



Electrical Connections

For regulatory authorities in the electrical inspection community.

Understanding Ground Fault and Leakage Current Protection *by Rich Berman*



Ground-fault circuit interrupters (GFCIs) have been in use for over 40 years, and have proven themselves to be invaluable in the protection of personnel from the hazard of electric shock. Other types of leakage current and ground fault protective devices have been introduced for various applications since the introduction of GFCIs. The use of some protective devices is specifically required in the National Electrical Code® (NEC)®. Others are a component of an appliance, as required by the UL standard covering that appliance. This article will help to differentiate the various types of protective devices used today and clarify their intended uses.

GFCIs

The definition of a ground-fault circuit interrupter is located in Article 100 of the NEC and is as follows: "A device intended for the protection of personnel that functions to de-energize a circuit or portion thereof within an established period of time when a current to ground exceeds the values established for a Class A device." Following this definition, a Fine Print Note provides additional information on what constitutes a Class A GFCI device. It states that a Class A GFCI trips when the current to ground has a value in the range of

4 milliamps to 6 milliamps, and references UL 943, the Standard for Safety for Ground-Fault Circuit-Interrupters.

Section 210.8 of the NEC covers specific applications where GFCI protection for personnel is required. In dwelling units, GFCIs are required in all 125-volt, single phase, 15- and 20-ampere receptacles installed in locations such as bathrooms, garages, outdoors, unfinished basements, and kitchens. Article 680 of the NEC covering swimming pools has additional GFCI requirements.

In almost every new edition of the NEC since 1968, new GFCI requirements were added. See the sidebar on page 2 for examples of when the NEC first required GFCIs for various applications. Please note that this list does not include all locations where GFCI protection is required.

UL Guide Information for Ground-Fault Circuit Interrupters (UL Product Category Code KCXS) can be found on page 179 of the 2008 UL White Book or online at www.ul.com/database.

Other Types of Leakage Current and Ground Fault Protective Devices

The following describes various types of leakage current or ground fault protective devices:

AFCI (Arc-Fault Circuit Interrupter) — Provides protection from the effects of arc faults that may pose a risk of fire, which in some cases may be ground faults. AFCIs are required in certain applications by the NEC, including Section 210.12 for many specific installations in dwelling units. AFCIs are not required to provide GFCI protection.

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GFPE Circuit Breaker

GFPE (Ground-Fault Protection of Equipment)

— Intended for the protection of equipment by disconnecting all ungrounded conductors of a circuit at current levels less than that of a supply circuit overcurrent protective device. This type of device is designed typically to trip in the 30 mA or higher range, and therefore is not used for personnel protection. This type of device may be provided as required by Section 230.95 of the NEC. UL Guide Information for Ground-Fault Sensing and Relaying Equipment (KDAX) can be found on page 180 of the 2008 UL White Book.

LCDI (Leakage Current Detector Interrupter)

— LCDIs are permitted as an alternative to AFCIs in accordance with Section 440.65 of the NEC. LCDI power supply cord assemblies use a special cord employing a shield around the individual conductors, and are designed to interrupt the circuit when leakage current occurs between a conductor and the shield. UL Guide Information for Cord Sets with Leakage-current Detection and Interruption (ELGN) can be found on page 113 of the 2008 UL White Book.

EGFPD (Equipment Ground-Fault Protective Device)

— Intended for applications such as fixed electric deicing and snow melting equipment, as well as fixed electric heating equipment for pipelines and vessels, in accordance with Articles 426 and 427 in the NEC. This device operates to disconnect the electric circuit from the source of supply when the ground-fault current exceeds the ground-fault pick-up level marked on the device, typically 6 mA to 50 mA. UL Guide Information for Equipment Ground-fault Protective Devices (FTTE) can be found on page 137 of the 2008 UL White Book.

The following types of devices are UL Component Recognized, and not intended for general sale or use. They are intended for use as factory-assembled components of specific appliances where the suitability of the installation is determined by UL. They have not been investigated for installation in the field, and may or may not satisfy requirements in the NEC.

ALCI (Appliance Leakage Current Interrupter)

— A component device on electrical appliances, ALCIs are similar to GFCIs, as they are designed to interrupt the circuit when a ground fault current exceeds 6 mA. An ALCI is not intended to replace the use of a GFCI device, where GFCI protection is required in accordance with the NEC.

IDCI (Immersion Detection Circuit Interrupter)

— A component device that interrupts the supply circuit to an immersed appliance. When a conductive liquid enters the appliance and contacts both a live part and an internal sensor, the device trips when current flow between the live part and the sensor exceeds the trip current value. The trip current may be any value below 6 mA sufficient to detect immersion of the connected appliance. The function of an IDCI is not dependent on the presence of a grounded object. Listed products that contain IDCIs or ALCIs have been investigated for installation in applications in accordance with Section 422.41 of the NEC.

Proven Benefit of Leakage Current and Ground Fault Protection

To help mitigate electrical shock hazards, UL has been at the forefront of detector research, technology and standards development. Statistics have shown that devices described in this article have proven to be an effective means to improve safety in residential occupancies and other electrical installations. Proper application and use of these protective devices is critical to coordinating required protection for safe installations.

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NEC Edition Where GFCI Protection Was First Required

- 1968** — Swimming pool underwater lighting
- 1971** — Outdoor receptacles and near swimming pools
- 1975** — Bathroom receptacles and construction sites
- 1978** — Garage receptacles
- 1981** — Spas or hot tubs
- 1984** — Bathrooms of hotel or motel guest rooms
- 1987** — Basements, receptacles near kitchen sinks, and boathouses
- 1990** — Unfinished basements and crawl spaces
- 1993** — Wet bar sinks
- 1996** — All kitchen countertop receptacles, unfinished accessory buildings, rooftops
- 2005** — Near laundry and utility room sinks, outdoors in public spaces
- 2008** — All sinks (other than dwelling units), electric water drinking fountains