

Breakers That Trip

YES Electric • NEC 2026 with NEC 2023 numbers in parentheses

Draft 1 (October 2026). This chapter is under review. Code numbers are NEC 2026. Your local inspector may use an earlier edition, so ask your journeyman which one applies. Boxes marked "Picture coming" will get drawings and photos in a later version.

Phase 2, Troubleshooting and Service Calls.

Before this module: R2.1 (the service call routine), R2.2 (meters and testers), and R2.3 (dead circuits and mid-pointing). This chapter uses mid-pointing on a circuit that trips instead of a circuit that is dead.

Code edition. Code references are NEC 2026. Where a section moved, the NEC 2023 number is in parentheses. The local inspector (the AHJ) may enforce an earlier edition, so ask your journeyman which one applies.

Learning Objectives

When you finish this module you will be able to:

1. Tell an overload, a short circuit, a ground fault, and an arc fault apart by how fast the breaker trips, when it trips, and what the breaker type is.
 2. Work a standard breaker that trips once in a while and one that trips every time you reset it.
 3. Work an AFCI that trips constantly and one that trips once in a while, and find the shared-neutral mistake that causes both.
 4. Work a GFCI that trips with no obvious fault, including leakage that adds up on long and outdoor circuits.
 5. Decide when the breaker itself is bad and when it is doing its job.
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Background: Why Breakers Trip

A circuit breaker is an automatic switch. It opens the circuit when something is wrong so the wire does not overheat and start a fire, and, for GFCI and AFCI types, so a person does not get shocked or a bad connection does not keep arcing. A breaker that trips is almost always telling you the truth. Your job is to find out what it saw.

The parts inside a breaker

Part	What it reacts to	How fast	Breakers that have it
Thermal element (a bimetal strip that bends when it heats)	Current above the rating for a while: an overload	Slow. Seconds to minutes. The more over, the faster.	Every breaker
Magnetic element (a coil that yanks the latch on a big current surge)	A very large current: a short circuit or a solid ground fault	Instant. Less than a second.	Every breaker
Ground-fault sensor	Current going out on the hot that does not come back on the neutral	Fast, a fraction of a second	GFCI breakers, dual-function (AFCI/GFCI) breakers, and, at a higher level, AFCI breakers
Arc-detection electronics	The signature of arcing in the current waveform	Fast, but only when the arc is happening	AFCI breakers and dual-function breakers

A standard breaker (Kuhlman calls it a "standard" or non-arc-fault breaker) has only the thermal and magnetic parts. It trips for only two reasons: an overload or a short circuit (Kuhlman, Residential Electrical Troubleshooting, p. 33). A GFCI trips when the current out on the hot and back on the neutral differ by more than about 5 milliamps (Kuhlman, pp. 27, 38; the Arc Guide gives 4–6 mA, Symptom 3). An AFCI also has a ground-fault sensor set higher than a GFCI's. Kuhlman notes one brand trips at about 7 milliamps (p. 35). That ground-fault sensor is why an AFCI trips on a neutral touching a ground or on two circuits' neutrals tied together, even though neither one is an arc.

The four trip types

Trip type	What is happening	How the breaker acts	What you usually find
Overload	Too much plugged in and running. The current is above the rating but the wiring is fine.	Holds when reset with nothing running. Trips after minutes of normal use. Trips faster the more it is overloaded.	A space heater and hair dryer on one circuit. Two window ACs. A microwave and toaster oven on one countertop circuit.
Short circuit	The hot touches the neutral. Current is limited only by the wire.	Trips instantly on reset, often with a loud snap.	A nail or screw through a cable, a wire pinched by a device or box, a crushed cord, a failed appliance.
Ground fault	The hot touches the ground wire, a metal box, or something grounded. Or current leaks to ground a little at a time.	A solid ground fault trips any breaker instantly. A small leak trips only a GFCI, dual-function, or AFCI breaker.	Wire touching a metal box edge, water in an outdoor box, a failing heating element, buried cable with damaged insulation.
Arc fault	A loose or damaged connection arcs, or a damaged cable arcs between conductors.	Only an AFCI or dual-function breaker trips. It may trip once a day or once a week.	Burned backstab, loose wire connector, a staple through a cable, a worn lamp cord. Also motors and some electronics that look like arcs.

Picture coming: Four-panel table-picture titled "Read the Trip." Four columns: Overload, Short Circuit, Ground Fault, Arc Fault. Row 1 "Cause": a power strip with a space heater and hair dryer; a nail through a cable; a bare ground touching a hot screw in a metal box; a blackened backstab hole. Row 2 "How fast it trips": a clock showing "minutes"; a lightning bolt showing "instant"; "instant (solid) or random (leak)"; "random, when the arc happens." Row 3 "What you will find": "Clamp reading above breaker rating"; "Ohms hot-to-neutral near 0 with loads off"; "Ohms hot-to-ground near 0, or a GFCI that won't hold"; "Burn marks, loose connection, or a motor load." Row 4 "How to test": clamp meter; ohmmeter at panel, breaker off; ohmmeter plus GFCI leakage clamp; unplug test, then mid-point.

Why you never fix a trip with a bigger breaker

NEC 240.4(D) limits the breaker on small copper wire: 14 AWG copper to 15 A, 12 AWG copper to 20 A, and 10 AWG copper to 30 A. For aluminum and copper-clad aluminum, 12 AWG is limited to 15 A (240.4(D)(5)). The breaker size is set by the wire, not by what the customer wants to plug in. A 20 A breaker on 14 AWG wire lets the wire carry more current than it can handle, and it can overheat inside the wall without ever tripping. The Arc Guide says the same thing: never upsize a breaker to stop overload tripping (Symptom 2, Step 6). If the circuit is overloaded, the fix is a new circuit or moving loads, which goes to the office as a scope (R3.1).

Breaker types you will see in a house

Breaker	How to recognize it	What it trips on	Reset
Standard single-pole	One handle, one wire terminal, no TEST button	Overload, short circuit	Handle fully to OFF, then ON
Standard two-pole	Two handles tied together, two wire terminals, 240 V	Overload, short circuit on either leg; both poles open together (Kuhlman, p. 34)	Fully OFF, then ON
Tandem (twin)	Two handles in the width of one breaker	Same as standard	Each handle separately
AFCI (combination type)	TEST button, white coiled pigtail (or plug-on neutral clip), often an LED	Arc faults, overload, short circuit, ground fault at a higher threshold than GFCI	Fully OFF, then ON
GFCI breaker	TEST button, white pigtail or plug-on neutral	Ground fault at about 5 mA, overload, short circuit	Fully OFF, then ON
Dual-function (AFCI/GFCI)	TEST button, pigtail or plug-on neutral, label says both	Everything above	Fully OFF, then ON
Two-pole AFCI or GFCI	Two handles, TEST button, neutral pigtail	Same as single-pole versions, on both legs	Fully OFF, then ON

On AFCI, GFCI, and dual-function breakers with a pigtail, the circuit's own white wire lands on the breaker, and the breaker's coiled white pigtail lands on the neutral bar. The breaker has to see both the hot and the neutral current to compare them (Arc Guide, Job 5; Eaton Technical Data TD003006EN, Figure 1). Plug-on neutral breakers clip onto a neutral rail in the panel instead of using a pigtail.

Where AFCI and GFCI breakers are required

You need to know this to understand why a customer has these breakers, and why you cannot "fix" nuisance trips by swapping in a standard breaker.

