
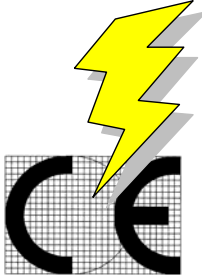
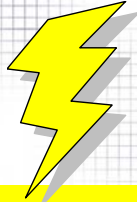




CE ELECTRICAL COMPLINACE



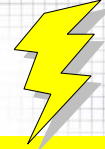
Low Voltage Directive



<p>From:</p> <ul style="list-style-type: none">▪ 1st June 1989▪ 1st January 1997 <p>Directive: 73/23/EEC and 93/68/EEC</p> <p>UK Regulations: The Electrical Equipment (Safety) Regulations 1994</p>	<p>Applies to:</p> <ul style="list-style-type: none">▪ Electrical equipment<ul style="list-style-type: none">➢ 50-1000 VAC➢ 75-1500 VDC➢ New and second-hand▪ Electrical components
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Low Voltage Directive



- Equipment must be **safe** i.e.
- No risk, apart from one reduced to the minimum
- Excludes improper installation maintenance and misuse
- Constructed to **good manufacturing practice** (complies with a standard)

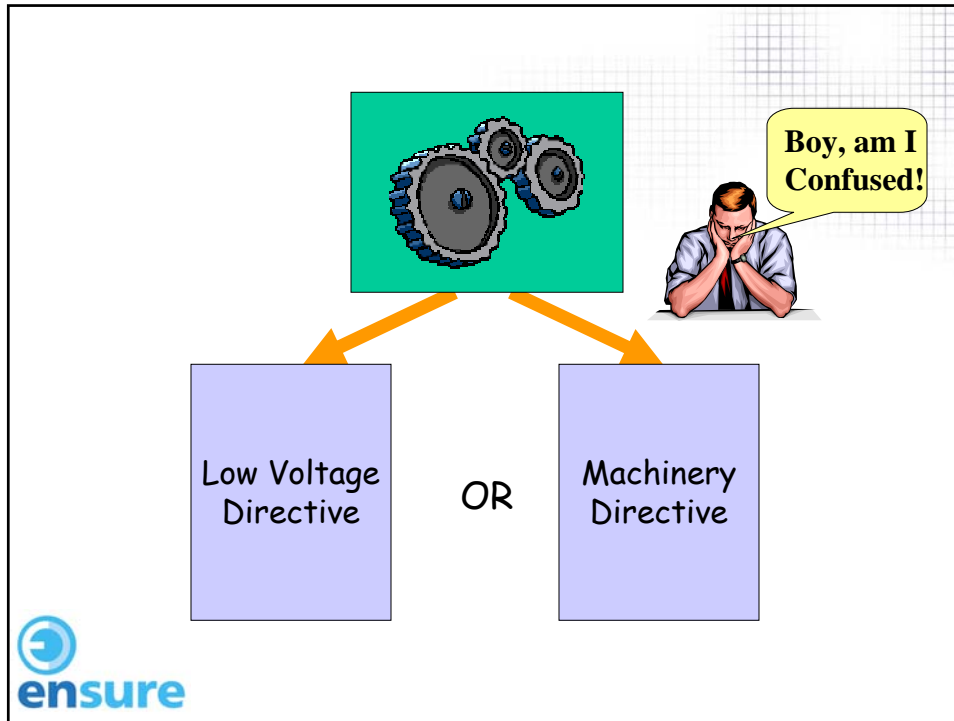


Low Voltage Directive

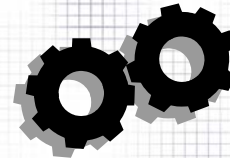


- Electrical equipment should be constructed in accordance with a standard in the following hierarchy
 - **Harmonised standards EN**
 - **International standards IEC**
 - **National standards BS**





Machinery Directive



From:

- 1st January 1993
- 1st January 1995

Directive: 98/37/EC

UK Regulations: The Supply of machinery (Safety) Regulations 1992

Applies to:

