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## Electrical Appliances

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**Abstract:** This paper discusses the IEC protection classes that are used to differentiate between the protective-earth connections requirements of electrical devices.

**Introduction:**

The live components (including Live and Neutral wiring) of any electrical appliance powered by mains supply electricity should not be immediately accessible to the user. These components must be electrically isolated from the user. This can be achieved by either through double-insulation or through the earthing of the appliance (the connection of the chassis to electrical earth by an earth conductor). A number of different types of electrical insulation of electrical appliances and these are listed below.

**Basic Insulation:** The insulation applied to live parts (e.g. the plastic insulated connectors that hold the live and neutral wires in place) to provide basic protection against electric shock.

**Supplementary Insulation:** An independent insulation, applied in addition to basic insulation, in order to ensure protection against electric shock in the event of failure of the basic insulation.

**Double Insulation:** Insulation comprising of both basic and supplementary insulation.

**Reinforced Insulation:** A single insulation system applied to live parts, which provides a degree of protection against electric shock equivalent to double insulation.

All electrical appliances using mains voltage must provide at least two levels of protection against electrical shock to the user (such as in double-insulation). This is to ensure that if one of the protection layers were to fail, there is a

back up of the second layer still in place. This makes electrical equipment very safe to use.

In the electrical appliance manufacturing industry, the IEC protection classes are used to differentiate between the protective-earth connection requirements of devices. Depending on how exactly the protection is provided, electrical appliances are put into five classes of equipment construction, Class I, II, III, 0 and 01. Of these the most important are Class I and II, but for reasons of completeness all the classes are described below.

**1 : Appliance Classes**

**1.1 : Class I**

In Class I appliances, the protection is provided by a combination of basic insulation and the use of electrical earth. These appliances must have their chassis connected to electrical earth by an earth conductor (coloured yellow/green in most countries, green in the U.S., Canada and Japan). The failure of an electrical appliances basic insulation may cause a metal chassis to become “live” at full mains voltage. This failure could occur through faults such as the incorrect fitting of the flexible chord, or a short-circuit caused by a stray strand of wire bridging the gap to the chassis.



To safeguard against electric shock from metal cased electrical appliances, the metal chassis or case or any exposed metal of appliances (other than double-insulated items) must incorporate

a Protective Earthing conductor connected to the Earth pin of an approved three pin plug incorporating an “Earth” terminal. The Earth pin is longer than the other two pins so that it is first to make contact and the last to break contact when the plug is withdrawn.

By connecting to the metal chassis of the appliance, the Protective Earth wire keeps all this metal at Earth potential. What this means is that it is impossible to get an electric shock even when the chassis is connected directly to the live voltage. A fault in the appliance which causes a live conductor to contact the casing will cause a current to flow in the earth conductor. This current should trip either an over current device (fuse or circuit breaker) or a residual current circuit breaker which will cut off the supply of electricity to the appliance.

In practice, the most common instance of faulty earthing are:

- Earth connections broken accidentally or corroded through age.
- Earth connections incorrectly made.
- Earth connections not made at all.
- Earth connection removed for some specific purpose and not reinstated.

### 1.2 : Class II

In a Class II appliance, the user is protected by at least two layers of insulation between the current carrying parts and any metal accessible to the user.

- Basic Insulation, and
- Supplementary Insulation

For this reason, Class II appliances are also known as Double Insulated appliances. They do not require an Earth connection. In Europe, a double insulated appliance must be labelled “Class II”, “double insulated” or bear the double insulation symbol (a square inside another square).



If the basic insulation or the supplementary insulation breaks down, it will not result in an electric shock risk. Protection will be afforded by the other system of insulation. The accessible metal parts will become “live” only in the event of a breakdown of both insulation systems. The probability of this occurring is very remote provided special care is taken when servicing or repairing double insulated electrical appliances to ensure that both insulation barriers remain effective.

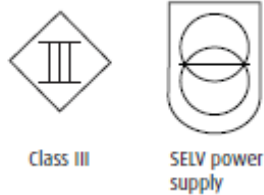
Class II electrical products may be any of the following types:

- Double-insulated electrical products which comprise both basic insulation and supplementary insulation. In other words, there are two layers of insulation between the live parts and accessible parts of this type of product. In the case of products with outer casing made from insulating material, the casing will be ranked as one of the required layers of insulation.
- Reinforced-insulated electrical products which comprise single layer of insulation system to the live parts and provide a degree of protection against electric shock equivalent to double insulation.
- Electrical products which have durable and substantially continuous enclosure made of insulating material. All metal parts, except small parts such as nameplates, screws and rivets which are separated from the live parts are enclosed by insulation at least equivalent to reinforced insulation. This type of electrical products is called insulation-encased Class II products.
- Electrical products which have substantially continuous metal enclosure in which double insulation is used throughout, except for those reinforced-insulated parts where the application of double insulation is obviously impracticable. Such electrical products are called metal-encased Class II products.

### 1.3 : Class III

Equipment built to the Class III standard is designed to be supplied from a special safety isolating transformer whose output is known as Separated Extra-Low Voltage or SELV. This must not exceed 50 V AC and is normally is below 24V or 12V.

All Class III appliances are marked as shown here. There is no use of an Earth in Class III appliance.



The electrical safety of Class III appliances is taken care of in the safety isolating transformer design where the separation between the windings of the transformer is equivalent to double insulation. The transformer is marked as shown here.

### 1.4 : CLASS 0 & 0I

This type of equipment is no longer used in business or residential environments. It is just presented here for completeness.

Class 0 appliances depend only on basic insulation for protection from electric shock and have no provision for connecting metal earths to a protective conductor. For this reason, they do not have 2 levels of protection built in and prohibited from sale.

In Class 0I appliances, there is provision for an Earth connection, but it is wired with either twin core cable or only has a 2-pin plug, so an Earth cannot be connected. As in Class 0 equipment, there is only one level of protection. For this reason, Class 0I appliances are also prohibited sale.

### 2 : Identifying Class I & Class II Appliance

There are a number of superficial observations that can be made to help identify an appliance as Class I or Class II.

- If there is a fuse in the plug, then it is probably Class I.
- If it is made of metal it is probably Class I.
- If the case is plastic so it is probably Class II.
- If it has a three core cable it is probably Class I.
- If the plug has a metal Earth pin it is probably Class I.

None of the above statements is a fool-proof way to identify Class I and Class II appliances and the best way is to locate the appliances rating plate and see if has the double box mark (signifying the presence of double-insulation, which means the appliance is a Class II).

### 3 : Are Class I and Class II appliances just as safe?

As both have two levels of protection built in, they are both safe for general use. However with a Class I appliance, one of the layers of safety is provided by the earth connection. For this to be effective, the wiring in the building has to be inspected regularly to check that the Earth in the mains socket is correctly taken to the local earth potential. Class I appliances depend on the external wiring in the building to fully provide the 2 levels of protection.

Class II appliances however always provide 2 levels of protection irrespective of the status of the wiring installation. Both layers of protection are built into the design making Class II appliances a lot safer than Class I appliances.

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