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PROTECTION AGAINST INTERFERENCE

BONDING CONFIGURATIONS AND EARTHING INSIDE A TELECOMMUNICATION BUILDING

ITU-T Recommendation K.27

(Previously "CCITT Recommendation")

FOREWORD

The ITU-T (Telecommunication Standardization Sector) is a permanent organ of the International Telecommunication Union (ITU). The ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Conference (WTSC), which meets every four years, establishes the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

The approval of Recommendations by the Members of the ITU-T is covered by the procedure laid down in WTSC Resolution No. 1 (Helsinki, March 1-12, 1993).

ITU-T Recommendation K.27 was revised by ITU-T Study Group 5 (1993-1996) and was approved under the WTSC Resolution No. 1 procedure on the 8th of May 1996.

NOTES

1. In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.
2. The status of annexes and appendices attached to the Series K Recommendations should be interpreted as follows:
 - an *annex* to a Recommendation forms an integral part of the Recommendation;
 - an *appendix* to a Recommendation does not form part of the Recommendation and only provides some complementary explanation or information specific to that Recommendation.

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CONTENTS

		<i>Page</i>
1	Introduction	1
2	Scope	1
3	Definitions	2
3.1	IEC definitions	2
3.2	Definitions for telecommunication earthing installations	3
4	Principles of bonding and earthing	4
4.1	Summary of theory	4
4.2	Implementation principles	5
4.3	Protection against electric shock	7
4.4	Protection against lightning	7
4.5	Functional earthing	8
5	Power distribution	8
5.1	a.c. power distribution	8
5.2	d.c. power distribution	8
6	Comparison between IBN and mesh-BN installations	10
7	Maintenance of bonding networks	11
8	Examples of connecting equipment configurations to the CBN	11
	Annex A – Brief theory of bonding and earthing networks	11
A.1	Overview	11
	Annex B – Examples of bonding configurations	14
B.1	Mesh-BN	14
B.2	Mesh-IBN with a bonding mat configuration	16
B.3	Star or sparse mesh-IBN with isolation of d.c. power return	18
	References	21

Recommendation K.27**BONDING CONFIGURATIONS AND EARTHING INSIDE
A TELECOMMUNICATION BUILDING***(Geneva, 1991; revised in 1996)***1 Introduction**

The main subject of the CCITT Handbook on "Earthing of telecommunication installations" [1], comprises the potential rise of a telecommunication building and the reduction of the associated voltage drop by combined use of intentional and incidental earth electrodes. However, the transition from analogue to complex digital telecommunication systems has indicated inadequacies with earthing techniques of the past and has therefore caused renewed interest in bonding and earthing techniques and their impact on electromagnetic compatibility (EMC). Consequently, there is a need for a CCITT Recommendation on bonding configurations and earthing inside a telecommunication building.

Within the field of EMC, regulations restricting electromagnetic emissions must be satisfied, and for acceptable performance, equipment must possess a specific level of immunity. Electromagnetic compatibility may be achieved by the construction of a common, earthed, conductive shielding network or structure (the Common Bonding Network: CBN). The CBN is the principal bonding and earthing network inside the building. The CBN may be augmented with nested shielding structures having "single-point" connections to the CBN. These single-point connected structures will be referred to as Isolated Bonding Networks (IBNs). In a telecommunication building, the bonding and earthing network takes the form of the CBN, to which equipment is attached by multiple connections (mesh-BN) or by a single point connection (IBN). The selection of the bonding configuration has an important influence on the responsibility for achieving EMC. A defined bonding configuration permits clear, structured cable routing and earthing. It facilitates control of electromagnetic emissions and immunity, which is especially important for buildings containing newly installed and existing equipment. A comparison of these approaches (IBN and mesh-BN), including their attributes as functions of frequency are discussed in clause 6 and Annex A. As part of its shielding function, the bonding and earthing network provides for personnel safety and lightning protection, and helps control electrostatic discharge (ESD).

Since the publication of the Earthing Handbook in 1976, several different bonding and earthing configurations have been introduced, and it is desirable to promote standardization by defining generic versions of these configurations. Although there are differences among the configurations, there are many important common aspects. These are discussed in this Recommendation. In addition, three example configurations are described.