- Machinery
- Assemblies of machines
- Interchangeable equipment
- Safety components



Electrical Standards



**EN IEC 60204: 1997 Safety of Machinery -
Electrical equipment for machines –
Part 1: Specification for general requirements**

Presumption of Conformity to

- Low Voltage Directive **and**
- Machinery Directive




EN IEC 60204-1 Electrical Enclosures





- Door interlock not essential
- Eye bolts for lifting
- High voltage markings






Electrical Enclosures

- Door protected with
 - **Key locks**
 - **Door interlocked isolator**
- Touch safe components (IP2X)



Protection of Enclosures IP Rating EN 60529

<i>Dust Objects</i>	<i>Water</i>
2X Finger	X2 Rain
3X Tool	X3 Spraying water
4X Wire	X4 Splashing water
5X Dust protected	X5 Water jets
6X Dust tight	X6 Powerful jets
	X7 Temporary immersion
	X8 Continuous immersion



IP Ratings



- IP 54 minimum rating for an enclosure
- IP 5X implies protected against dust
- IP X4 implies protected against splashing water



Enclosures with PLCs



- Access required with panel live
- Key access to enclosure
- High voltage touch safe or in another enclosure
- Isolator within easy reach, but not on door



EN IEC 60204-1 PLC Enclosure



- Touch safe IP2X
- Lexan covers for DC controllers
- 13A socket for programmer on right



EN IEC 60204-1 Supply Disconnect



- Rotary switches
- Insulated contacts
- Black or grey handles
- Red and yellow if used as an emergency stop



EN IEC 60204-1 Cable Entry



- Each cable separately glanded
- Marked at entry point



EN IEC 60204-1 Cable Entry



- Cables secured
- Cables with large radius bends



EN IEC 60204-1 Cable Entry



- Incomer taken directly to the main disconnect



EN IEC 60204-1 Wiring in Enclosures



- Mechanical protection of cables next to door hinge



EN IEC 60204-1 Neutral and Protective Earth



- Separate terminal must be provided for a **neutral** conductor
- Connections for the **protective earth** (PE) and neutral should be separate.



EN IEC 60204-1 Cable colours



Colour	Used to indicate
Green Yellow	Protective earth PE
Light blue	Neutral
Black	a.c. and d.c. power circuits
Red	a.c. control circuits
Blue	d.c. control circuits
Orange	Interlock control circuits supplied from an external power source



EN 60204-1 New phase colours



Colour	Used to indicate
Brown	Phase 1
Black	Phase 2
Grey	Phase 3



EN IEC 60204-1 Wiring in Enclosures



- Conductors laid side by side in the same duct or in trunking should be **insulated to the highest voltage**
- **Spare terminals** must be installed.
- Fill percentages of ducts must **allow for additional cables** to be installed.



EN IEC 60204-1 Earth Continuity



- Earth straps
- Plated back plate



EN IEC 60204-1 Earth Faults



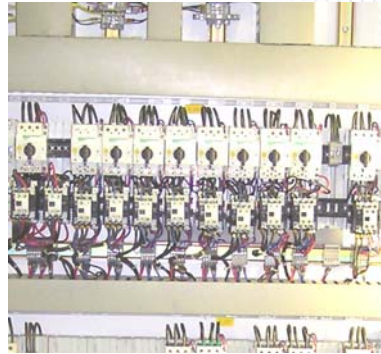
- An earth fault on a control circuit should not cause **unintentional starting** and not **prevent stopping** of a machine.
- Protection against electric shock must be provided i.e. **RCD** Residual Current Device, Circuit Breakers, **where there is a significant risk** of earth leakage.



