to [IEC 62305-2]. If the risk level is higher than the acceptable one, protection against lightning shall be performed according to [ITU-T K.66], [IEC 62305-1] and [IEC 62305-3].

Appendix I

Consideration in cases of fault to ground in an MV power feeding

(This appendix does not form an integral part of this Recommendation.)

If, at least, one building is fed by a medium voltage (MV) network (typically 10 or 20 kV), the transformer MV/LV should be installed at the entrance of the building.

The MV network can be with directly earthed neutral or with non-directly earthed neutral.

When an earth fault occurs on the MV side of the transformer MV/LV, and the MV power system is with directly earthed neutral, there will be an earth potential rise (EPR) at the fault location and also at the feeding substations. In most cases, the EPR will be much higher at the fault location because the equivalent impedance to the earth at this point is much higher than at the substations.

When an earth fault occurs on the MV side of the transformer MV/LV, and the MV power system is with non-directly earthed neutral, the EPR will be very small due to the small amplitude of the fault current. However, double earth faults may also occur. In this case, the fault current will be much higher and result in a substantial EPR at both fault locations.

For this reason, when a single earth fault on a power line of a network with directly earthed neutral or a double earth fault on a power line of a network with non-directly earthed neutral occurs, a large EPR will appear at the transformer MV/LV. The EPR, as a general term, involves two kinds of potential rise:

- Potential rise of the earthing system of the MV/LV transformer station (T-EPR) is the potential of the earthing system with respect to the remote earth occurring during earth fault.
- Zone of the earth potential rise (Z-EPR) is that area surrounding the tower of the power line where earth potential, with respect to the remote earth, occurs in cases of a single phase to earth fault, or in cases of a non-directly earthed network, double earth fault. This potential falls more or less rapidly in the earth as the distance from the transformer increases.

The T-EPR depends on different factors such as:

- a) earth fault current magnitude;
- b) earth resistance of the transformer station.

In the Z-EPR, the magnitude and the way of decrease of the potential depends on the following factors:

- a) the magnitude of the T-EPR causing the Z-EPR;
- b) the geometry (size and structure) of the earthing system;
- c) soil characteristics (geological nature, stratification, etc.).

Figure I.1 shows a general example of magnitude of T-EPR and way of decreasing Z-EPR.

Figure I.2 shows an example of T-EPR and Z-EPR in the case of one building being fed by a TN-S system (by transformer MV/LV), and the other one fed by a TT system. In this case, the earthing system of the two buildings can modify the way of decrease of the potential, which depends also on the geometry of the earthing system of the buildings and on the distance between buildings.

This figure shows a potential difference ΔV_1 that causes a flow of current in the cable screen that could damage a telecommunication cable. To protect the cable, a PBC conductor connecting the earthing system of the two buildings should be laid.

The value of ΔV_1 allows to calculate the current that could flow into the cable screen and evaluate if the PBC is necessary or not.

NOTE – When the value of ΔV_1 cannot be identified, the copper PBC of minimum size 50 mm² is recommended to be laid.

Furthermore, a single earth fault on a power line of a network with directly earthed neutral or a double earth fault on the power line of a network with non-directly earthed neutral produce, both inside or in the vicinity of the buildings, a voltage can cause damage to people (whether by direct contact or through shoes). The limits of such voltage shall comply with national regulations.

The technique for minimizing the potential and potential differences that may damage equipment, cable, or people (whether by direct contact or through shoes) depends upon the power feeding conditions of the two buildings (see Figures 1 to 10).

