# Troubleshooting Tips for AFCI Installations

Overview of the basic wiring practices electricians should follow on AFCI-protected circuits and pointers for combating potential problems

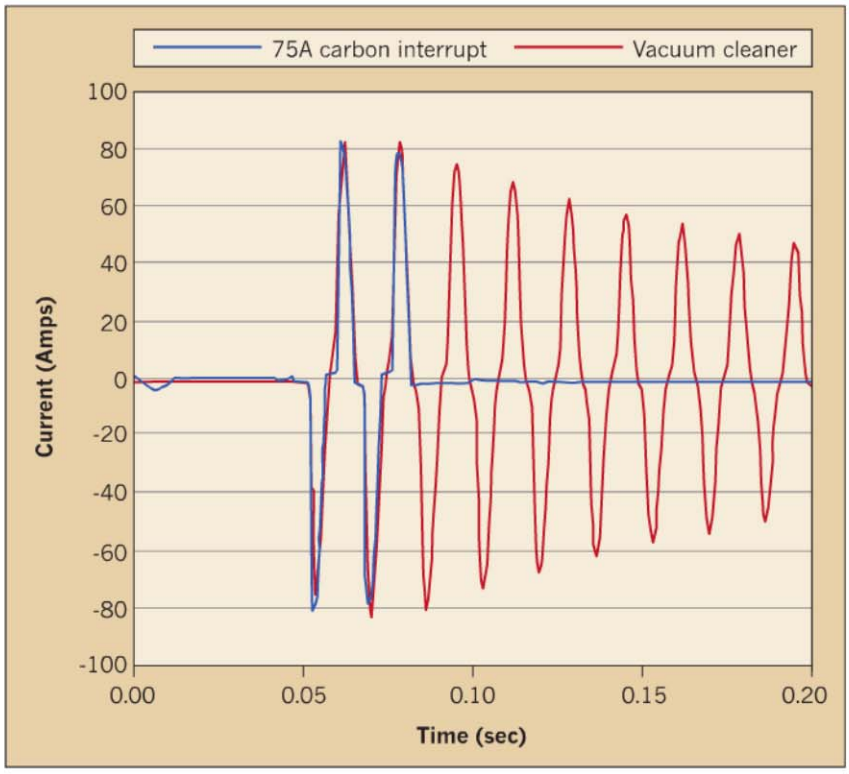


**Fig. 1.** A vacuum cleaner is one example of how current waveform of a home electrical product can mimic the characteristics of an arc.

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Unlike a conventional circuit breaker, which detects overloads and short circuits, an arc fault circuit interrupter (AFCI) uses advanced electronic technology to sense different arcing conditions. This device weeds out the harmful arc characteristics from the "normal" arcs that occur during the normal operation of loads and other wiring devices. Common household items, such as a motor-driven vacuum cleaner or a furnace motor, naturally create arcs when they operate — each of which is considered a normal arc (**Fig. 1**).

Another example is the arc that may occur when a light switch is turned off. Dangerous arc faults, however, may result from improper installation, damaged wiring, overheated or stressed electrical cords, worn electrical insulation, wires and/or cords in contact with vibrating metal, damaged electrical appliances, and