2 Scope

Experience in the operation of telecommunication centres shows that the use of a bonding and earthing network that is coordinated with equipment capability and with electrical protection devices, has the following attributes:

- promotes personnel safety and reduces fire hazards;
- enables signalling with earth return;
- minimizes service interruptions and equipment damage;
- minimizes radiated and conducted electromagnetic emissions;
- reduces radiated and conducted electromagnetic susceptibility;
- improves system tolerance to discharge of electrostatic energy, and lightning interference.



Within this framework, this Recommendation:

- a) is a guide to bonding and earthing of telecommunication equipment in telephone exchanges and similar telecommunication switching centres;
- b) is intended to comply with safety requirements imposed by IEC [2] or national standardizing bodies on a.c. power installations;
- c) can be used for installation of new telecommunication centres, and, if possible, for expansion and replacement of systems in existing centres;
- d) treats coordination with external lightning protection, but does not provide details of protective measures specific to telecommunication buildings;
- e) addresses the shielding contribution of the effective elements of the building;
- f) addresses shielding provided by cabinets, cable trays and cable shields;
- g) is intended to encourage EMC planning, which should include bonding and earthing arrangements that accommodate installation tests and routine diagnostics;
- h) does not include:
 - required values of surge current immunity and insulation withstand voltages;
 - limits of radiated and conducted electromagnetic emission or immunity;
 - techniques for verifying and maintaining bonding and earthing networks.

3 Definitions

In this Recommendation, definitions with respect to earthing already introduced by the IEC [3] are used to maintain conformity. For convenience, they are reproduced in 3.1. Definitions specific to telecommunication installations, and not covered by the IEC, are added in 3.2.

3.1 IEC definitions

The following definitions are taken from IEC 50 [3]. The term “earthing network” is defined in Chapter 604, all others are in Chapter 826.

3.1.1 earth: The conductive mass of the earth, whose electric potential at any point is conventionally taken as equal to zero (in some countries the term “ground” is used instead of “earth”).

3.1.2 earth electrode: A conductive part or a group of conductive parts in intimate contact with and providing an electrical connection with earth.

3.1.3 earthing network: The part of an earthing installation that is restricted to the earth electrodes and their interconnections.

3.1.4 main earthing terminal: A terminal or bar provided for the connection of protective conductors, including equipotential bonding conductors and conductors for functional earthing, if any, to the means of earthing.

3.1.5 earthing conductor: A protective conductor connecting the main earthing terminal or bar to the earth electrode.

3.1.6 equipotential bonding: Electrical connection putting various exposed conductive parts and extraneous conductive parts at a substantially equal potential.

3.1.7 equipotential bonding conductor: A protective conductor for ensuring equipotential bonding.

3.1.8 neutral conductor (N): A conductor connected to the neutral point of a system and capable of contributing to the transmission of electrical energy.

3.1.9 protective conductor (PE): A conductor required by some measures for protection against electric shock by electrically connecting any of the following parts:

- exposed conductive parts;
- extraneous conductive parts;
- main earthing terminal;
- earth electrode;
- earthed point of the source or artificial neutral.

3.1.10 PEN conductor: An earthed conductor combining the functions of both protective conductor and neutral conductor.

3.2 Definitions for telecommunication earthing installations

3.2.1 bonding network (BN): A set of interconnected conductive structures that provides an electromagnetic shield for electronic systems and personnel at frequencies from d.c. to low rf. The term “electromagnetic shield”, denotes any structure used to divert, block or impede the passage of electromagnetic energy. In general, a BN need not be connected to earth but all BNs considered in this Recommendation will have an earth connection.

The following definitions of BN configurations are illustrated in Figures 1 and 2.

3.2.2 common bonding network (CBN): The CBN is the principal means for effecting bonding and earthing inside a telecommunication building. It is the set of metallic components that are intentionally or incidentally interconnected to form the principal BN in a building. These components include: structural steel or reinforcing rods, metallic plumbing, a.c. power conduit, PE conductors, cable racks, and bonding conductors. The CBN always has a mesh topology and is connected to the earthing network.

3.2.3 mesh-BN (MBN): A bonding network in which all associated equipment frames, racks and cabinets, and usually, the d.c. power return conductor, are bonded together as well as at multiple points to the CBN. Consequently, the mesh-BN augments the CBN.

3.2.4 isolated bonding network (IBN): A bonding network that has a single point of connection (“SPC”) to either the common bonding network or another isolated bonding network. All IBNs considered here will have a connection to earth via the SPC.

