203: Electrical installations technology  
**Handout 22: Earthing systems**

**Learning outcome**

The learner will:

1. know requirements of earthing systems.

**Assessment criteria**

The learner can:

4.1 identify different types of **earthing systems.**

**Range**

**Earthing systems**: TT, TN-S, TN-C-S.

**Earthing systems**

**Purpose of earthing**

The three main reasons for earthing electrical systems are as follows:

* to maintain the potential of any part of the system at a defined value with respect to earth
* to allow current to flow to earth in the event of a fault, so that the protective equipment will operate to isolate the faulty circuit
* to ensure that, in the event of a fault, apparatus normally ‘**dead**’ cannot reach a dangerous potential with respect to earth (earth is normally taken as 0 volts, ‘**no volts**’).

**Supply system earthing**

Local distribution is normally undertaken with a three‑phase three‑wire system at 11kV. This is then transformed down to 400V/230V four‑wire system, as shown in the diagram below:

|  |
| --- |
| 01 Supply transformer.png |

The primary is connected in delta, whilst the secondary is connected in star. The star point of the secondary provides the neutral. Connecting between any two line conductors will give us 400 volts, whilst connecting between any line and neutral will give us 230 volts.

It is a legal requirement that all electrical systems connected to the public supply system must be earthed. This is usually achieved by connecting the star point of the supply transformer to earth using an earth electrode.

Electrical installations connected to the public supply system will also be earthed in some way. The method of providing this earth will determine the earthing system used.

Earthing systems are distinguished by a series of letters that identify the nature of earthing as follows.

* **First letter – relationship of the power system to earth:**

|  |  |  |
| --- | --- | --- |
| **T** | **=** | direct connection of one point to earth |
| **I** | **=** | all live parts are isolated from earth, or one point connected to earth through a high impedance. |

* **Second letter – relationship of the exposed‑conductive‑parts of the installation earth:**

|  |  |  |
| --- | --- | --- |
| **T** | **=** | direct electrical connection of exposed‑conductive‑parts to earth, independently of the earthing of any point of the power system |
| **N** | **=** | direct electrical connection of the exposed‑conductive‑parts to the earthed point of the power system (in a.c. systems, the earthed point of the power system is normally the neutral point or, if a neutral point is not available, a line conductor). |

* **Subsequent letter(s) (if any) – arrangement of neutral and protective conductors:**

|  |  |  |
| --- | --- | --- |
| **S** | **=** | protective function provided by a conductor separate from the neutral conductor or from the earthed line (or, in a.c. systems, earthed phase) conductor |
| **C** | **=** | neutral and protective functions combined in a single conductor (PEN conductor). |

**TN‑S system**

Neutral and protective conductors are separate throughout the system. The protective earth conductor (PE) is generally the metal sheath and armour of the underground cable which this is connected to the consumer’s main earthing terminal. All exposed and extraneous conductive parts of the installation, including gas pipes, water pipes and any lightning protective system are connected to the protective conductor via the main earthing terminal of the installation. The arrangement is shown in the diagram below:

|  |
| --- |
| TNS |

The layout of a typical TN‑S domestic service position is shown in the following diagram:

|  |
| --- |
| 03 TN-S system.png |

**TN‑C‑S system**

The supply cable uses a combined protective earth and neutral conductor (PEN conductor). At the supply intake point a consumer’s main earthing terminal is formed by connecting the earthing terminal to the neutral conductor. All exposed and extraneous conductive parts of the installation, including gas pipes, water pipes and any lightning protective system, are connected to the main earthing terminal. Line to earth faults are effectively converted into line to neutral faults, which give a lower value of Ze. This system is frequently referred to as protective multiple earthing (PME). The arrangement for a TN‑C‑S is shown in the diagram below:

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| --- |
| TNCS |

The layout of a typical TN‑C‑S domestic service position is shown in the following diagram:

|  |
| --- |
| 05 TN-C-S system.png |

**TT system**

Often, TT systems are fed to the installation via overhead cables and the regional electricity company (REC) do not provide an earth. The installation’s circuit protective conductors must be connected to earth via an earth electrode provided by the consumer. An effective earth connection is sometimes difficult to obtain and in most cases a residual current device is provided when this type of supply is used. The arrangement for a TT is shown in the diagram below:

|  |
| --- |
| TT |

The layout of a typical TT domestic service position is shown in the following diagram:

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| --- |
| 07 TT system.png |