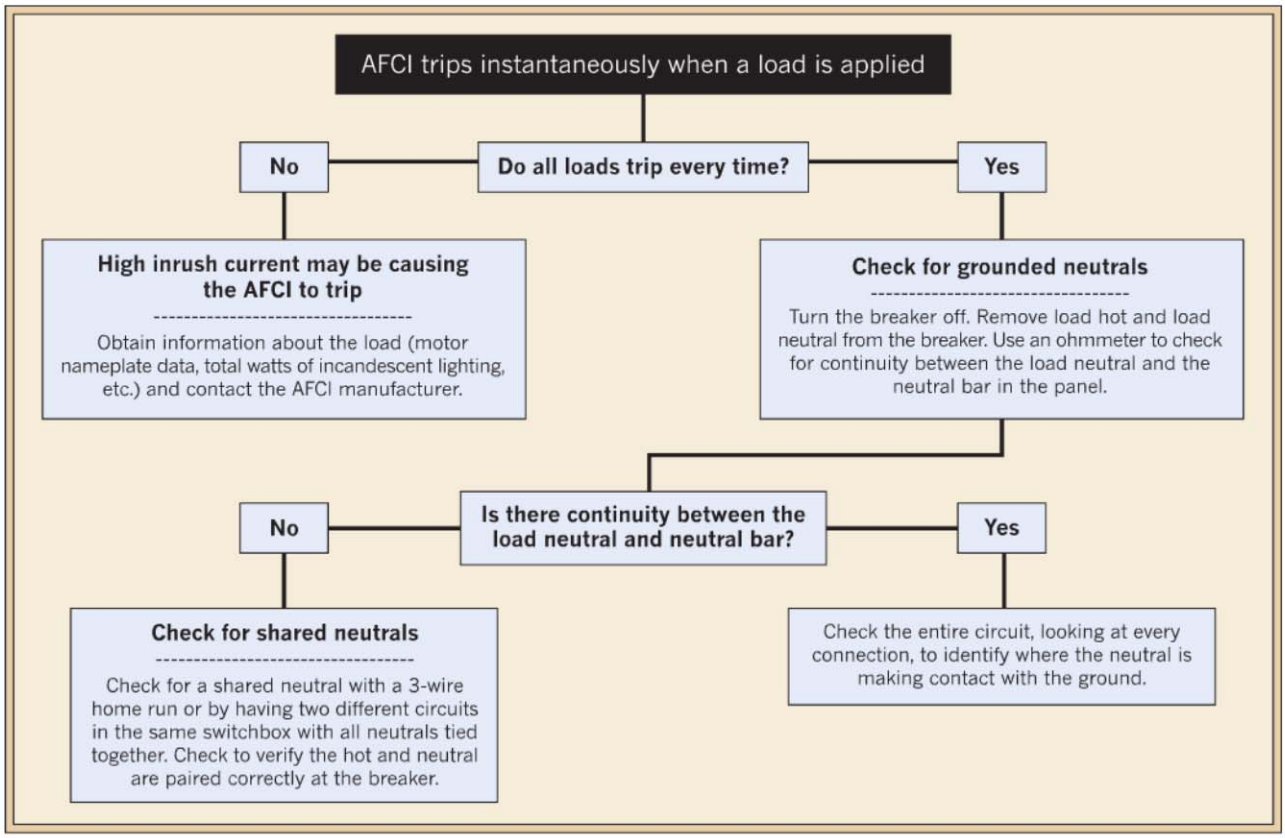


**Fig. 2.** Instantaneous tripping is defined as a trip that occurs immediately after a load is applied while the handle of the AFCI is set in the ON position. This process outlines the steps to troubleshoot this problem.

more. This type of arc condition creates high-intensity heat, which may exceed 10,000°F and result in burning particles that can easily ignite surrounding material, such as wood framing or insulation.

AFCIs are designed to recognize arc faults when they occur and automatically shut the circuit down before it becomes a fire hazard. Manufacturers of AFCIs test for hundreds of possible operating conditions, designing each AFCI to constantly discern between normal and dangerous arcs.

Due to the proven effectiveness of AFCIs, it's important electricians follow proper wiring practices to help minimize troubleshooting efforts. The following sections highlight some of the best practices for electrical installation projects, but especially those performed on circuits that will be protected by AFCIs. Appropriate steps to successfully troubleshoot a potential wiring problem that will cause the AFCI to trip are also covered.

**Proper tools and work practices.** Using the right tools to do the job is critical. A simple task like drilling holes in studs, if done incorrectly, can jeopardize the integrity of the insulation of the wiring being pulled. Damaged

## AFCIs and the NEC

The National Electrical Code (NEC) requirements for AFCI installation in new home construction have expanded with each Code cycle. AFCIs first appeared in the 1999 edition of the NEC, which required their use on all branch circuits that supply 125V, single-phase, 15A and 20A receptacle outlets installed in dwelling unit bedrooms, effective Jan. 1, 2002. After further research and analysis of the technology and its potential safety benefits, the 2002 NEC expanded its requirement for AFCIs to all branch circuits that supply 125V, single-phase, 15A and 20A outlets installed in dwelling unit bedrooms, including those that supply lighting fixtures, smoke alarms, and other equipment. The 2008 edition of the NEC took safety a step further by requiring that all new home construction install the technology on other circuits in the home.

