

# Safety Design Checklist

## ENCLOSURES

Enclosures provide protection against electric shock, fire, and mechanical hazards. Mechanical and electric hazards shall not lead to a hazard in a normal or single-fault condition. Moving parts shall not crush, cut, pierce, or severely pinch an operator's skin. Parts are considered accessible if they can be touched with a test pin or finger. If the operator must perform actions in normal use, with or without a tool that increases the accessibility of parts, these actions shall be taken before testing. Examples include any doors, covers, or parts opened or removed.

### Product Enclosures

- Jointed test finger (12 mm) applied to all sides and openings with 10-N force for accessibility
- Top openings test pin (4-mm dia × 100-mm long)
- Bottom openings; 2-mm dia max × 3-mm spacing or wire mesh or baffle
- Pre-set controls openings (for tool adjust) test pin (3-mm dia × 100-mm long)
- Fasteners for covers/filters over hazardous live parts and mechanical hazards shall require tool to remove

### Additional Considerations for chassis and rack equipment, as applicable (IEC 61010-1)

- Stability: 10° tilt and must not overbalance
- Equipment of >1-m height and >25-kg; mass: 250 N/20% weight test
- Handles capable of withstanding force of four times the weight of the equipment
- Static test (impact hammer): 12-mm dia × 30 N
- Dynamic Test (ball impact): 50-mm dia sphere
- Corner Drop Test: 25 mm ±2.5 mm or 30°, one drop each of four corners

## GROUNDING, WIRING, AND CONNECTIONS

User-accessible conductive parts shall be bonded to the Protective Earth (PE) (safety-ground) conductor terminal if they could become hazardous live in the case of a single fault, or parts shall be separated from other parts which are hazardous live. The integrity of the PE bonding shall be assured. Circuit/wiring connections shall not cause accessible parts to become live in normal or single fault condition.

### Protective Earth (PE)

- PE required for accessible conductive part, such as a metal enclosure, if the part can become hazardous live as the result of a single fault (not if part/enclosure separated by double/reinforced)
- Products using PE shall provide a suitable terminal for connection of PE conductor
- PE soldered connection/s require mechanical securement in addition to solder
- PE shall not be used for other purposes such as fixing constructional parts
- Hinges and slides shall not be used for PE path
- Exterior metal braids/foils of cables shall not be considered as PE bonding
- PE conductors may be bare or insulated; clear or green/yellow for PE insulation color

### General Construction

- If power disconnect switch used, locate close to supply, disconnect L&N
- Circuit breakers for AC supply should break L&N since not polarized in Europe
- Plugs and connectors for AC supply connection to comply with the relevant standards
- Keep hazardous voltage wires separated from uninsulated SELV circuits
- Security of wiring connections shall not depend on soldering
- Accidental loosen of wiring and screws shall not cause accessible part to become live
- Self-tapping screws and screws of insulating material should not be used for electrical connections
- Double fix wire connections
- Edges, corners accessible to users and wireways shall be rounded or smoothed
- Circuits and connectors for external use (PCBs and cables) shall have limited energy
- Unmated measuring terminals at hazardous live shall not be accessible

## LABELS AND MARKINGS

Products shall bear voltage, power, and frequency ratings and company identification markings. Symbols shall be in accordance with IEC standards; for example, V (voltage), A (amperage), Hz (hertz), AC/DC (alternating/direct current) or

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AC/DC symbols. Check standard for markings, caution wording, and exceptions. The user documentation needs to reflect the product's rating.

## Markings and Labels Visible to the User

- Manufacturers name and/or logo, model number, and factory ID on label
- Input RATING in V, A, and Hz for AC power such as 100 to 240 VAC, 4 to 2 A, 60/50 Hz
- 115/230 VAC convenience outlets marked such as 100 to 240 VAC, 3 A max
- On and off symbols (I/O), standby or push-push symbols for disconnect switch

## Markings Typically Internal to the Product

- AC terminals shall be identified (L, N, PE)
- PE symbol (IEC 60417-5019) adjacent to ground terminal
- Earth (ground) symbol (IEC 60417-5017 or other) for nonsafety grounds

## Markings for Measurement Products Visible to the User

- CATI marking is not typically required for nonhazardous voltage products
- Measurement terminals marked with rated V or A and symbol 14
- Measurement terminals for CATII to IV marked with rated V or A and category

## FLAMMABILITY OF MATERIALS

Materials are classified for burning resistance, such as V-0 Class for vertical burn test where the flame will extinguish within 5 s and flaming drops will not ignite cotton. V-1 extinguishes within 25 s. HB is a horizontal burn class, and HF class is for foamed materials. Components, wiring, and parts inside an enclosure and materials that support live parts shall be constructed of materials intended to reduce the propagation of fire. A fire enclosure is intended to minimize the spread of fire from within, such as fire resulting from a single fault.

## Minimum Flammability Ratings

- Plastics for fire enclosures rated V-1 after molding
- PCB rated V-1
- V-2 for plastics enclosures that have other means to prevent the spread of fire; for example, a metal subenclosure
- Plastics in I/O connectors with nonhazardous voltages, rated V-2
- Connectors and plastic on which components are mounted, rated V-2
- Plastic air filters, rated V-2 or HF-2
- Plastic enclosures and decorative parts outside fire enclosures, rated HB
- Plastic wire insulation, rated FV-1
- Exempt: PVC/TFE/PTFE/FEP/neoprene wire insulation, small parts on PCBs, layers of insulation, adhesive tape, nameplates, mounting feet, cable ties, knobs, and others

*NOTE: This checklist gives a safety overview based on IEC 61010-1. Flammability of material requirements are from IEC 61010-1 and IEC 60950-1. The checklist covers some design tips; refer to the standards for other safety requirements, tests, and pass/fail criteria.*

## Table 2. Safety Design Checklist

connector pin-to-pin, optical isolator input-to-output pins, and ground trace/metal enclosure to live circuits.

## Conclusion

With international standards becoming the *de facto* rules worldwide and consumer awareness of safety increasing, it is incumbent on manufacturers to understand and apply a sound safety design policy. By reading the standards and understanding safety concepts, product manufacturers will be better equipped to design products that comply with established safety norms.

To get started, use the information contained in this article along with the standards and the Safety Design Checklist (Table 2). It is important to remember the steps to a safe design are components, construction and design, and testing.

## About the Author

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