

Basic understanding of Electrical Distribution Systems

In an electrical system, earth fault is caused due to the insulation loss between conductor which is live and conductive part which is exposed. These faults may cause damage to the electrical installation and more critically the human safety. There is always a possibility that people could get in touch with exposed conductive parts which are not normally live but due to fault might have high potential to ground which are dangerous.

Before we analyse different method of system, let us review different definitions in accordance with IEC60050.

1. Touch voltage – It is the voltage between conductive parts when touched simultaneously by person or animal
2. Direct contact – Electric contact of persons with live conductive parts.
3. Indirect contact – Persons coming in contact with exposed conductive parts which have become live under fault conditions
4. PEN Conductor – Conductor combining the functions of both a protective earth conductor as well as neutral conductor
5. PE (Protective conductor) – Conductor provided for safety purpose. For example
 - Earth electrode
 - Exposed conductive parts

In order to select a right protective device, it is necessary to know distribution system adopted in a project. IEC 60364 classifies different types of distribution system with combination two letters and subsequent letters defines arrangement of neutral and protective conductors. The following paragraphs give basic understanding of each of these letters.

The 1st letter indicates relationship of power system to earth

- T – Direct connection to earth of one point, usually neutral in ac systems
- I – All live parts are isolated from earth, usually neutral is connected to earth through an impedance

The 2nd letter indicates relationship of exposed conductive parts of the installation to earth.

- T – Direct connection of exposed conductive parts to earth
- N – Direct electrical connection of exposed conductive parts to earthed point of the power system.

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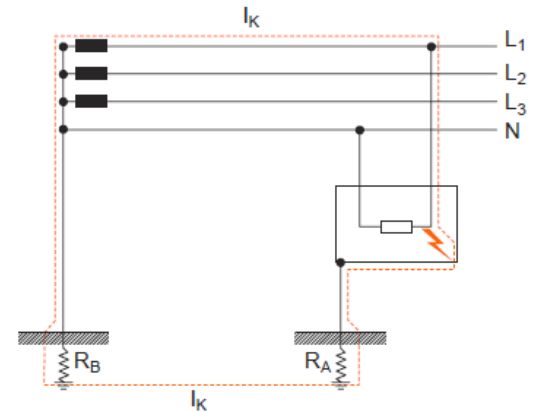
The subsequent letters where applicable indicates the arrangement of neutral and protective conductors

- S – Separate conductors are to be provided for neutral and protective functions
- C – Single conductor is used for combined function of neutral and protective functions

TT System

In this type of system which is shown in the figure, the neutral and exposed conductive parts are connected to earth electrodes which are electrically independent.

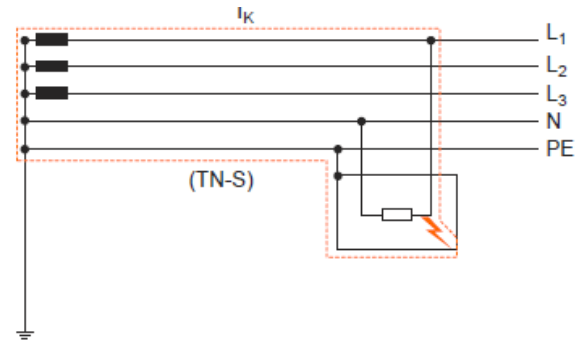
In the event of fault, it can be clearly seen fault current returns to power supply through soil. Here neutral is distributed to load points to make convenient for connecting the single-phase loads



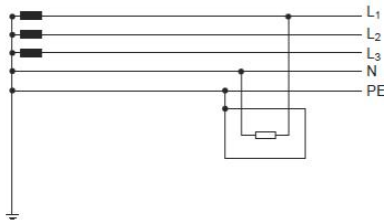
TN System

The neutral in this type system is directly earthed and exposed conductive parts are connected to same earthing system of neutral which can be seen in figure.

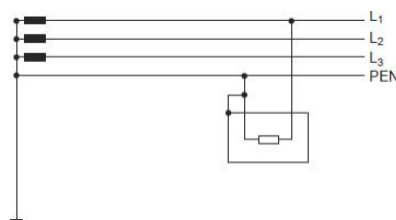
In TN system, based on the arrangement of neutral and protective conductor, we can have different configuration as indicated below.



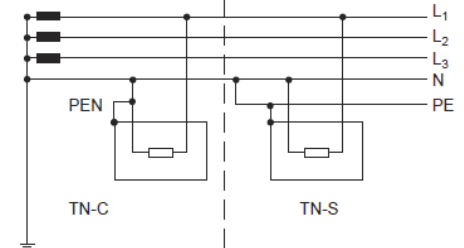
TN-S System



TN-C System



TN-C-S System



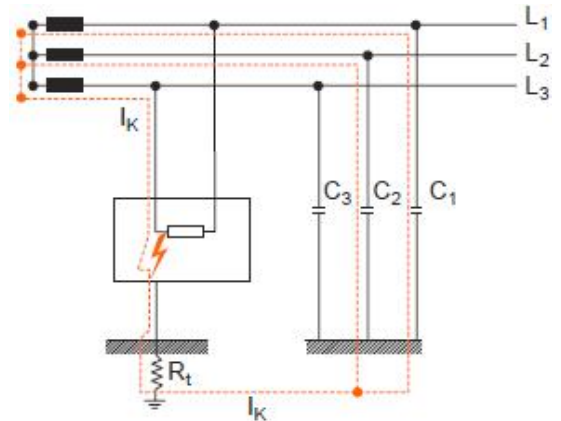
In this system, as you can see the return path for the earth fault current is through a direct conductor connection through PE/PEN and practically not affecting the earth electrode.

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IT System

In this type of distribution system, as you can identify in the figure there are no active parts which are directly earthed. The system may have live parts earthed through high value impedance. Here all exposed conductive parts separately or in group are connected to an independent earth electrode.

The fault current returns to power supply through the earthing system as shown.



System	Advantages	Disadvantages	Area of Application
TN System	Fast disconnection of fault or short circuit. Least danger for people and property	High cost of cable due to protective conductors. Interruptions due to faults	Power Plants, Public power supply and networks
TT System	Less wiring and cable requirement is also less. Zones with different touch voltages are allowed. Can also be combined with TN system	Complex earthing. Equipotential bonding is necessary for each building	Typically example is livestock farming
IT System	Less expensive with respect to wiring and cables. Very high system availability meaning 1 st fault is only signaling and 2 nd fault is disconnection	Equipment must be insulated throughout for the voltage between outside conductors. Equipotential bonding is necessary in this case.	Hospitals

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