



D12: Electrical regulations & earthing

Length: 60 minutes

Theory

Learning outcomes

- Have an overview of the electrical regulations
- Understand the purpose of earthing
- Know the various protective devices in use to reduce the chances of getting an electric shock
- Have an overview of the different earthing systems in use (TT, TN, IT)
- Understand sizing of protective conductors
- Understand that there are different types of protective conductors
- Understand what is Electrostatic Discharge and how it can be avoided or removed
- Understand why equipment requires bonding Know which equipment requires main bonding

Agenda Module D – Regulations and earthing

 Electrical regulations

Earthing arrangements and protective conductors

Equipotential bonding

Electrical Regulations

Check national standards and regulation regarding electrical safety!

In general all system designs of the electrical equipment should comply with:

- product standard of the EN 60335 series,
- EN ISO 13849-1 and / or EN 62061 (Safety-related parts of control systems)
- EN 60079-0 (VDE 0170/0171-1) Explosive atmospheres - Part 0: Equipment - General requirements
- EN 60079-14 (VDE 0165-1) Explosive atmospheres - Part 14: Electrical installations design, selection and erection
- EN 60079-15 (VDE 0170/0171 part16), Explosive atmospheres - Part 15: Equipment protection by type of protection "n"

Electrical Regulations

The regulations and standards that cover electrical installations and practices associated with plumbing, gas, heating and ventilation, and refrigeration installations will vary from country to country, but below are some of the standards used throughout these notes:

- EN 60204-1 - Safety of machinery- Electrical equipment of machines- Part 1: General requirements
- HD 60364-8-1:2019 Low-voltage electrical installations. Functional aspects. Energy efficiency
- IEC 60364 - Erection of low voltage installations - Part 100: Fundamental principles, assessment of general characteristics and definitions
- IEC 60529 Degrees of protection provided by enclosures
- EN 61010 defines measurement categories (CAT)
- EN 61010-031:2015 Safety requirements for electrical equipment for measurement, control and laboratory use. Safety requirements for hand-held probe assemblies for electrical measurement and test
- IEC 61140: 2016 Protection against electric shock – common aspects for installation and equipment
- EN 61243-3:2014 Live working. Voltage detectors. Two-pole low-voltage type
- IEC 61557-8:2014 specifies the requirements for insulation monitoring devices (IMD) which permanently monitor the insulation resistance (R_f) to earth of unearthed a.c. IT systems.
- IEC 61558-2-6 Safety transformer for supply voltages up to 1,100 V
- ISO 7000/IEC 60417 Graphical symbols for use on equipment

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Electrical regulations

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Earthing arrangements and protective conductors

Connections to Earth

The earthing arrangements shall be such that:

- the value of impedance* from the consumer's main earthing terminal to the earthed point of the supply for TN systems, or to Earth for TT and IT systems, is in accordance with the protective and functional requirements of the installation, and considered to be continuously effective, and
- earth fault currents and protective conductor currents which may occur are carried without danger, particularly from thermal, thermomechanical and electromechanical stresses, and
- they are adequately robust or have additional mechanical protection appropriate to the assessed conditions of external influence.

**Impedance: In electrical engineering, electrical impedance is the measure of the opposition that a circuit presents to a current when a voltage is applied*

Earthing arrangements and protective conductors

Main earthing terminals or bars

A main earthing terminal must be provided in every installation to enable the earthing conductor to connect to:

- circuit protective conductors,
- protective bonding conductors
- lightning protection system bonding conductors

NOTE: Provision must be made for disconnection of the earthing conductor for test measurement of the earthing arrangements.

Earthing arrangements and protective conductors

Protective conductors

- The minimum cross-sectional area of protective conductors can be obtained by using the Table below.
- This establishes the minimum cross-sectional area of the protective conductor in relation to the cross-sectional area of the associated phase conductor.