- NEC 210.12(B) requires AFCI protection on all 120 V, 10, 15, and 20 A branch circuits supplying outlets or devices in dwelling kitchens, family rooms, dining rooms, living rooms, parlors, libraries, dens, bedrooms, sunrooms, recreation rooms, closets, hallways, laundry areas, and similar areas.
- NEC 210.12(E) says that when branch-circuit wiring in those areas is modified, replaced, or extended, the circuit must get AFCI protection, either by a breaker-type AFCI or by an outlet-type AFCI at the first receptacle or switch. An extension of 6 ft or less with no new outlets is exempt.
- NEC 210.8(A) requires GFCI protection for dwelling receptacles in bathrooms, garages, outdoors, crawl spaces, basements, kitchens, areas with sinks, receptacles within 6 ft of a sink or tub, boathouses, laundry areas, and indoor damp and wet locations.

- NEC 210.8(D) in the 2026 code adds GFCI protection for the outlets supplying several appliances, including dishwashers, sump pumps, electric ranges, wall ovens, cooktops, clothes dryers, and microwave ovens. Newer houses will have GFCI or dual-function breakers on these 240 V and 120 V appliance circuits, and some older appliances leak enough current to trip them.
- NEC 210.8(F) requires GFCI protection on dwelling outdoor outlets. In the 2026 code, the exception for listed HVAC equipment expired September 1, 2026, and listed Class C special-purpose GFCI (SPGFCI) protection is permitted for listed HVAC equipment instead.

When a customer says "just put a regular breaker in," the answer is that the code requires the protection, and a standard breaker would remove it. If you are troubleshooting and want to prove whether the AFCI or GFCI is the problem, Kuhlman's method is to go the other way: install a dual-function breaker where a standard one was, because it catches more faults (p. 82). You never leave a required AFCI or GFCI replaced with a standard breaker.

Part A: Ask the Customer First

The answers to these questions point you at the trip type before you open the panel. Ask them in addition to the R2.1 intake questions.

#	Ask	What the answer tells you
1	"Which breaker is it? Can you show me?"	Standard, AFCI, GFCI, or dual-function. This decides which section of this chapter you use.
2	"Does it trip right when you reset it, after a while, or only once in a while?"	Instantly = short or ground fault. After a while = overload. Once in a while = intermittent fault, arc fault, a specific appliance, or wet conditions.
3	"What is usually running when it trips?"	A heater or hair dryer = overload. A vacuum = AFCI motor trip (Kuhlman, p. 37). The ceiling fan or one light = maybe, but do not trust it until tested.
4	"Does it happen more when it rains?"	Outdoor receptacles, post lights, landscape lights, buried cable (Kuhlman, pp. 83, 100-101).
5	"Has anyone hung pictures, put up shelves, put in trim, or done any work lately?"	A nail or screw through a cable. Kuhlman says ask about work done before the problem started (p. 75).
6	"When did it start? Was anything new installed or plugged in around then?"	New stereo, new lights, a new appliance. Write it down but test before you believe it.
7	"When it trips, does a cleaning crew come that day?"	Kuhlman asks this before he even drives out on an occasional AFCI trip (p. 85). If yes, have them try their vacuum while you watch, or have the customer try their own vacuum in the same receptacle.
8	"Is it a GFCI receptacle or the breaker in the panel that trips?"	GFCI receptacle problems are in R2.3. Breaker problems are here.

Write down the answers on the job board. Then do the R2.1 five safety checks.

Part B: First Tests for Any Tripping Breaker

Do these in order on every tripping-breaker call. They take 10 to 20 minutes and they sort the call into one of the procedures in Parts C through F.

Test B1. Identify the breaker

1. Open the panel door. Look before you touch: water, rust, scorching, smell (R2.1, Part E).
2. Find the tripped breaker. Its handle sits between ON and OFF, or shows a trip flag.
3. Read the breaker face: amp rating, brand, and type (standard, AFCI, GFCI, dual-function).
Look for a TEST button and an LED.
4. Read the panel label. Note the brand and the breaker types listed for the panel.
5. Photograph the breaker face and the panel label.

Safety: Federal Pacific Stab-Lok. If the panel is Federal Pacific or the breakers say Stab-Lok, do not trust any breaker position. Prove dead with your meter on anything you touch (R2.1; R-OLDHOUSE).

Test B2. Read the LED, if there is one, before you reset

Many AFCI, GFCI, and dual-function breakers record why they last tripped and show it with an LED. The blink patterns are different for every brand and model, so you read them from the chart printed on the breaker or in the manufacturer's instructions. Do not use a blink chart from memory or from a general field guide. The Arc Guide prints two blink charts for the same brands that do not agree with each other (Symptom 4 and Part 8), which is the reason for this rule.

One manufacturer example, from Eaton's technical data sheet for its Type CH dual-purpose arc-fault/ground-fault breaker (Eaton TD003006EN, September 2014, Table 3):

Code	Eaton's description	What it points you to
No code recorded	Thermal overload, short circuit by the mechanical part, TEST button, or manual off. The LED shows the last recorded code instead.	Overload or a hard short. Go to Part C or D.
1	Series arc: a low-current arc in one current path	Worn cords, loose connections in appliances or fixtures, contacts in equipment. Part E.
2	Parallel arc: a high-current arc between two conductors	Damaged installed wiring: a nail, screw, tight staple, damaged insulation. Mid-point the wiring.
3	Short delay: an electronic backup to the short-circuit trip	A short circuit. Part D.
4	Overvoltage: the breaker saw 160 V rms or more	The house voltage is too high. Check for a lost neutral (R2.5).
5	Ground fault	Current going to ground. Part F.
6	Self-test failure	The breaker has failed. Replace it.

Eaton's sheet says the code repeats 30 times. If you reset the breaker before reading it, the code may be gone from the display. Follow the manufacturer's instructions for recalling it. This table applies to that Eaton breaker only. For any other breaker, read its own chart.

Test B3. Reset and watch

1. Before you reset, ask the customer to turn off or unplug the big loads on that circuit (heaters, hair dryers, window ACs).
2. Push the handle firmly to OFF until it clicks, then to ON.
3. Watch and listen.

What happens	What it means	Go to
Will not reset. The handle will not latch, even fully OFF first.	AFCI/GFCI with a fault still present (some will not latch on a ground fault), a self-test failure, or a mechanically failed breaker	Part G, then Parts D and F
Trips instantly, the moment it reaches ON	Short circuit or solid ground fault, either in the wiring or in something plugged in or switched on	Part D
Holds now, trips after minutes of normal use	Overload, or a fault that happens under load	Part C
Holds now and the customer says it trips once in a while	Intermittent fault, arc fault, a specific appliance, or wet weather	Part C first (to rule out overload), then Part E
Holds, but you hear crackling from the breaker or bus when you work the handle	A burned connection between the breaker and the bus. Kuhlman calls that sound a dead giveaway that the breaker is breaking down (p. 33).	Part G, and R2.7

Safety: do not keep resetting into a short. Each reset into a short circuit lets thousands of amps flow for a split second. Reset a breaker that trips instantly once to confirm, then stop and test it dead.

Test B4. The unplug test

This splits "the wiring is bad" from "something plugged in is bad." It is in both books (Arc Guide, Symptom 2, Step 2; Kuhlman, p. 83).

1. Turn the breaker off.
2. With the customer, find everything on that circuit. Put blue painter's tape on each receptacle and switch you identify. Kuhlman uses the same tape trick (p. 85).
3. Unplug everything from every receptacle on the circuit. Turn every switch on the circuit off.
4. Reset the breaker.
5. If it holds, the wiring is likely fine and something you unplugged is the cause, or the fault only shows up under load. Go to Step 6.
6. Plug things back in and turn things on one at a time. Wait at least 5 minutes after each one on an AFCI circuit (Arc Guide, Symptom 4, Step 2). The item that trips the breaker is the cause.
7. If nothing trips it with everything back on, put a known load on the circuit, such as your own shop vacuum or a 1,500 W heater. Kuhlman explains that many AFCIs do not trip on a neutral touching ground until there is a load on the circuit (p. 84). If it trips with your load, the fault is in the wiring and you mid-point it (Part E).

