

Choose certainty. Add value.

**An introduction to EN 60204-1**

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TUV SUD Product Service

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BS EN 60204-1:2006+A1:2009



**Safety of Machinery - Electrical Equipment of Machines  
Part 1: General Requirements.**

**Defined Scope**

This part of IEC 60204 applies to the application of electrical and electronic equipment and systems to machines not portable by hand while working, including a group of machines working together in a co-ordinated manner, but excluding higher level systems aspects (e.g. communications between systems).

The standard defines the basic terminology and specifies general design methods to help designers and manufacturers in achieving safety in the design of machinery.

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EN 60204-1 Scope



- EN 60204-1 gives safety guidance and recommendations on electrical equipment for “non-portable” machinery.
- EN 60204-1 refers to machinery that operates with nominal supply voltages below 1,000V for alternating current or 1,500V for direct current
- EN 60204-1 covers control circuits and control functions, wiring practices and protection against electrical shock

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## EN 60204-1 Out of scope



- BS EN 60204-1 does not include guidance on:-
- machinery designed for outdoor use in mines and in flammable atmospheres
- machinery that produces explosive material
- machinery that operates as a sewing machine.

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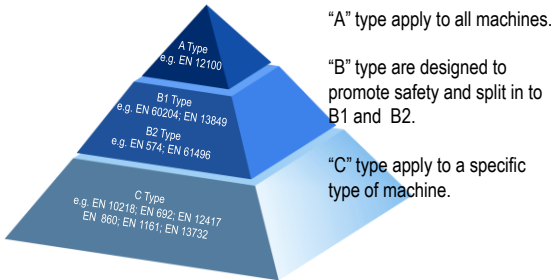
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## EN Standards and European Directives



EN 60204-1 is harmonised against the Machinery Directive and the Low Voltage Directive



"A" type apply to all machines.

"B" type are designed to promote safety and split in to B1 and B2.

"C" type apply to a specific type of machine.

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## EN 60204-1 and BS 7671 (IET Wiring Regulations)



- BS 7671 - Requirements for electrical installations. IET Wiring Regulations. Seventeenth edition.
  - The guidelines cover all aspects of designing and installing electrical wiring and temporary or permanent power systems in buildings



- As a general rule BS 7671 applies up to the connection of the electrical supply to the machine isolator. EN 60204-1 applies from that point onwards

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## Definitions - Examples



### Control gear

- Switching devices and their combination with associated control, measuring, protective, and regulating equipment, also assemblies of such devices and equipment with associated interconnections, accessories, enclosures, and supporting structures, intended in principle for the control of electrical energy consuming equipment.

### Direct opening action (of a contact element)

- achievement of contact separation as the direct result of a specified movement of the switch actuator through non-resilient members (for example not dependent upon springs)  
[IEC 60947-5-1, K.2.2]

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## Definitions - Examples



### Emergency stop device

- Manually actuated control device used to initiate an emergency stop function

### Emergency switching off device

- Manually actuated control device used to switch off the supply of electrical energy to all or a part of an installation where a risk of electric shock or another risk of electrical origin is involved

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## Definitions - Examples



### Failure

- Termination of the ability of an item to perform a required function.

### Fault

- State of an item characterized by inability to perform a required function, excluding the inability during preventive maintenance or other planned actions, or due to lack of external resources.

“Failure” is an event, as distinguished from “fault”, which is a state

In practice the terms fault and failure are often used synonymously

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## Definitions - Examples



### Live Part

- Conductor or conductive part intended to be energized in normal use, including a neutral conductor.

### Protective Bonding

- Equipotential bonding for protection against electric shock.

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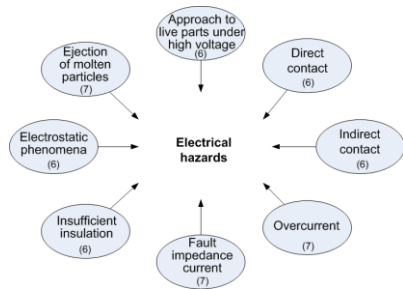
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## Electrical Hazards



EN 60204-1: Chapter (6) and (7)

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## Risk and Consequence



### General Requirements:

- Risk due to electrical equipment is part of the risk assessment of machine :
  - Equipment failure leading to electrical shock.
  - Control circuit failure leading to malfunction of the machine.
  - Disturbance / interruption of the power source leading to malfunction of the machine.
  - EMC problems leading to malfunction of the machine.
  - Release of stored energy leading to unexpected movements / electrical shock.
  - High surface temperatures leading to burns.