As per 210.12 of the 2008 NEC, "All 120V, single-phase, 15A and 20A branch circuits supplying outlets installed in dwelling unit in family rooms, dining rooms, living rooms, parlors, libraries, dens, sun rooms, recreation rooms, closets, hallways, or similar rooms or areas shall be protected by a listed arc-fault circuit interrupter, combination type installed to provide protection of the branch circuit."

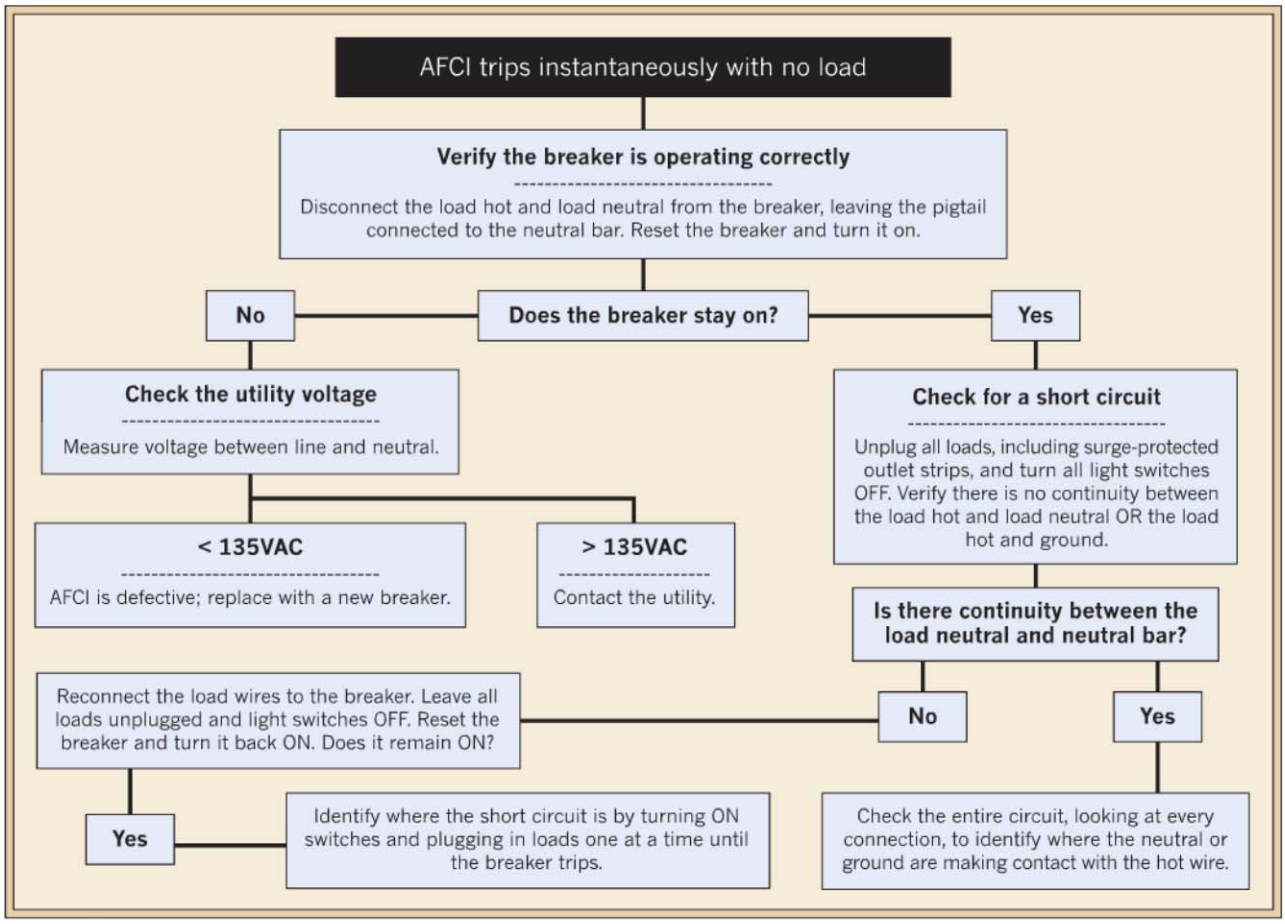


**Fig. 3.** No load on the AFCI is when the hot wire is disconnected from the load terminal of the AFCI. This process outlines the steps that should be followed when an AFCI with no load instantaneously trips.

conductors during installation could result in immediate tripping of the AFCI when the circuit is energized.