Do not blame the last thing you turned on. Kuhlman warns that if the neutral and ground are touching somewhere, any load anywhere on the circuit can make the breaker trip. A new tech

sees it trip when the recessed lights come on and decides the lights are the problem. The lights only supplied the load. You still have to mid-point (p. 84).

Part C: Overload (Standard Breaker Trips After a While)

Symptom. The breaker holds when reset, then trips after the circuit runs for a while. It may trip at the same time every day: breakfast, hair-drying time, when the heaters come on at night.

Questions. What runs on this circuit? What was running when it tripped? Is it worse in winter (space heaters) or summer (window ACs)?

Tests.

1. **Find everything on the circuit.** Turn the breaker off and walk the house with the customer, taping every dead receptacle and light.
2. **Recreate the normal load.** Turn the breaker on. Ask the customer to run what they normally run when it trips.
3. **Clamp the circuit.** Set the clamp meter to AC amps (A~). With your journeyman's OK and the dead front removed, clamp around the single hot wire leaving the breaker. Do not clamp the whole cable. A cable has hot and neutral current flowing in opposite directions, and they cancel to near zero (R2.2).
4. **Read the meaning.**

Clamp reading compared to the breaker	Meaning
At or above the breaker rating (for example 15.5 A on a 15 A breaker)	Overload. The breaker is doing its job.
80 to 100 percent of the rating (12 to 15 A on a 15 A) for hours	Heavy load. It may trip on a warm day or after hours. Breakers are typically applied so continuous loads stay at or below 80 percent of the rating.
Well below the rating (for example 3 A on a 15 A) and it still trips	Not an overload. Go to Part E (intermittent fault) or Part G (weak breaker).

1. **Check the wire size.** Look at the cable jacket where it enters the panel, or the print on the conductor. 14 AWG must be on a 15 A breaker and 12 AWG on a 20 A breaker or less (240.4(D)). If you find 14 AWG on a 20 A breaker, that is a safety finding. Turn the breaker off and talk to your journeyman.
2. **Check the terminal.** With the breaker off and proven dead, look at the wire on the breaker terminal. Discoloration or a loose screw means heat. A loose terminal makes its own heat and can trip a breaker that is lightly loaded (Arc Guide, Symptom 2, Step 7; R2.7). Torque it to the value on the breaker label (110.14(D)).

The fix.

- If it is an overload: explain the reading to the customer and show them which loads to move. A space heater on a different circuit, a hair dryer in a bathroom receptacle (which is on its own 20 A circuit in newer houses, 210.11(C)(3)), a window AC on its own circuit. If they need more capacity, write up a recommendation for a new circuit. The office prices it.
- Never install a larger breaker.
- If the wire is too small for the breaker, the fix is the right-size breaker. Document it.

Worked numbers. Kuhlman's example: a vacuum and a window AC on one 15 A circuit draw a combined 19 A, which trips it (p. 33). Clamp readings tell you this in 30 seconds, without arguing about nameplates.

Part D: Short Circuit or Solid Ground Fault (Trips Instantly)

Symptom. The breaker trips the moment you reset it, even with everything unplugged and switched off. Sometimes there was a bang, a flash at a receptacle, or a burning smell.

Questions. Did anything spark, pop, or smell? Did anyone drill, nail, or screw into a wall? Did anyone change a light, switch, or receptacle? Did it start after rain?

Tests.

Safety: these tests are done with the breaker OFF and proven dead. An ohmmeter connected to a live circuit can be damaged, can give false readings, and can put you at risk. Prove dead with live-dead-live before every ohms reading.

1. **Unplug and switch off everything** on the circuit (Part B, Test B4). If the breaker now holds, the short is in something plugged in or something switched on. Find it by plugging in and switching on one at a time. Stop here.
2. **If it still trips instantly**, the fault is in the fixed wiring or a hard-wired device. Turn the breaker off.
3. **Prove the circuit dead** at the breaker terminal and at one receptacle on the circuit.
4. **Lift the circuit wires at the panel.** With your journeyman, take the hot off the breaker terminal. On an AFCI, GFCI, or dual-function breaker, also take the circuit neutral off the breaker's neutral terminal. On a standard breaker, find the circuit's neutral on the neutral bar.

Safety: lifting a neutral in a live panel. A neutral can carry current from another circuit if it is shared (Part E3). Before you take any neutral off the bar with the main on, clamp it and confirm 0 A. If you cannot identify the neutral for sure, ask your journeyman to shut off the main breaker.

Remember that the main lugs and the service conductors are still live with the main off (Arc Guide, Job 4).

1. **Take three ohms readings on the lifted wires.** Set the meter to ohms (Ω). Keep all switches on the circuit OFF and everything unplugged so the reading is not through a lamp or appliance.

Probes on	Healthy reading	Fault reading	Meaning
Circuit hot to circuit neutral	OL (open)	Near 0 Ω	Hot-to-neutral short in the wiring
Circuit hot to ground bar (or the circuit's bare ground)	OL	Near 0 Ω	Hot-to-ground fault
Circuit neutral to ground bar	OL	Near 0 Ω	Neutral touching ground. This does not trip a standard breaker, but it trips an AFCI, GFCI, or dual-function breaker.

The Arc Guide gives the same first two readings (Symptom 2, Step 3). A reading of a few ohms to a few hundred ohms on hot-to-neutral means something is still connected, such as a lamp left on, a hard-wired fixture with its switch on, or a bathroom fan. Turn off the switch or disconnect the device and read again.

1. **Mid-point to find it.** You know the fault is in the wiring. Now find the box. Pick a box near the middle of the circuit. Kuhlman likes switch boxes with several cables in them because they often split the circuit in two directions (p. 76). With the breaker still off:
2. Open the box and separate the splices so the downstream cables are disconnected from the upstream ones. Cap every wire.
3. Go back to the panel and read hot-to-neutral and hot-to-ground on the lifted wires again.
4. If the short is gone, the fault is downstream of that box. If it is still there, the fault is between the panel and that box.
5. Pick the middle of the half that has the fault and repeat.
6. When you are down to one box or one cable between two boxes, look for the cause.

Picture coming: Mid-pointing a short on an eight-box circuit. A panel at the left, eight boxes in a line numbered 1 to 8. Box 4 is opened with its splices separated and capped. An ohmmeter at the panel reads "OL" with a green check and the label "Short is downstream of box 4." A second frame shows box 6 opened, meter reads "0.3 Ω " with the label "Short is between box 4 and box 6." A third frame shows a picture-hanging nail through the cable between boxes 5 and 6.

1. **What you usually find.** The Arc Guide lists a wire touching a staple, a screw through insulation, a wire pinched under a device, or a nick in insulation touching a metal box (Symptom 2, Step 4). Kuhlman's "Billerica" fault was a cable pinched by a metal post supporting an addition (p. 98). His "Lynnfield" short was in underground wiring to old

landscape lights (p. 99). His photo pages show a dryer cable that had been resting on a heating pipe (p. 126).

The fix.

