Replacing 2-Wire Ungrounded Receptacles

COMMENTS

You may run into some "resi" work that involves retrofitting an existing 2-wire system. What are your options when working with old 2-wire wiring devices?

The NEC requires you to install grounding-type receptacles on 15A and 20A branch circuits. Per Sec. 210-7, it also requires you to effectively ground the grounding contacts of those receptacles to the branch circuit equipment-grounding conductor. But, what can you do about old 2-wire nongrounding-type receptacles, where no ground exists in the outlet box?

Sec. 210-7(d)(3) permits any of the following installations when replacing a 2-wire ungrounded receptacle:

(a) Replace it with another 2-wire receptacle;

(b) Replace it with a GFCI-type receptacle and mark the receptacle with the words “No Equipment Ground;” or

(c) Replace it with a grounding-type receptacle protected by a GFCI device (circuit breaker or receptacle). Since the grounding terminals for the receptacles are not grounded, you must mark the receptacles with the words “GFCI Protected” and “No Equipment Ground” (see Sidebar: Understanding GFCIs).

Let’s talk about the last two options. A GFCI-protected grounding-type receptacle without an equipment-grounding conductor is safer than a grounding-type receptacle with an equipment-grounding conductor, but without GFCI protection. This is because the GFCI protection device will clear a ground-fault when the fault current is 5mA (+ or - 1mA), which is less than the current level necessary to cause serious electric shock or electrocution.

A grounding-type receptacle without a ground is a safe installation, as long as the protection circuitry within the GFCI device has not failed from shorts or voltage transients.

When there is no GFCI protection provided, Sec. 250-130(c) allows you to replace an ungrounded-type receptacle with a grounding-type receptacle at an outlet box not containing an equipment-grounding conductor—if you bond the grounding contacts of the receptacle to any one of the following locations:

- Grounding electrode system (Sec. 250-50);
- Grounding electrode conductor;
- Panelboard equipment-grounding terminal; or
- Grounded service conductor.
Check Sec. 250-146 for the proper method of grounding receptacles and Sec. 250-148 for the proper method of terminating equipment-grounding conductors within receptacle outlet boxes.

**Knob-and-tube wiring**

Two-wire (nongrounding) circuits are often part of knob-and-tube wiring. Some old wiring designs of this type have shared-neutral conductors (actually a form of multiwire branch circuits) connected at unforeseeable points downstream of the receptacle. Some have loads connected through snap switches installed in the neutral conductor. This can create a troubleshooting nightmare. So how can these conditions affect GFCI operation?

Basically, a new GFCI device can appear to work normally—until someone switches on a downstream load that’s connected from a different ungrounded (hot) conductor to the neutral the GFCI is monitoring. The result: a differential neutral current that immediately nuisance trips the GFCI.

Here’s another knob-and-tube problem. Suppose you’ve correctly associated a line-side neutral with its line-side ungrounded counterpart. Although unimportant on a conventional feed-through receptacle, you have to know which is which when connecting the GFCI receptacle. Often conductor identification (if the grounded conductors were, in fact, ever identified) has long since been obliterated. So, you’ll have to actually connect and verify the operation of a small load (with only the circuit in question energized) to be sure.

**By design, GFCI testers will not test a GFCI that’s protecting a 2-wire circuit. Here’s why.** The GFCIs integral test button applies test current between the hot and neutral. This is not the case with GFCI testers. Instead, these testers apply the test current between the hot and equipment ground. So, if there’s no equipment ground, no test current will flow.

If any exposed metal parts are connected to the receptacle grounding contact (such as a metal faceplate or a weatherproof cover), the tester will energize them. Some testers apply up to 30mA of test current; so using one of these while touching a metal cover plate could result in an uncomfortable and possibly dangerous shock.
Sidebar: Understanding GFCIs

A GFCI protection device operates on the principle of monitoring the current imbalance between the ungrounded (hot) and grounded (neutral) conductors. In a typical 2-wire circuit, the current in amperes returning to the power supply will be the same as the current leaving the power supply (except for small leakage). If the difference between the current leaving and returning through the current transformer of the GFCI protection device is 5mA (or 11mA), the solid-state circuitry activates the shunt trip feature to open the switching contacts of the GFCI, thereby de-energizing the circuit.

**WARNING**: Sever electric shock or death can occur if a person touches the energized (line or hot) conductor and neutral conductor at the same time, even if the circuit is GFCI protected. This is because the current transformer within the GFCI protection device doesn’t sense any imbalance between the departing and returning current. Therefore, the switching contacts remain closed.

When a GFCI protection device fails, the switching contacts remain closed and the device continues to provide power—providing no GFCI protection.

According to a study (based on data accumulated by the American Society of Home Inspectors) published in the November/December 1999 issue of the IAEI News, **21% of the 1583 GFCI circuit breakers tested failed. Also, 19% of 4585 GFCI receptacles tested failed.**

These failures were primarily attributed to damage from short circuits and voltage surges (lightning and other transients) to the metal oxide varistors (MOVs) used for built-in surge suppression. In areas of high lightning activity (such as Southwest Florida), **the failure rate for GFCI circuit breakers was more than 57%.**