For example, simply changing the blade in a razor blade knife can not only prevent needlessly damaging conductors, but also increase the safety of performing the task. Keep in mind, if you nick a wire or accidentally remove strands from a conductor, there is less copper to carry the same amount of current, resulting in overheating and possibly further damage to the installed wiring. These same conductors, if damaged due to poorly maintained tools, will eventually be hidden by drywall and paint, preventing easy identification of the cause of an AFCI tripping.

Selecting proper equipment and derating conductors is as much a part of circuit protection as the application of the circuit breaker itself. Make sure you select the right conductor and wiring device for the application. Additionally, pay attention to ampacity, interrupting ratings, and other important factors. Derating of conductors when necessary and making ambient/other adjustments could help you avoid a call back to a job — and the hours of troubleshooting that follow to remedy the situation.

Protecting the conductors and other wiring devices from the environment in which they are placed is also important. Simply placing nail guard plates in those areas where the likelihood is high that a future tradesperson will nail a trim or secure a cabinet/other item to the wall could save the wire from being damaged — and save you hours of work when the AFCI detects the problem. Choosing where to drill your holes through the studs and joists can save the money in nail guards. For example, knowing that kitchen cabinets will be installed on a wall — more specifically, how high up on that wall — can help you determine where to route your wires, ensuring they are out of the danger zone.

It's important to remember that you are not the only trade that will be working on the installation. Other trades will be on-site before and after your work is completed. Don't forget that these trades working around your electrical installation can jeopardize it. Timing your work to avoid unnecessary damage to the conductors you have installed is recommended. In a typical home construction scenario, for example, plumbing and HVAC trades should have completed their work before you start pulling wire.

Understanding this process and the timing of construction elements can help reduce, if not eliminate, troubleshooting due to other trades damaging conductors, wiring devices, and any other electrical component in your installation.

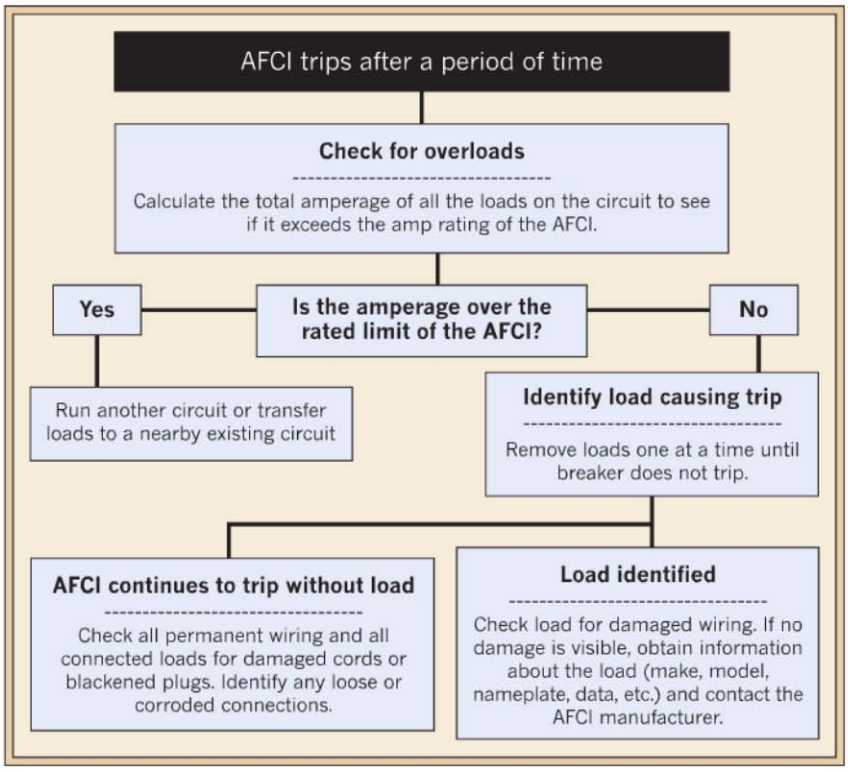


**Fig. 4.** In some instances, the circuit or a load may appear to be causing the AFCI to trip after the circuit breaker has been in operation for some length of time. This procedure will help you work through one of the most difficult problems to troubleshoot.