- A nicked or pinched cable between boxes: replace that run of cable. Splices must be in a box (R1.3). Kuhlman fished a new 14/2 between two outlets when the hot inside a cable opened with no visible cause (p. 82).
- A wire pinched behind a device or touching a metal box: re-dress the wires, replace damaged conductor, re-terminate, and check box fill (R1.3).
- A shorted fixture or appliance: disconnect it and recommend repair or replacement.
- A buried outdoor run that shorts: disconnect it at the first box (as Kuhlman did at "Lynnfield") and write up the repair for the office.

Verify. Reconnect everything you separated. Read hot-to-neutral, hot-to-ground, and neutral-to-ground again at the panel with loads off: all OL. Re-land the wires and torque to the breaker label. Reset. Turn on loads one at a time. Test every receptacle with your plug-in tester.

Part E: Arc-Fault Breakers

AFCIs cause more callbacks than any other breaker. Kuhlman writes that they are prone to false tripping, that motors can fool them, and that they need more careful troubleshooting than standard breakers (pp. 37, 75). Most AFCI trips you will see fall into four groups:

Group	Examples	How common
A real wiring problem	Neutral touching ground, two circuits' neutrals tied together, loose splice, nail or screw through a cable, damaged wire	Kuhlman lists these as the legitimate reasons (p. 37). On a constant-trip AFCI, this is most of what you find.
Something plugged in	Vacuums (Kuhlman ranks them first, p. 37), window ACs, older microwaves, worn lamp cords and lamp switches, under-cabinet light transformers and LED drivers	The most common cause of occasional trips (p. 85)
Something upstream	A bad neutral connection at the service, a loose service connection, voltage swings. Kuhlman notes AFCIs can see disturbances upstream of themselves (p. 37).	Less common. Check if several AFCIs trip.
The breaker	Failed self-test, worn mechanism, wrong breaker for the panel	Least common. Rule out the rest first.

E1. AFCI that trips constantly (will not hold, or trips within minutes)

Symptom. The AFCI trips every time it is reset, or within a few minutes, every day.

Questions. Is this a new circuit or new work? Did someone add a receptacle, a light, or a fan? Was a switch box with several switches worked on? Kuhlman's experience is that crossed neutrals show up after new work, especially in switch boxes with different circuits in the same box (p. 36).

Tests.

1. **Read the LED and the label** before resetting (Test B2).
2. **Press TEST.** The breaker should trip. Reset it. If TEST does not trip it, the breaker has failed (Arc Guide, Symptom 4, Step 1). Replace it with the same brand and type listed for the panel.
3. **Check the panel wiring for this breaker.** Turn the breaker off and prove dead. - The circuit's white wire must land on the breaker's neutral terminal, not on the neutral bar. The breaker's coiled pigtail must land on the neutral bar (Arc Guide, Symptom 11, Step 5, and Job 5). If the circuit neutral is on the bar, the breaker sees current going out on the hot and none coming back, and it trips as a ground fault. - On a plug-on neutral breaker, confirm the breaker is fully seated on the neutral rail. - Confirm the circuit's neutral goes only with its own hot. If the circuit came in as a 14/3 or 12/3 cable (black, red, white), it may be a multiwire branch circuit. Go to E3.
4. **Unplug test** (Test B4). Unplug everything and switch everything off. Reset. - If it still trips with nothing on: the fault is in the wiring. Go to Step 5. - If it holds: add a known load, like your own shop vacuum that you know does not trip AFCIs. If it trips with your load, the fault is in the wiring (go to Step 5). If it holds with your load, plug the customer's things back in one at a time until it trips (Kuhlman, p. 84).
5. **Neutral-to-ground reading.** With the breaker off and the circuit's neutral lifted off the breaker, read ohms from the circuit neutral to the ground bar. Near 0 Ω means the neutral touches ground somewhere on the circuit. Kuhlman says that is what you will be looking for in most constant-trip cases (p. 84).
6. **Mid-point.** Kuhlman gives this procedure for a constant-trip AFCI (pp. 83-84):
7. Estimate the middle of the circuit from where the panel is and where the dead outlets and lights are.
8. At that box, separate the splices. Separate the neutrals as well as the hots. Cap every wire.
9. Reset the breaker. If it holds, the problem is downstream. If it still trips, the problem is between the panel and that box.
10. Once the breaker holds with the box apart, identify the incoming feed. Reconnect the feed neutral to one outgoing neutral at a time, with its hot, and reset after each. When the breaker trips again, that outgoing cable leads to the problem.
11. Repeat at the next box down that cable until you find it.
12. **Look for the cause** in the last box. Bare ground touching the neutral screw. A neutral pinched against a metal box. Neutrals from two different circuits spliced together in a box with several switches. A ballast or transformer in a light fixture (Kuhlman, p. 84).

The fix. Separate the neutral from the ground and re-dress the box. Un-splice crossed neutrals so each circuit's neutral goes back with its own hot. Repair damaged cable. Replace a faulty fixture driver or transformer.

E2. AFCI that trips once in a while

Symptom. The breaker holds while you are there. The customer says it trips "sometimes," maybe once a day or once a week.

Kuhlman calls this the hardest AFCI problem, because the breaker may not trip at all while you are there (p. 85). He finds that when an AFCI trips only once in a while, the cause is usually something being turned on or used once in a while: a motor (a vacuum or window AC) or a bad ballast, transformer, or driver in a light. Actual arcing at a connection is rare in that case. He has also found old lamp switches causing it (p. 85).

Questions. Ask Part A questions 3, 4, and 7. Add: "What room were you in and what were you doing when it last tripped? Was a vacuum, a hair dryer, a window AC, or a lamp in use? Does it trip at night or in the day?"

Tests.

1. **Rule out the vacuum.** If it trips when a cleaning crew is there, have the crew's vacuum and another vacuum each plugged into the same receptacle. If the crew's vacuum trips it and the other does not, the vacuum is the cause (Kuhlman, pp. 37, 85).
2. **Rule out overload** with the clamp test (Part C).
3. **Check the panel connections** for this breaker. Breaker off, proven dead, torque the hot, the circuit neutral, and the pigtail. Look at the neutral bar screw (Kuhlman, p. 85).
4. **Tape and inventory.** With the breaker off, tape every receptacle and switch on the circuit. Leave lamps and TVs plugged in as they normally are (Kuhlman, p. 85).
5. **Use an arc-fault diagnostic tool if YES has one.** Kuhlman describes a tester that connects between the breaker and the circuit, with a handheld that shows how likely each load is to cause an arc-fault trip. You walk the house, turn each light, lamp, and appliance on and off one at a time, and watch the handheld. A load that reads at the top of the scale is the likely cause (pp. 11, 85). In his "Saugus" call, every load read normal except one plug-in lamp with a bad switch, which read 3/4 of the way up the scale. The customer stopped using the lamp and the trips stopped (p. 101).
6. **Without the tool:** turn on every load one at a time with the breaker on and watch for a trip. Give each one 5 minutes. Pay attention to lamps with old switches, under-cabinet lighting transformers, LED drivers, motor loads, and anything with a worn cord.
7. **If nothing trips it,** document every load you tested and the results, and talk to your journeyman. Kuhlman's fallback, without the tool, is to disconnect suspect loads like under-cabinet transformers and ask the owner to call back if it trips again. He says he does not like that approach because it is guessing and can mean many return trips (pp. 85–86). The office decides whether to schedule a return or bring the tester.

The fix. Replace or repair the bad load, or tell the customer to stop using it and why. Write up anything hard-wired (a transformer, a driver) for the office.

E3. The shared-neutral mistake (multiwire branch circuits)

A multiwire branch circuit (MWBC) uses two hots on opposite legs of the panel and one shared neutral. It usually shows up as a 14/3 or 12/3 cable: black hot, red hot, one white neutral. It is legal and common in older houses, especially for kitchen countertop circuits. It is a frequent cause of AFCI and GFCI trips.