Cross sectional area of phase conductor SIZE (S) mm ²	Minimum cross sectional area of the protective conductor if it is of the same material as the phase conductor SIZE (S) mm ²
$S \leq 16$	S
$16 < S \leq 35$	16
$S > 35$	$\frac{S}{2}$

Earthing arrangements and protective conductors

Type of protective conductor

A protective conductor may consist of one or more of the following:

- A single-core cable
- A conductor in a cable
- An insulated or bare conductor in a common enclosure with insulated live conductors
- A fixed bare or insulated conductor
- A metal covering, for example, the sheath, screen or armouring of a cable
- A metal conduit, metallic cable management system or other enclosure or electrically continuous support system for conductors
- an extraneous-conductive part.

Earthing arrangements and protective conductors

Electrical earthing is essential

All RACHP appliance, components and systems must be earthed!

- Electrical equipment can cause a fault current if any electrical parts or cable/flex are damaged.
- Fault current discharged over your body can cause serious injury including death!
- In an electric power system, a fault or fault current is any abnormal electric current.
- e.g. a short circuit is a fault in which current bypasses the normal load.
- An open-circuit fault occurs if a circuit is interrupted by some failure.
- Sparks and arcing generated by short-circuits are a potential source of ignition (SOI)

Earthing arrangements and protective conductors

Electrostatic Discharge (ESD)

Steps to be taken for elimination of risk for ESD:

- Use anti static wrist strap equipment to avoid potential differ between you and the appliances being serviced



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Static electricity



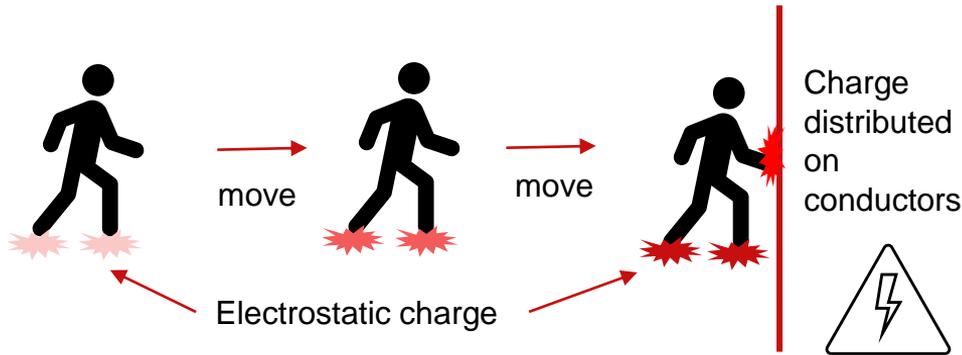
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Earthing arrangements and protective conductors

Electrostatic Discharge (ESD)

All HC appliance components must be earthed!

Electrostatic Discharge (ESD) can cause a range of harmful effects of importance in different industries, including gas, fuel vapour and coal dust explosions, as well as failure of solid state electronics components such as integrated circuits.



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Earthing arrangements and protective conductors

Electrical earthing is essential

All HC appliance components must be earthed!

Electrostatic discharge (ESD) is the sudden flow of electricity between two electrically charged objects caused by contact, an electrical short, or dielectric breakdown.

A build-up of static electricity can be caused by tribocharging (*Tribocharging is a contact electrification process that enables build up of static electricity due to touching or rubbing of surfaces in specific combinations of two dissimilar materials*) or by electrostatic induction.

The ESD occurs when differently-charged objects are brought close together or when the dielectric between them breaks down, often creating a visible spark.

Earthing arrangements and protective conductors

Electrostatic Discharge (ESD)

All HC appliance components must be earthed!

Metal-based material can cause sparks when operating and working on HC appliance. The resulting electrical discharge can cause catastrophic failure in sensitive electrical components and ignite HC refrigerants.

Steps to be taken for elimination of this risk:

Touch an earthed metal object occasionally to remove any charge from your body.

- Touching a water tap works extremely well.
- As does touching a corner of a wall where there is metal stripping under the plaster.
 - But beware: These moulding strips are not always earthed!