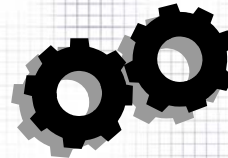
EN IEC 60204-1 Overload protection



- Power circuit breakers complying to *EN60947-3*
- Overload protection for motors above **0.5Kw**
- Miniature circuit breakers (**MCBs**) preferred



Machinery Directive 1.2 Controls



- 1.2.1 Must be safe & reliable
- 1.2.2 Appropriate & appropriately positioned
- 1.2.3 Start only by voluntary action
- 1.2.4 **Stops at each work station**
 - at least one emergency stop

STOP



EN IEC 60204-1 Start Functions



- The start operation should only be possible when all **safeguards are in place** and functional
- An immediate switch off **stop has priority over a start** function;
- Start devices must be **mounted to minimise inadvertent operation.**



EN IEC 60204-1 Sop Function



- Stop function options
 - **Category 0** - power removed immediately
 - **Category 1** – machine stops under power and then power is disconnected
 - **Category 2** – machine stops under power, power remains connected.



EN IEC 60204-1 Emergency Stop function



- **Devices must comply with EN 418**
- **Function must be either:**
 - **Category 0** - power removed immediately
 - **Category 1** – machine stops under power and then power is disconnected
- **Function must override all other functions**
- **Initiation must remove hazard automatically without creating other hazards**



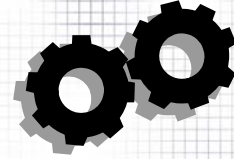
EN IEC 60204-1 Emergency Stop function



- When **reset** is operated the machine is only ready to start i.e. it does not restart automatically
- No further than **5m** to find a stop



Machinery Directive 1.2 Controls



1.2.5 Mode Selection – If a mode is required where safeguards are neutralised, it must

- Lockable selector switch
- Hold to run control
- Limited movement or power
- Step by step motion
- Controls near adjustment point



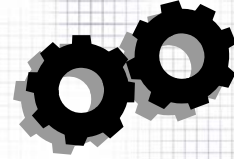
EN IEC 60204-1 Mode Selection



- It should not affect safety levels i.e. immobilise safety protection or interlocking devices;
- If it does alter safety levels, the device must have restricted access e.g. via a key switch or code;
- If it does alter safety levels there must be some other means of decreasing risk e.g. limited speed, limited movement or “hold to run” control.



Machinery Directive 1.2 Controls



1.2.6 No danger after a power failure

1.2.7 No danger after a control failure

1.2.8 Interactive software must be user friendly



Packaging Machine Standards



Shortly to be published

EN 415 Safety of packaging machinery

- Part 5 Wrapping machines
- Part 6 Pallet wrapping machines
- Part 7 Group packaging machines
- Part 8 Strapping machines



EN 415 Series Electronic Motor Drives



- Inverter drives, rectifier drives, servomotors
- Issue of disconnection of power during a short term intervention
- Fault tolerance requirements
 - **Non programmable Category 3 EN 954-1**
 - **Programmable SIL 2 IEC 61508**




EN 415 Series Electronic Motor Drives



- Galvanic disconnection
 - Cat 2 EN 954-1
- Safe Pulse Blocking
 - SIL 2 IEC 61508
- Position monitoring
 - SIL 2 IEC 61508
- Mechanical braking
 - Cat 3 EN 954-1






Category off control circuits

EN 954-1 Safety of Machinery - Safety related parts of control circuits
EN954-100 explains how to use EN954-1

Ideas are not new to UK. BS5304 had the same categories of control circuit



EN 954-1 Category B

The safety-related parts of control systems shall, as a minimum, be designed, constructed, selected, assembled and combined, in accordance with the relevant standards, using basic safety principles for the specific application so that they can withstand:

Standard components, single circuit



EN 954-1 Category 1



- “Well tried”** components, in a **single circuit**
- widely used in the past with successful results in similar applications; or
 - made and verified using principles which demonstrate its suitability and reliability for safety-related applications.