Why it trips AFCIs and GFCIs. A single-pole AFCI or GFCI compares the current on its own hot with the current on its own neutral. On an MWBC, the shared neutral carries the difference between the two hots. A single-pole AFCI or GFCI on one of those hots sees current on the neutral that did not come from its hot, and it trips as a ground fault. Kuhlman describes the same thing for two separate circuits whose neutrals get spliced together in a box: the neutral current has two paths back to the panel, and usually one breaker trips while the other stays on (p. 36). The Arc Guide calls a shared neutral the most common cause of AFCI nuisance trips and says the fix is a two-pole AFCI for the pair (Symptom 4, Step 3).

Picture coming: Shared neutral between two AFCI breakers. Left drawing labeled "WRONG": two single-pole AFCI breakers on opposite legs, a black wire from one and a red wire from the other running in one 14/3 cable to two receptacles, a single white neutral from that cable landed on one AFCI's neutral terminal (or on the bar), with red arrows showing neutral current splitting and a "TRIP" burst on one breaker. Right drawing labeled "RIGHT": one two-pole AFCI with both handles tied, black and red on its two terminals, the shared white on its single neutral terminal, its pigtail to the neutral bar, and a green check. A third small inset labeled "ALSO RIGHT": the two circuits re-run as separate 14/2 cables, each with its own neutral, on two single-pole AFCIs.

The rules.

- NEC 210.4(B): each MWBC must have a means that disconnects all its hots at the same time where the circuit starts. That means a two-pole breaker or two single-pole breakers with an identified handle tie (240.15(B)(1)).
- NEC 210.4(A): all conductors of an MWBC must start in the same panel.
- NEC 210.4(D): the hots and the neutral of each MWBC must be grouped (the cable does this for you).
- NEC 300.15(B) (2023: 300.13(B)): on an MWBC, the neutral's continuity cannot depend on a device. The neutral is spliced with a pigtail to the receptacle, not run through the receptacle's two silver screws, so pulling a receptacle does not open the neutral for everything downstream.

How to find an MWBC.

1. At the panel, look for a 3-conductor cable (black, red, white, ground) whose black and red land on two breakers and whose white lands once.

2. At receptacles and in boxes, look for a red wire you cannot otherwise explain, or a white wire splice that has wires from two different cables.
3. With both breakers on, read voltage from the black to the red at a box where both are present. About 240 V means they are on opposite legs, which is correct for an MWBC. About 0 V means both hots are on the same leg.

Safety: an MWBC with both hots on the same leg. If both hots of an MWBC are on the same leg, the shared neutral carries the sum of both currents instead of the difference. Two 15 A loads put up to 30 A on a neutral sized for 15 A, and it overheats. This happens when someone moves breakers around in a panel or replaces a two-pole breaker with two single-poles in the wrong slots. If you read about 0 V between the two hots of an MWBC, turn both breakers off, tell the customer, and tell your journeyman.

Safety: working on an MWBC. Turning off one breaker of an MWBC does not make its neutral safe. The neutral still carries current from the other hot. If you open a neutral splice on a live MWBC, you can get the full current through your hands, and every device on the other half can see a voltage swing. This is why 210.4(B) requires both hots to shut off together. Turn off both before you open any box on an MWBC.

The fix.

- Replace two single-pole AFCIs on an MWBC with one two-pole AFCI listed for the panel, with the shared neutral on its neutral terminal and its pigtail on the bar.
- Or separate the circuits so each has its own neutral, if the cable run allows it.
- Where two separate circuits' neutrals were spliced together in a box, un-splice them so each neutral goes with its own hot. Kuhlman describes finding many of these on the final connections of a modular house (p. 36).
- If two single-poles on an MWBC have no handle tie, that is a finding. Write it up for a two-pole breaker or a listed handle tie.

E4. Other AFCI notes

- **Smoke alarms and AFCIs.** Kuhlman had a house where hard-wired smoke alarms on an AFCI circuit went off at random. Putting a standard breaker in temporarily stopped it. The alarm maker's support line told him not to use their alarms with AFCIs, and he switched alarm brands (p. 38). Do not use his temporary test as a fix. A standard breaker on a required AFCI circuit is not allowed (210.12). Note the alarm brand and model, report it to your journeyman, and see R2.8.
 - **Dimmers.** Some older dimmers cause AFCI trips. The Arc Guide suggests replacing them with a dimmer listed as compatible with AFCIs (Symptom 4, Step 2). R2.6 covers dimmers.
 - **Several AFCIs tripping in the same house.** If more than one AFCI circuit trips with no pattern, or a breaker shows an overvoltage code, check the house voltage. Kuhlman lists bad neutral connections at the service and voltage swings as things that can fool AFCIs (p. 37). Go to R2.5.
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Part F: GFCI Breakers and Dual-Function Breakers

GFCI receptacles are covered in R2.3. This part covers GFCI and dual-function breakers in the panel, and the GFCI side of any breaker.

Symptom. A GFCI or dual-function breaker trips with nothing obviously wrong, or will not reset.

Questions. Is anything outdoors or in a wet area on this circuit? Did it start after rain? Is there a hot tub, pool pump, sump pump, dishwasher, range, or dryer on it? Is a lot of electronics, like a computer desk with power strips, on it?

Tests.

1. **Read the LED code** if there is one (Test B2).
2. **Press TEST.** It should trip. If it does not, it has failed.
3. **Check the panel wiring.** Same as Part E1, Step 3: circuit neutral on the breaker, pigtail on the bar. The Arc Guide calls out the mistake of landing both on the bar (Job 5).
4. **Unplug test** (Test B4). If it holds with everything unplugged, plug items in one at a time. Older appliances, power tools, and some LED drivers leak enough current to trip a GFCI (Arc Guide, Symptom 3, Step 1).
5. **Leakage clamp test.** A GFCI compares the current out and the current back. You can measure the same thing.
6. With the circuit on and loads running, clamp around the hot and the circuit neutral together at the breaker. Do not include the bare ground.
7. A healthy circuit reads near 0 A, because the out and back currents cancel.
8. Any reading is leakage, the current that is going somewhere other than back on the neutral (Arc Guide, Part 10, "GFCI Ghost Trips").
9. A standard clamp meter only reads down to about 0.1 A or so, which is too coarse for a 5 mA trip level. A leakage clamp (a clamp meter that reads milliamps) is the right tool. If YES does not have one, use the unplug test and mid-pointing instead.
10. Move the clamp to the hot and neutral of each branch at a box to find which part of the circuit leaks most.
11. **Insulation check on the wiring.** Breaker off, proven dead, lift the circuit hot and neutral. Read ohms from each to the ground bar. Near 0 Ω is a hard fault, which you mid-point (Part D). A normal multimeter cannot find a slow leak through damp insulation, because it tests at low voltage. An insulation tester (megger) can. Commercial Module 2.2 covers the megger.
12. **Look for water.** Open outdoor boxes, garage boxes near the door, boxes near a sump pump. Water in a box is a ground-fault path. The Arc Guide calls out moisture in outdoor, garage, and bathroom boxes (Symptom 3, Step 2).

Leakage that adds up. Every foot of cable leaks a tiny amount of current through its insulation, and every computer, TV, and surge strip has small filter parts that leak a little to ground on purpose. On one short circuit this is nothing. On a long circuit with many outlets, many

electronics, or aging outdoor wiring, it can add up close to the trip level, and then one more small leak trips it. The Arc Guide describes this as GFCI "ghost trips" from accumulated leakage, and suggests spreading loads to other circuits, replacing old surge strips, or protecting fewer outlets per GFCI (Symptom 3, Step 4; Part 10). It also says a long AFCI run can pick up enough leakage to trip, though it calls this rare (Symptom 4, Step 4).