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## Equipment selection



- Correct selection of electrical components and devices based upon the:
  - Intended use.
  - Conformity to applicable standards.
  - Applied according to manufacturers instructions.
  - Suitability for purpose.
  - Ability to withstand the expected influence.
  - Appropriate for the intended use.
  - Suitably placed / positioned.
  - Readily identifiable with physical durable marking of the component or device.
- Low voltage switchgear / control gear assemblies must comply with IEC 60439.

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## EMC Requirements



- Emission Protection.
  - Power supply filtering
  - Cable shielding.
  - Enclosures designed to minimize RF radiation.
  - RF suppression techniques – filters.
- Immunity Protection
  - The design of functional earth bonding system.
  - Connect sensitive electrical circuits to chassis.
  - Connect the chassis to earth (PE) (low RF impedance, short distance).
  - Functional earthing conductor (FE) minimize common disturbance.
  - The separation of sensitive circuits from disturbance sources.
  - Enclosures should be designed to minimize RF transmission.

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## Electrical Supply and Isolation



A single incoming supply is recommended for machines. However where a second supply for electronic equipment with different voltage is required (for example from a 24vdc PSU), this should be derived from main machine supply.

- Isolators must be readily accessible located between 0.6 m and 1.9 m above servicing level (with an upper limit 1.7 m recommended).
- Isolators should be lockable (LOTO type) and attached to the machine i.e. on-board.

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## Electrical Supply and Isolation



- They should disconnect all supplies!!!
- If not intended for emergency operation it is recommended that the isolators should be coloured black or grey.
- Emergency off isolators must be coloured red and yellow.
- It must have one off (isolated) and one on position marked with "O" and "I".
- The isolator must be clearly identified as to its function i.e. what it isolates.

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## Electrical Supply and Isolation



- The isolator should ideally be interlocked to the panel door. If this is not possible then IP2X protection must be installed to all devices that remain live when to door is opened.
- The isolator must not be mounted on the door itself.
- For large complex machinery there may be a need for more than one incoming supply, therefore consideration must be given to ensuring all supplies can be appropriately isolated by the use of protective interlocks for correct operation to prevent hazardous situations arising, including damage to the machine.

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## Electrical Supply and Isolation



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## Supply Termination



### Incoming Supply Terminations and the Neutral Conductor:

- All terminals for incoming supply connection must be clearly identified e.g., L1, L2, L3, N, PE, and 400V (or the appropriate voltage).
- Should be clearly indicated in technical documentation installation diagram and circuit diagram.
- The Neutral should have a separate insulated terminal, labelled 'N'.
- There should be no connection between neutral and protective bonding circuit inside electrical equipment .

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## Protection against electric shock



Persons must be protected from electric shock from:

- Direct contact.
- Indirect contact.



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## Protection against indirect contact



The risk in this case is an insulation fault between live parts and exposed conductive parts.



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## Protection by enclosures



Protection against electric shock by locating live parts inside enclosures



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## Protection by enclosures



- The opening of the enclosure (i.e. opening doors, lids, covers, and the like) must be by one of the following:
  - The use of a key or tool
  - Disconnection of live parts inside before opening which can be achieved by Interlocking the door with a disconnecting device.

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## Enclosures



- Enclosure doors should not be wider than 0.9m
- Ideally vertical hinges, with an angle of opening of at least 95°
- There must be no opening between enclosures containing electrical equipment and compartments containing coolant, lubricating or hydraulic fluids, or those into which oil, other liquids, or dust can penetrate.

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## Defeat Interlocked Isolator



- However it is allowed to defeat the interlock with a special device or tool provided that:
  - It is always possible to operate and lock the disconnecting device in the off position.
  - When closing the door, the interlock is automatically restored.
  - All live parts, used for resetting or adjusting while connected must have at least IP2X protection.
  - All other live parts inside the enclosure must have at least IP1X protection.

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## Protection by Insulation



- Live parts protected by insulation shall be completely covered with insulation that can only be removed by destruction.
- Such insulation shall be capable of withstanding the mechanical, chemical, electrical, and thermal stresses to which it can be subjected under normal operating conditions.