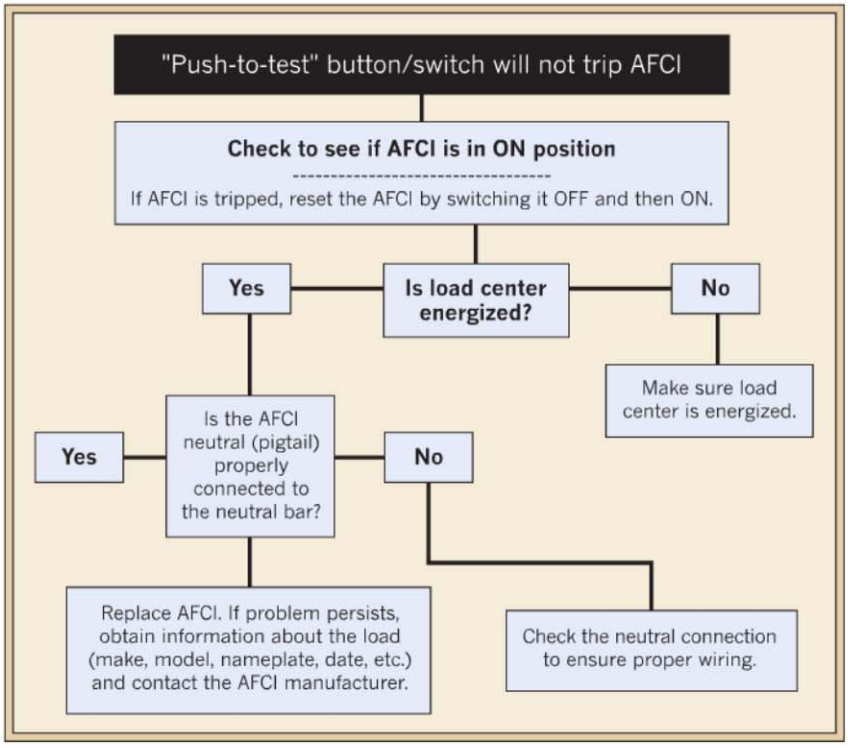


**Fig. 5.** This process outlines the steps that should be followed when the AFCI's "push-to-test" button does not trip the breaker.

You can make the right decisions on where to route wiring and what preventive measures to take in order to ensure a nail or screw won't penetrate or nick electrical wiring behind walls. A nicked wire, if left uncorrected, may lead to an arc fault condition, which will trip an AFCI. Therefore, installing electrical wiring around the installation of HVAC duct work and water supplies/drains will help avoid any future repairs that arise from such damage.

**Installation and troubleshooting tips.** Install the breaker and connect the pigtail to the neutral bar. Reset the breaker, if necessary, and turn it ON. Press the test button. The breaker should trip. Turn the breaker OFF. Connect the load hot (black) and neutral (white) wires to the breaker. Turn the breaker ON. It should not trip. If it does, you must now troubleshoot the circuit and/or system.

Items you should focus on during the troubleshooting stage include: reversed neutral and ground wires; shared neutral wiring on single-pole AFCI circuits; and ground wires touching neutral wires. Lighting fixtures and appliances attached to these circuits have also been found to be damaged/faulty and should be inspected if an AFCI trips.

Some electrical contractors have been very active in providing information about these types of wiring problems. Many indicate that the initial installation errors have disappeared as installers become more familiar with the installation and operation of AFCIs.

Investigating and determining the true reasons why AFCIs trip ultimately prove beneficial to everyone. The troubleshooting guidelines, as outlined in **Fig. 2** (on page C22), **Fig. 3** (on page C24), **Fig. 4**, and **Fig. 5**, provide common scenarios and the appropriate steps to diagnose and effectively alleviate any problem you might encounter in the field. **EC&M**

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