Picture coming: Leakage current adding up along a long outdoor GFCI circuit. A GFCI breaker in a panel at the left, a long cable running out to six outdoor receptacles and two landscape-light transformers. Under each item, a small arrow down to the ground with a label: "cable insulation 0.2 mA," "surge strip 0.5 mA," "damp box 1.5 mA," "old pump 2 mA," and so on. A running total bar at the top fills from green to red, reaching "5 mA - TRIP" at the last item. A caption: "No single item is a fault. The total is."

The fix. Dry and seal wet boxes, with weather-resistant devices and in-use covers where required. Repair or replace the leaking appliance. Split a long circuit or give a big appliance its own circuit, as a recommendation for the office. Replace a failed GFCI breaker with the same brand and type listed for the panel.

HVAC on GFCI. Under the 2026 code, outdoor HVAC equipment outlets need GFCI protection now that the HVAC exception to 210.8(F) expired on September 1, 2026, and Class C SPGFCI protection is allowed for listed HVAC equipment instead (210.8(F) Exception No. 3). If a GFCI on an outdoor AC unit trips at startup, do not swap in a standard breaker. Document the unit's brand and model, the breaker, and when it trips, and give it to your journeyman. Ask your journeyman which code edition the AHJ uses, since this changed recently.

Part G: When the Breaker Itself Is the Problem

A breaker is the cause less often than customers think. Rule out overload, short, ground fault, and arc fault first. Then the breaker is bad when one of these is true:

Sign	How you confirm it	Source
TEST button does not trip an AFCI or GFCI	Press TEST with the circuit on	Arc Guide, Symptom 4, Step 1
LED shows a self-test failure code	Read the manufacturer's chart	Eaton TD003006EN, Table 3, code 6
Handle will not latch even with the circuit disconnected	Breaker off, lift the circuit wires (leave the pigtail on the bar), try to reset	Arc Guide, Symptom 2, Step 1
Trips with a clamp reading well below its rating and the wiring tests clean	Clamp shows, say, 4 A on a 15 A breaker that trips	Arc Guide, Symptom 2, Step 6
Shows ON but has no voltage at its terminal	Meter from breaker terminal to neutral bar reads 0 V with the handle ON	Arc Guide, Job 9
Crackles when you work the handle, or the plastic is melted or brown near the bus	Look and listen; feel for heat on the outside of the breaker	Kuhlman, p. 33; R2.7
Something is visibly broken	Look	Kuhlman's "Ipswich" breaker had something broken in it (p. 100)

Replacing a breaker.

1. Use the same brand and type the panel label lists. A breaker from another brand that physically fits is not the same thing (Arc Guide, Part 2). NEC 110.3(B) requires equipment to be installed according to its listing and labeling, and the panel label lists the breakers it accepts.
2. Match the amp rating to the wire (240.4(D)), not to the old breaker if the old one was wrong.
3. Match the protection: replace an AFCI with an AFCI, a GFCI with a GFCI, a dual-function with a dual-function.
4. If the bus stab the old breaker sat on is burned or pitted, do not put a new breaker on it. That is a panel repair or panel replacement (R2.7, R1.5). Escalate.
5. Follow Arc Guide Jobs 4 and 5 for the steps, and torque to the label (110.14(D)).

Tandem breakers. Tandems (two breakers in one slot) are allowed only in panels listed for them and only in the slots the panel label shows (Kuhlman, p. 34; Arc Guide, Part 2). Kuhlman has often found tandems melting in panels not rated for them (p. 35), and his photo pages include a panel packed with tandems that was not rated for them (p. 128). If a tripping or warm breaker is a tandem in a panel that does not allow it, that is a finding to write up.

Double taps. Two wires under one breaker screw is a common home-inspector finding. Most breaker terminals are rated for one wire. Kuhlman notes that Square D QO and Homeline

breakers allow two wires of the same size, one on each side of the screw (p. 34). Check the breaker label. A double tap can loosen and heat, which can cause trips. The fix is a pigtail or a separate breaker (Kuhlman, p. 33).

Worked Example Service Calls

Call 1: The pinched cable under the addition

Based on Kuhlman's "Billerica" call (pp. 98–99).

Complaint. A standard 15 A breaker trips every 3 to 4 hours. It feeds a small room addition built on posts: three receptacles, a ceiling fan and its switch, an outdoor GFCI, two outdoor sconces and their switch.

Intake. The owner is sure the ceiling fan causes it, because it trips after the fan runs a while.

Tests. With the room in normal use, the clamp reads about 2.5 A on the 15 A breaker. Not an overload. All the receptacles test fine. The outdoor boxes show nothing.

What went wrong the first time. Kuhlman let the owner's theory steer him, took down the fan, and put up a plain light. The breaker tripped again about three hours after he left.

What worked. On the return trip he swapped the standard breaker for a dual-function breaker, which tripped right away. That gave him a fault he could mid-point. He opened a receptacle in the middle of the circuit and separated the wires: still tripped. He opened the next one toward the panel: it held. The fault was between those two receptacles. Under the addition, the cable was being pinched by a metal post and was just barely cut into the hot and neutral. He replaced that run of cable.

What you take from it. On a standard breaker that trips once in a while with a low clamp reading, a dual-function breaker in its place can turn a hidden fault into one you can find (Kuhlman, pp. 82–83). Keep a circuit load on while the dual-function breaker is in, because that speeds up the trip (p. 83). The dual-function breaker must be the right brand and type for the panel.

Call 2: The post light in the bushes

Based on Kuhlman's "Ipswich" call (pp. 100–101).

Complaint. A standard 15 A breaker trips some nights, not every night. It feeds the living room and an outdoor sconce and GFCI.

Intake. The owners are elderly and spend evenings in that room with electric blankets, lamps, a TV, and stereo equipment. They think the stereo started it.

Tests. With everything on, the clamp reads 7 to 8 A. Not an overload. Kuhlman noticed the breaker had something broken in it, replaced it, left the stereo unplugged, and asked them to call if it tripped. It tripped the next morning.

What found it. It had rained overnight. He flipped the switch for the outdoor scone and the breaker tripped. In the switch box, a second cable was tied to the load side of the switch. It ran to a post light 50 to 60 feet away in the bushes, which he had never noticed. The buried feed shorted when the soil was wet.

What you take from it. Ask about rain. Look at the outside of the house for loads before you go in (R2.1). Kuhlman says the dual-function breaker would have found it on the first visit (p. 101).

Call 3: New circuit that will not hold

Complaint. YES added a receptacle in a bedroom last week, extending the existing circuit. Since then the bedroom AFCI trips within a minute of being reset.

Tests.

1. TEST button trips it. LED code (Eaton CH dual-purpose breaker in this house): code 5, ground fault.
2. Panel wiring: the circuit neutral is on the breaker, pigtail on the bar. Correct.
3. Unplug test: still trips with everything off.
4. Breaker off, circuit hot and neutral lifted, ohms. Hot-to-neutral: OL. Hot-to-ground: OL. Neutral-to-ground: 0.4 Ω .
5. A neutral touches ground somewhere. Start with the new work. At the new receptacle's box, the neutral is fine. At the existing receptacle it was fed, the box also holds a second circuit passing through. The new cable's white was spliced into the white bundle of the other circuit instead of its own.

Fix. Move the new cable's white to its own circuit's neutral splice. Neutral-to-ground reads OL. Reset holds. Run a heater on the circuit for 10 minutes: holds. Test every receptacle on both circuits.