3.2.5 single point connection (SPC): The unique location in an IBN where a connection is made to the CBN. In reality, the SPC is not a “point” but, of necessity, has sufficient size to accommodate the connection of conductors. Usually, the SPC takes the form of a copper bus-bar. If cable shields or coaxial outer conductors are to be connected to the SPC, the SPC could be a frame with a grid or sheet metal structure.

3.2.6 SPC window (SPCW): The interface or transition region between an IBN and the CBN. Its maximum dimension is typically 2 metres. The SPC bus-bar (SPCB), or frame, lies within this region and provides the interface between IBN and CBN. Conductors (e.g. cable shields or d.c. return conductors) that enter a system block and connect to its IBN must enter via the SPCW and connect to the SPC bus-bar or frame.

3.2.7 mesh-IBN: A type of IBN in which the components of the IBN (e.g. equipment frames) are interconnected to form a mesh-like structure. This may, for example, be achieved by multiple interconnections between cabinet rows, or by connecting all equipment frames to a metallic grid (a “bonding mat”) extending beneath the equipment. The bonding mat is, of course, insulated from the adjacent CBN. If necessary the bonding mat could include vertical extensions, resulting in an approximation to a Faraday-cage. The spacing of the grid is chosen according to the frequency range of the electromagnetic environment.

3.2.8 star IBN: A type of IBN comprising clustered or nested IBNs sharing a common SPC.

3.2.9 system block: All the equipment whose frames and associated conductive parts form a defined BN.



3.2.10 isolated d.c. return (d.c.-I): A d.c. power system in which the return conductor has a single point connection to a BN. More complex configurations are possible, see 5.2.

3.2.11 common d.c. return (d.c.-C): A d.c. power system in which the return conductor is connected to the surrounding BN at many locations. This BN could be either a mesh-BN (resulting in a d.c.-C-MBN system) or an IBN (resulting in a d.c.-C-IBN system). More complex configurations are possible (see 5.2).

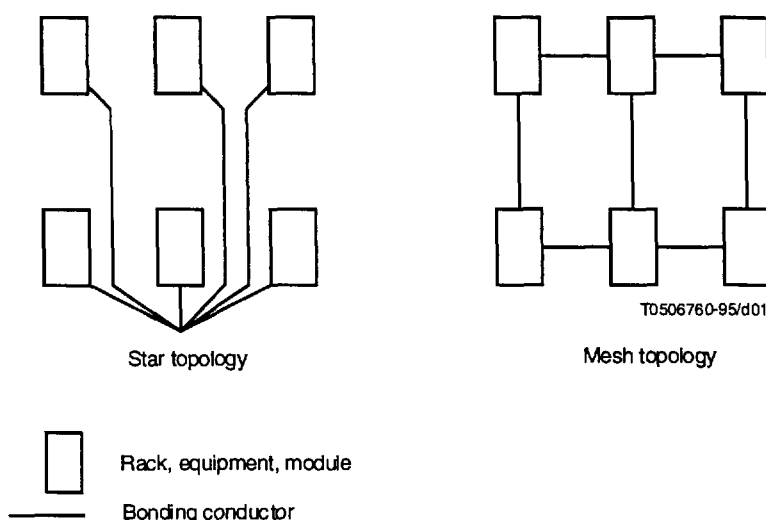


FIGURE 1/K.27

Bonding network configurations forming a system block

4 Principles of bonding and earthing

4.1 Summary of theory

Bonding and earthing refer to the construction and maintenance of Bonding Networks (BNs) and their connection to earth. In this Recommendation the acronym BN implies that a connection to earth exists. Also, BN is used to refer to CBNs and IBNs collectively.

The primary purpose of a BN is to help shield people and equipment from the adverse effects of electromagnetic energy in the d.c. to low rf range. Typical energy sources of concern are lightning, and a.c. and d.c. power faults. Of generally lesser concern are quasi steady-state sources such as a.c. power harmonics, and “function sources” such as clock signals from digital equipment. All of these sources will be referred to generically as “emitters”. People and equipment that suffer adversely from the energy from the emitters will be referred to as “susceptors”. The coupling between a particular emitter and a particular susceptor may be characterized by a transfer function. The purpose of a BN is to reduce the magnitude of the transfer function to an acceptable level. This may be achieved by appropriate design of the CBN, and the MBNs and IBNs attached to that CBN. Theoretical and quantitative aspects are discussed in Annex A. Practical aspects are discussed below.

Other purposes of a BN are to function as a “return” conductor in some signalling applications, and as a path for power fault currents. The capability of the BN to handle large currents helps to rapidly de-energize faulted power circuits. Also the BN and its connection to earth is used in “ground return” signalling (see 4.5).