Grounded Plug

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Equipotential bonding

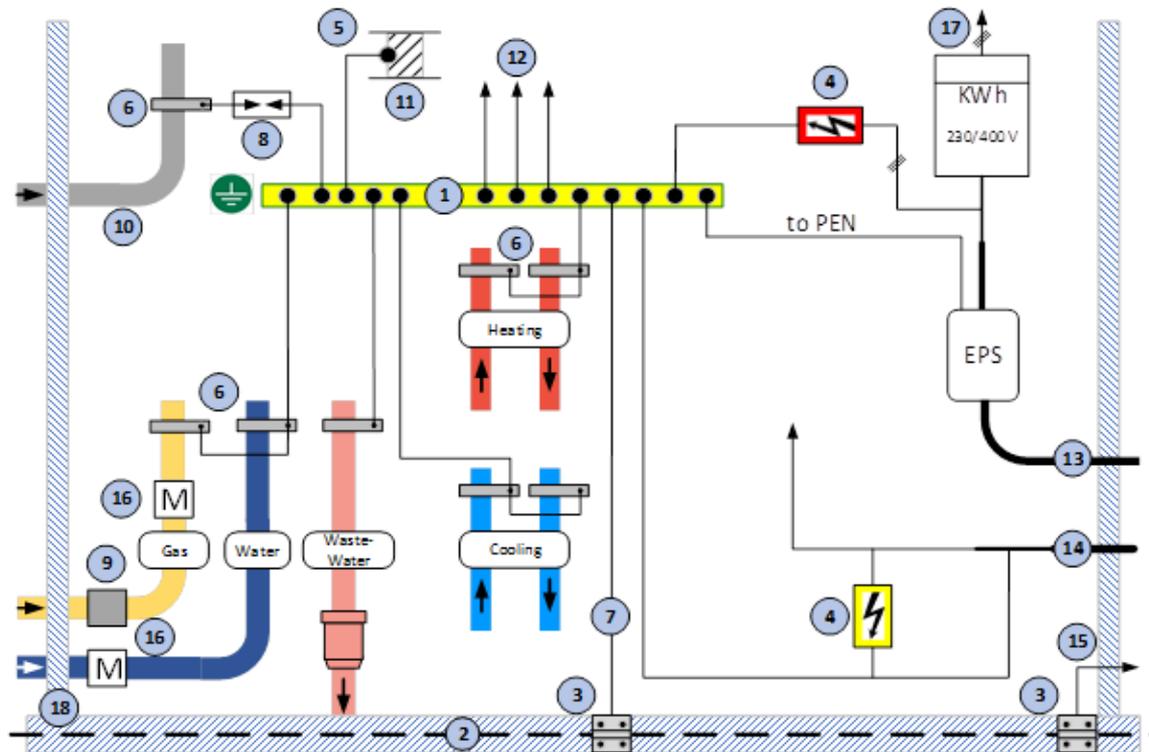
Main equipotential bonding

Equipotential bonding prevents life-threatening potential differences or voltages between conductive parts and the protective earth in the event of an insulation fault. This means that all conductive materials are connected together and to earth. Some examples of building systems and their conductive material are directly integrated:

- Telecom networks
- Data system
- Power utility cables
- Internal gas pipe
- Metal water supply pipe
- Metal drain pipe
- Central heating system
- Central chilled water piping system
- Foundation earth electrodes or lightning protection earth electrodes
- Earthing conductor for antennas (if any)

Equipotential bonding

Main equipotential bonding



Equipotential bonding

Supplementary bonding conductors

A supplementary bonding conductor used to connect exposed conductive parts must have a cross-sectional area not less than the smallest protective conductor connected to the exposed conductive parts, subject to a minimum of:

- 2.5 mm² if sheathed or mechanically protected.
- 4 mm² if mechanical protection is not provided.

In situations where a supplementary bonding conductor connects two extraneous conductive parts, neither of which are connected to an exposed conductive part, the minimum cross-sectional area of the supplementary bonding conductor shall be:

- 2.5 mm² if sheathed or mechanically protected.
- 4 mm² if mechanical protection is not provided.

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Published by:

Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH

Registered offices
Bonn and Eschborn

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