What you take from it. A neutral spliced to another circuit's neutral is the crossed-neutral case Kuhlman describes (p. 36). It usually shows up right after new work. A neutral-to-ground ohms reading and the job history found it in 20 minutes.

Call 4: The kitchen countertop with a red wire

Complaint. In a 1990s house, the kitchen countertop receptacles on one wall trip an AFCI breaker that an electrician installed last year when replacing the panel. The other countertop circuit, on a GFCI breaker next to it, trips too.

Tests.

1. At the panel: a 12/3 cable. Black lands on the AFCI, red on the GFCI breaker two slots down, and the white lands on the AFCI's neutral terminal.
2. Black-to-red at the first countertop box: 241 V. Opposite legs, so this is a correct MWBC that was connected to two separate single-pole breakers with protection.
3. Each breaker sees neutral current from the other hot, so each one trips as a ground fault.

Fix. This is a scope for the office: a two-pole breaker with the protection the kitchen needs, listed for the panel, or separating the circuits. Until then, your journeyman decides how to make it safe. Document the cable, the breakers, the voltage reading, and photos.

What you take from it. The Arc Guide's fix for a shared neutral on AFCIs is a two-pole AFCI (Symptom 4, Step 3). The two single-poles also had no handle tie, which 210.4(B) requires.

Call 5: The cleaners' vacuum

Complaint. A bedroom AFCI trips "randomly," maybe twice a month.

Intake. Question 7 in Part A: "Does it happen on days the cleaners come?" The customer checks the calendar. Yes, both times last month.

Test. You ask the customer to have the crew plug in their vacuum while you are there, or you plug your own vacuum and then the customer's vacuum into the same bedroom receptacle. Your vacuum runs 5 minutes with no trip. The crew's vacuum trips the breaker in 20 seconds.

Fix. The vacuum. Kuhlman has handled this call at least 50 times (p. 37). Tell the customer, in plain words, that the breaker is doing what it was designed to do and the vacuum's motor is the problem. Recommend the crew use a different vacuum or a different receptacle, and write it up.

Common Mistakes

1. **Upsizing a breaker.** Never. The wire size sets the breaker size (240.4(D)).
2. **Swapping a required AFCI or GFCI for a standard breaker** to stop trips. The code requires the protection (210.12, 210.8), and you would leave the customer without it.
3. **Believing the last load turned on is the cause.** Any load can make a breaker trip when the neutral touches ground somewhere else (Kuhlman, p. 84).
4. **Following the customer's theory instead of testing.** Kuhlman's "Billerica" and "Ipswich" calls each took a second trip because of this (pp. 98–101).
5. **Clamping the whole cable.** Hot and neutral cancel and you read near 0 A. Clamp one wire.
6. **Taking ohms readings on a live circuit, or with lamps left on.** Prove dead, turn off switches, unplug everything.

7. **Lifting a neutral without checking for current.** A shared neutral can carry current with its own breaker off. Clamp it first or have the main turned off.
 8. **Landing the circuit neutral on the bar on an AFCI or GFCI breaker.** The circuit neutral goes on the breaker. The pigtail goes on the bar.
 9. **Missing the MWBC.** A red wire in a 3-conductor cable on two single-pole AFCI or GFCI breakers trips them both.
 10. **Reading a blink code from memory.** Read the chart on the breaker or in the manufacturer's instructions for that model.
 11. **Replacing a breaker with a different brand that fits.** Use the brand and type the panel label lists (110.3(B)).
 12. **Putting a new breaker on a burned bus stab.** The new breaker will fail too. Escalate.
 13. **Resetting a breaker over and over into a short.** Confirm once, then test dead.
 14. **Leaving without the outdoor check.** Post lights, landscape lights, and buried feeds cause trips that happen only when it is wet.
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Field Exercise: Make Every Trip Happen

Setup. Use the training panel with a 15 A standard breaker, a 15 A AFCI, and, if available, a two-pole AFCI, wired to receptacles on the training wall. Your journeyman supervises every step. Wear safety glasses. Use the training panel's own protection. Never create these faults on a customer's circuit.

Part 1: Overload. On the 15 A standard breaker, plug in a 1,500 W space heater and a 1,200 W toaster oven. Clamp the hot at the breaker and write down the current. Time how long until the breaker trips. Reset. Run only the heater, clamp it, and confirm it holds. Write the two readings and the trip time.

Part 2: Short circuit. Your journeyman sets up a deliberate hot-to-neutral short at the end of the training string using the training wall's fault switch. Close it and reset the breaker. Note that it trips instantly. Turn the breaker off, lift the circuit wires, and read hot-to-neutral, hot-to-ground, and neutral-to-ground with the meter. Write the readings. Then mid-point the string to the fault box with the breaker off, writing each reading.

Part 3: Ground fault. Your journeyman sets up a hot-to-ground fault at a box on the AFCI circuit. Reset the AFCI. Note how fast it trips and the LED code, if the breaker has one, and look up the meaning in that breaker's instructions. Repeat the three ohms readings with the circuit dead.

Part 4: Shared neutral. Your journeyman wires two circuits from two single-pole AFCIs on opposite legs into one box, with one shared neutral, as in the "WRONG" drawing in Part E3. Turn both on, put a load on each, and note which breaker trips and how fast. Read the voltage between the two hots. Then rewire it correctly: either a two-pole AFCI with the shared neutral on its terminal, or separate neutrals. Show that both now hold with both loads on.

Part 5: Blink codes. If the training AFCIs have an LED, read the code after each trip in Parts 3 and 4. Use only the manufacturer's chart.

Part 6: Leakage. On a GFCI breaker circuit, run a load and clamp the hot and neutral together. Note the reading. If a leakage clamp is available, add a known small leakage path your journeyman provides (such as a resistor box from hot to ground) and watch the reading rise until the GFCI trips. If only a standard clamp is available, show that the hot and neutral clamped together read near 0 A on a healthy circuit and explain why.

For each part, record: the breaker type, what you did, whether the trip was instant or delayed, the time to trip, the LED code and its meaning, and the meter readings. Reset after each part and confirm the circuit holds with the fault removed.

Pass standard. You pass when your journeyman signs off that you named each trip type from how the breaker acted before testing, took every ohms reading on a proven-dead circuit, clamped one conductor (or hot and neutral together for leakage), found the Part 2 fault by mid-pointing, and correctly rewired the shared neutral in Part 4.