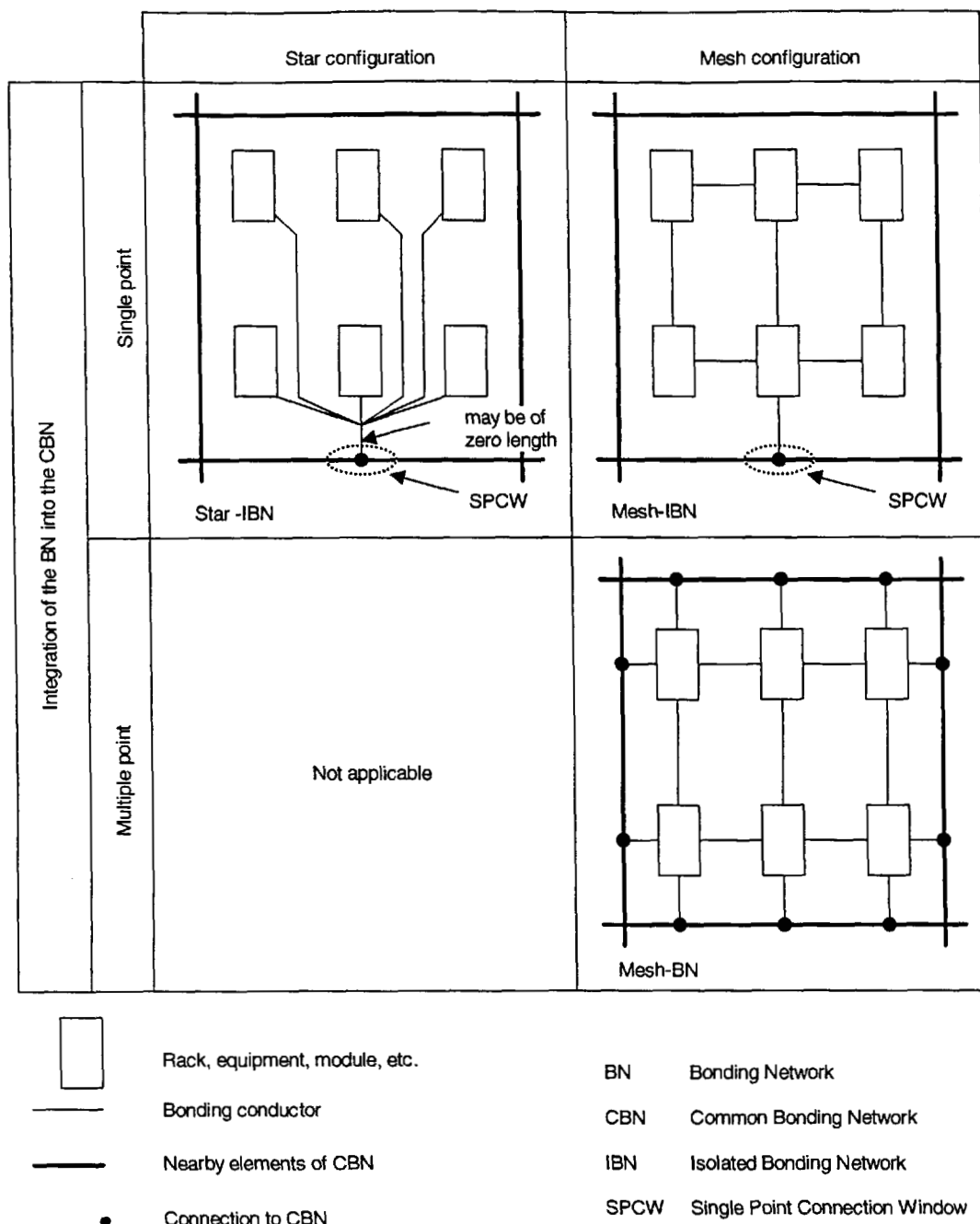


FIGURE 2/K.27
Connection of system block to the CBN

4.2 Implementation principles

4.2.1 Implementation principles for the CBN

The theoretical concepts of Annex A are confirmed by practical experience and lead to the general principles listed below. A consequence of applying these principles is that the number of conductors and interconnections in the CBN is increased until adequate shielding is achieved. Concerning the important issue of electric shock, the following implementation principles apply to mitigation of electric shock as well as to equipment malfunction. Electric shock is discussed further in 4.3.