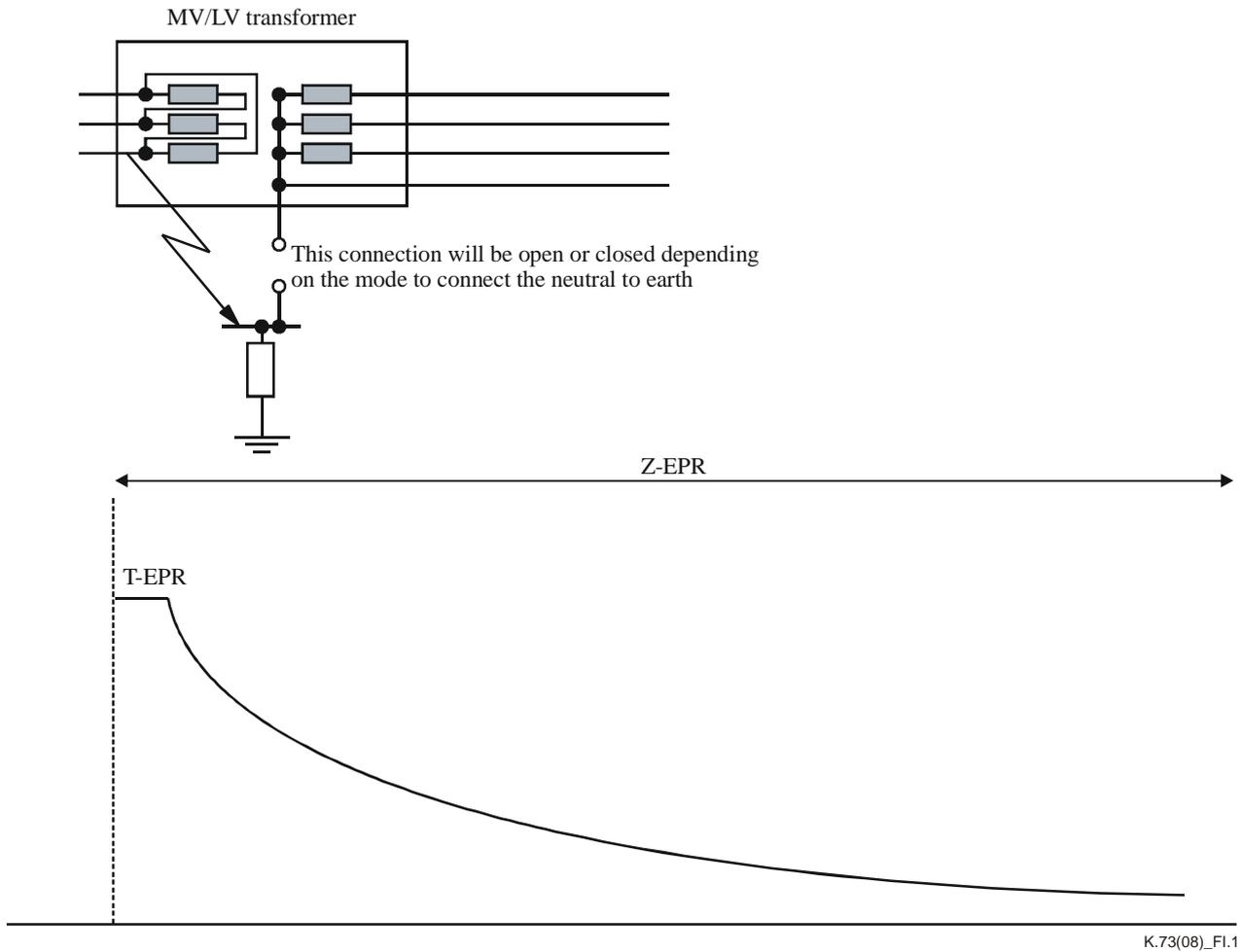


Figure I.1 – Example of T-EPR and Z-EPR

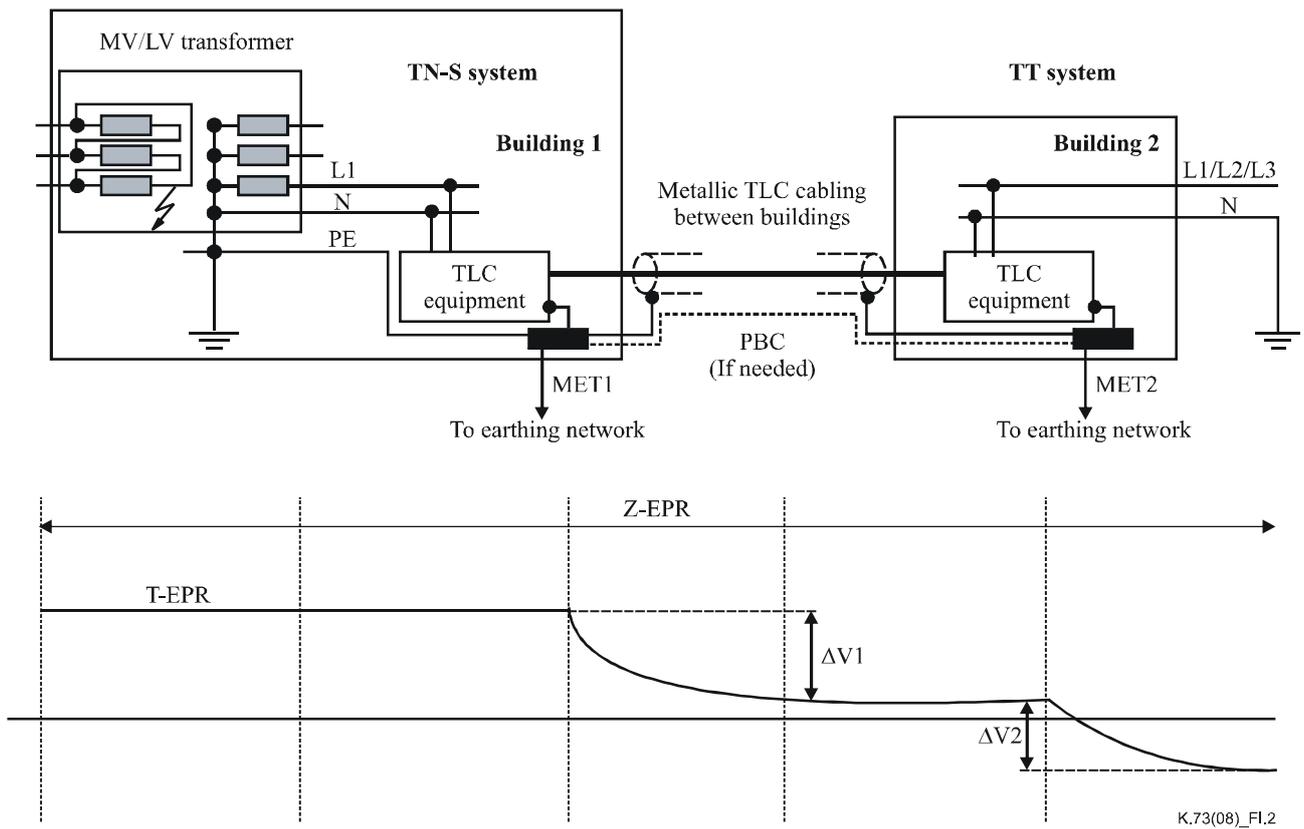


Figure I.2 – Example of T-EPR and Z-EPR in the case of two buildings fed by TT and TN-S systems

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