NEC 2026 Cross-References

Section	What it says	Why it matters for trips
110.3(B)	Install and use listed equipment according to its listing and labeling	Replacement breakers must be the type the panel label lists
110.14(D)	Tighten terminals to the torque on the equipment or instructions, using an approved means	Loose terminals cause heat and trips
210.4(A)	All conductors of an MWBC start in the same panel	MWBC rules
210.4(B)	Each MWBC must have a means to disconnect all its hots at once where it starts	Two-pole breaker or handle-tied single-poles
210.4(D)	The hots and neutral of an MWBC are grouped	Find the right neutral
210.8(A)	GFCI for dwelling receptacles in bathrooms, garages, outdoors, crawl spaces, basements, kitchens, sink areas, within 6 ft of sinks and tubs, laundry areas, boathouses, indoor damp and wet locations	Where GFCI trips come from
210.8(D)	GFCI for outlets supplying listed appliances, including dishwashers, sump pumps, electric ranges, wall ovens, counter-mounted cooking units, clothes dryers, and microwave ovens	New GFCI trips on 240 V appliance circuits
210.8(F)	GFCI for dwelling outdoor outlets; HVAC exception expired September 1, 2026; Class C SPGFCI permitted for listed HVAC equipment	Outdoor AC on GFCI
210.11(C)(3)	At least one 20 A circuit for bathroom receptacles, with no other outlets (exception for a single bathroom)	Where to move a hair dryer
210.12(A)	The permitted means of AFCI protection	Breaker-type and outlet-type AFCI
210.12(B)	AFCI for 120 V, 10, 15, and 20 A dwelling circuits in kitchens, family rooms, dining rooms, living rooms, parlors, libraries, dens, bedrooms, sunrooms, recreation rooms, closets, hallways, laundry areas, similar areas	Why the customer has AFCIs and why you keep them
210.12(E)	AFCI when circuits in those areas are modified, replaced, or extended; exception for 6 ft or less with no new outlets	Why new work brings AFCI calls
240.4(D)	Small conductors: 14 AWG Cu 15 A, 12 AWG Al/CCA 15 A, 12 AWG Cu 20 A, 10 AWG Cu 30 A	Never upsize
240.15(B)(1)	Single-pole breakers with identified handle ties are permitted for MWBCs serving line-to-neutral loads	MWBC disconnect
240.24	Breakers readily accessible and in proper locations	R2.1
300.15(B) (2023: 300.13(B))	On an MWBC, the neutral's continuity cannot depend on device connections	Pigtail the neutral on MWBCs

End-of-Chapter Checklist

Before you touch the panel - [] Asked the eight Part A questions, including rain, vacuums, cleaners, and recent work. - [] Did the R2.1 five safety checks. - [] Identified the breaker type and read the panel label. - [] Read and wrote down any LED code before resetting, using only the manufacturer's chart.

Sort the trip - [] Reset once: noted instant, delayed, will not latch, or holds. - [] Did the unplug test, then added a known load if it held. - [] Clamped a single hot wire and compared to the breaker rating. - [] Checked wire size against breaker size (240.4(D)).

Short or ground fault - [] Proved the circuit dead before every ohms reading. - [] Clamped any neutral for 0 A before lifting it in a live panel, or had the main turned off. - [] Read hot-to-neutral, hot-to-ground, and neutral-to-ground with all loads off. - [] Mid-pointed to the box or cable with the fault.

AFCI - [] Pressed TEST. - [] Confirmed circuit neutral on the breaker and pigtail on the bar. - [] Checked for an MWBC: 3-conductor cable, voltage between hots, handle tie or two-pole. - [] Ruled out vacuums and other motor loads. - [] Mid-pointed using Kuhlman's split-and-reconnect-one-neutral-at-a-time method.

GFCI - [] Pressed TEST. - [] Unplug test. - [] Clamped hot and neutral together for leakage. - [] Opened outdoor and damp boxes for water.

Breaker replacement - [] Ruled out every other cause first. - [] Same brand and type the panel lists, same protection, sized to the wire. - [] Inspected the bus stab; escalated if burned. - [] Torqued to the label.

Close out - [] Re-tested every device on the circuit. - [] Ran the load that caused the complaint. - [] Documented trip type, readings, LED code, cause, fix, and photos on the job board. - [] Sent any new circuit or panel recommendation to the office with no price.

Sources

- Jesse Kuhlman, Residential Electrical Troubleshooting (2019). PDF page numbers equal book page numbers. Pages cited: 11–12 (arc-fault diagnostic tool), 27 (GFCI 5 mA), 33 (standard breakers trip for two reasons; double taps; crackling bus), 34–35 (two-pole; Square D double-wire terminals; tandems), 35–38 (AFCI history, ground-fault threshold, crossed neutrals, nuisance causes, vacuums, smoke alarm story, GFCI breakers), 75 (ask about prior work), 76 (mid-pointing), 82–83 (standard breaker occasionally trips; dual-function breaker method; failed cable), 83–84 (AFCI tripping constantly), 85–86 (AFCI tripping occasionally), 98–101 (Billerica, Lynnfield, Ipswich, Saugus), 126 and 128 (photos: wire on heat pipe, tandems in an unrated panel). All paraphrased. No photos reproduced.

- Arc Workforce, Residential Electrical Field Guide. Symptom 2 (breaker trips), Symptom 3 (GFCI nuisance tripping), Symptom 4 (AFCI nuisance tripping), Symptom 11 (new installation), Part 2 (breakers), Part 10 ("GFCI Ghost Trips"), Jobs 4, 5, and 9. Its code references are NEC 2020; this chapter uses NEC 2026. Its AFCI blink-code charts in Symptom 4 and Part 8 disagree with each other and are not used here.
 - Eaton, Type CH (3/4-inch) dual purpose arc fault/ground fault circuit interrupter, Technical Data TD003006EN, effective September 2014, Table 3 (trip codes) and Figure 1 (wiring). Retrieved from <https://inspectapedia.com/electric/Eaton-AFCI-Type-CH-Breaker-Installation-Guide.pdf>
 - YES Electric commercial course, Modules 2.2 (meters, megger) and 2.4 (breaker inspection and nuisance tripping).
 - NFPA 70, National Electrical Code, 2026 edition, sections listed above.
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Videos to watch

These videos are made by other electricians and companies, not YES Electric. Watch each one after you read the section it goes with. Where a video does something differently from this module, the caution line says so. Follow this module and your journeyman, not the video. Click a title to open it on YouTube.

Section	Video
Part D Short circuit or solid ground fault (trips instantly)	How To Troubleshoot Circuit Breaker Tripping & Testing United Tradesman Academy • 24:41 On a real call where a 15 A breaker snaps back with a spark, the tech proves the breaker is good by moving the wire to another breaker, splits the circuit at boxes to isolate sections, and uses continuity to find the hot-to-neutral short. Caution: He moves a circuit conductor to another breaker in an energized panel; at YES, test the circuit with the breaker off and the wire lifted (insulation or continuity to ground and neutral), with a journeyman. Some live work and rambling in a 24-minute video.
Part E, E1 AFCI that will not hold	Arc Fault Breaker Keeps Tripping! How To Fix It! Benjamin Sahlstrom • 16:31 A licensed electrician isolates an AFCI that trips the instant a switch is turned on by disconnecting three LED recessed trims one at a time; the last one, a failed cheap LED trim, was the cause. Caution: Brand complaints and channel talk in the middle. Works on the trims with the circuit on but the switch off; YES turns the breaker off before unplugging fixtures.
Part E, E3 The shared-neutral mistake; E4 Other AFCI notes	AFCI Nuisance Tripping and Trouble Shooting #electrician #electricalcodecoach Electrical Code Coach • 20:45 Electrical Code Coach lists the installer errors that make AFCIs trip: neutral landed on the wrong breaker, neutrals from two circuits tied together in a box, reversed polarity, and neutral touching ground. Caution: Talking head, 20 minutes, no field footage. His history of AFCI code dates is approximate; use the NEC references in the module.
Part G When the breaker itself is the problem	How to Tell if a Breaker is Bad Electrician U • 11:44 Electrician U explains thermal (about 130%) and magnetic (about 200%) trip ranges and how to judge a bad breaker: will not reset with no load, signs of heat at the terminal or bus stab, and voltage at the breaker output. Caution: He mentions intentionally shorting a circuit to see if a breaker trips; YES does not do that. Never fix a tripping circuit with a bigger breaker.
Part C Overload (trips after a while)	How to Use a Clamp Meter to Measure Amps in a Breaker Panel Joseph Ask a Real Electrician • 4:53 Shows clamping one hot conductor at the breaker to read the circuit's running current and compare it to the breaker size. Caution: He reaches into the live panel; journeyman-supervised only. Read the current with the customer's usual loads running, as Part C says.