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## Potential sources of electrical shock from wiring



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## Protection Against Residual Voltages



- Live parts with a residual voltage of greater than 60V must discharge to 60V or less within 5 s (as long as the discharge does not interfere with the proper functioning of the equipment)
- If this is not possible then a durable warning notice with required delay before opening time on it should be fitted.
- In the case of plugs or similar devices the minimum discharge time shall be less than 1 second, otherwise protection to IP2X must be installed or fitted.
- If neither can be achieved such as on removable collectors on conductor wires, conductor bars, or slip-ring assemblies then additional switching devices or appropriate warning devices (warning notice), must be installed or fitted.

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## Appliance Classes



Appliance Class	Marking	Protection
Class 0	No Marking	Single level of insulation no protective-earth
Class I		Chassis Connected to Electrical Earth (PE)
Class II	"Class II" „Double Insulated“ 	Double Insulated
Class III		Supplied from a SELV (Separated Extra-Low Voltage) Power Source.

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## Protection against indirect contact - touch voltage



Use class II equipment or equipment with the equivalent level of insulation.

This is provided by one or more of:

- Class II electrical devices or apparatus with double insulation, reinforced insulation or by equivalent insulation in accordance with IEC 61140.
- Switchgear and control gear assemblies with total insulation in accordance with IEC 60439-1.
- Supplementary or reinforced insulation in accordance with article 412 of IEC 60364-4-41.

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## Protection by the use of Extra Low Voltage



- Protective Extra Low Voltage PELV:
  - Limited voltage.
    - 25vac or 60vdc for dry conditions
    - 6vac or 15vdc in all other cases
  - One side connected to protective earth
  - Safe separation (by double or reinforced insulation) of the PELV system to all non PELV systems.

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## Protection of equipment



Equipment should be protect against the effects of:

- Over current arising from a short circuit.
- Overload and / or loss of cooling of motors.
- Abnormal temperature.
- Loss of or reduction in the supply voltage.
- Over speed of machines / machine elements.
- Earth fault / residual current.
- Incorrect phase sequence.
- Over voltage due to lightning and switching surges.

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## Control Functions - Examples



- Start Functions.
- Stop Functions.
- Operating Modes.
- Suspension of Safety Functions and / or Protective Measures.
- Normal Operation.
- Other Control Functions such as Hold to Run Devices, Two Hand Controls, and Enabling devices.

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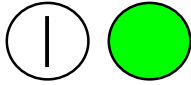
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## Start Functions



Shall only be possible only when all safety functions and / or protective measures are in place and fully operational.

Where safety functions and / or protective measures cannot be applied for certain operations, manual control of such operations by hold-to-run controls, together with enabling devices must be activated and fully controlled.



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## Stop Functions



Stop functions fall into three categories

Stop category 0 - Stopping by immediate removal of the power.

Stop category 1 - A controlled stop with power available to the actuators to achieve the stop, then final removal of power.

Stop category 2 - A controlled stop with power left available to the actuators.



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## Stop Functions



- Emergency Stop where the emergency stop device complies with EN ISO 13850
  - An emergency stop can only be a category 0 or 1 stop.
  - The initiation of the emergency stop must supersede all modes of operation and other functions.
  - There must be no automatic restart of the machine on reset.
- The switching of an 'Emergency Off' device (EMO) but only if the hazard is from electricity.



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## Verification and Testing



If there is no dedicated product standard (a 'C' standard) for the machine the verifications shall always include the items a), b) and f) and may include one or more of c) to e), in the following order:

- a) Verification that electrical equipment complies with its technical documentation.
- b) in case of protection against indirect contact by automatic disconnection, conditions for protection by automatic disconnection shall be verified
- c) Insulation resistance test.
- d) Voltage test.
- e) Protection against residual voltage.
- f) Functional tests.

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## Verification and Testing – Functional Tests



### f) Functional tests:

The functions of electrical equipment shall be tested, particularly those relating to safety and safeguarding, verification shall be completed for all steps necessary for safe intended use.

Verification is more than just verification of electrical parameters, it must also include the verification of all mechanical safety devices such as interlocks, ventilation, and cooling etc.....

It must also include verification of the operating manual and manufacturers instructions as necessary.

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## Verification and Testing – Documentation of Results



Results of the inspections and verifications should reflect the following:

The date of the test or inspection.

The actual results.

Whether or not the system or machines passed or failed the test or inspection.

Any comments.

Any corrective action required or carried out.

The name and signature of tester.

It should also be remembered that where a portion of the machine and its associated equipment is changed or modified, that portion shall be verified and retested, as is appropriate.

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**Thank you for Your Time and for Listening**

**Any Questions**



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**Thank you for listening**

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