The standard form of control circuit used in most machinery since 1974



EN 954-1 Category 2



“Well tried” components, in a **single circuit** with monitoring of function of components

The **check** of the safety function(s) shall be performed:

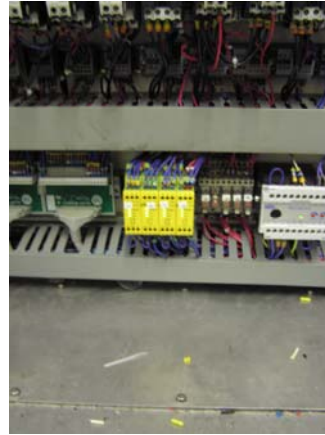
- at the machine **start-up**
- prior to the initiation of hazardous situation
- **periodically** if required
- **Manual** or automatic
- allow operation if no faults have been detected
- Stop machine or warn if a fault is detected



EN 954-1 Category 2



- Self monitoring relay



EN 954-1 Category 3



- A **single fault** in any of these parts does not lead to the **loss** of the safety **function**
- **Common mode** faults shall be taken into account
- **Single fault** shall be **detected** at, or before the next demand upon the safety function.
- *Two circuits*
- *100% redundancy*



EN 954-1 Category 4



- A **single fault** in any of the safety-related parts does not lead to a **loss** of the safety **function** and
- The **single fault** is detected at or before the next demand upon the safety functions, e.g. **immediately**, at switch on, at end of a machine operating cycle.
- An **accumulation** of faults shall not lead to a loss of the safety function.



EN 954-1



- Choose category by risk assessment
- The category depends on
 - **Hazard**
 - **Use**
 - **Integrity of components**
- There can be more than one category of circuit on a machine



Failure of Control Devices

Component	Likely failure	How often?
<i>Guard switch</i>		
<i>Main relay</i>		
<i>Safety relay</i>		
<i>E - stop</i>		
<i>Brake motor</i>		

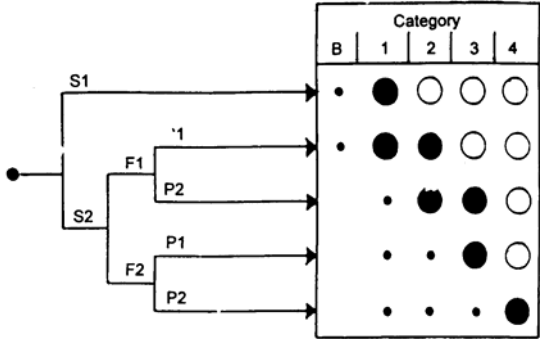


Failure of Control Devices


Component	Likely failure	How often?
<i>Guard switch</i>	Mechanical	Likely
<i>Main relay</i>	Contact wear	Rare
<i>Safety relay</i>	Component failure	Possible
<i>E - stop</i>	Mechanical	Possible
<i>Brake motor</i>	Mechanical wear	Likely



EN 954-1 Category of Circuit




S1	Reversible injury
S2	Irreversible injury
F1	Infrequent access
F2	Frequent access
P1	Possible to avoid injury
P2	Not possible to avoid injury



Use of Categories

B	Machines which cannot cause irreversible injuries
1	Most automatic machinery protected by interlocked guards
2	Automatic machines incorporating trip devices
3	Semi-automatic machines and automatic machines where access is frequent
4	Semi automatic machines where a single fault will inevitably lead to an accident



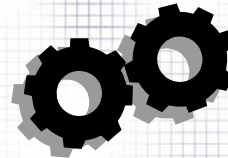
EN IEC 60204-1 Markings



- Components in enclosures must be **easily identifiable** without moving them or the wiring
- **Warning signs** must be provided



Machinery Directive 1.7 Indicators



- 1.7.0 The information needed to control machinery must be easily understood**
- 1.7.1 Warnings must be unambiguous
- 1.7.2 Warn of residual hazards



Signs and Symbols



EN 61310-1 Safety of machinery – Indication marking and actuation – requirements for visual, auditory and tactile signals



EN 61310-2 Safety of machinery – Indication marking and actuation – requirements for marking

ISO 7000 Graphical symbols for use on equipment – index and synopsis



Questions?



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