# Electrical Safety in the Shop

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# The FPE problem

If your home was built 1950 - 1990 and has a **Federal Pacific Electric** (**FPE**) breaker panel with Stab-Lok breakers, you run a significant risk of malfunction and fire

One in four Stab-Lok breakers are defective and will not properly trip

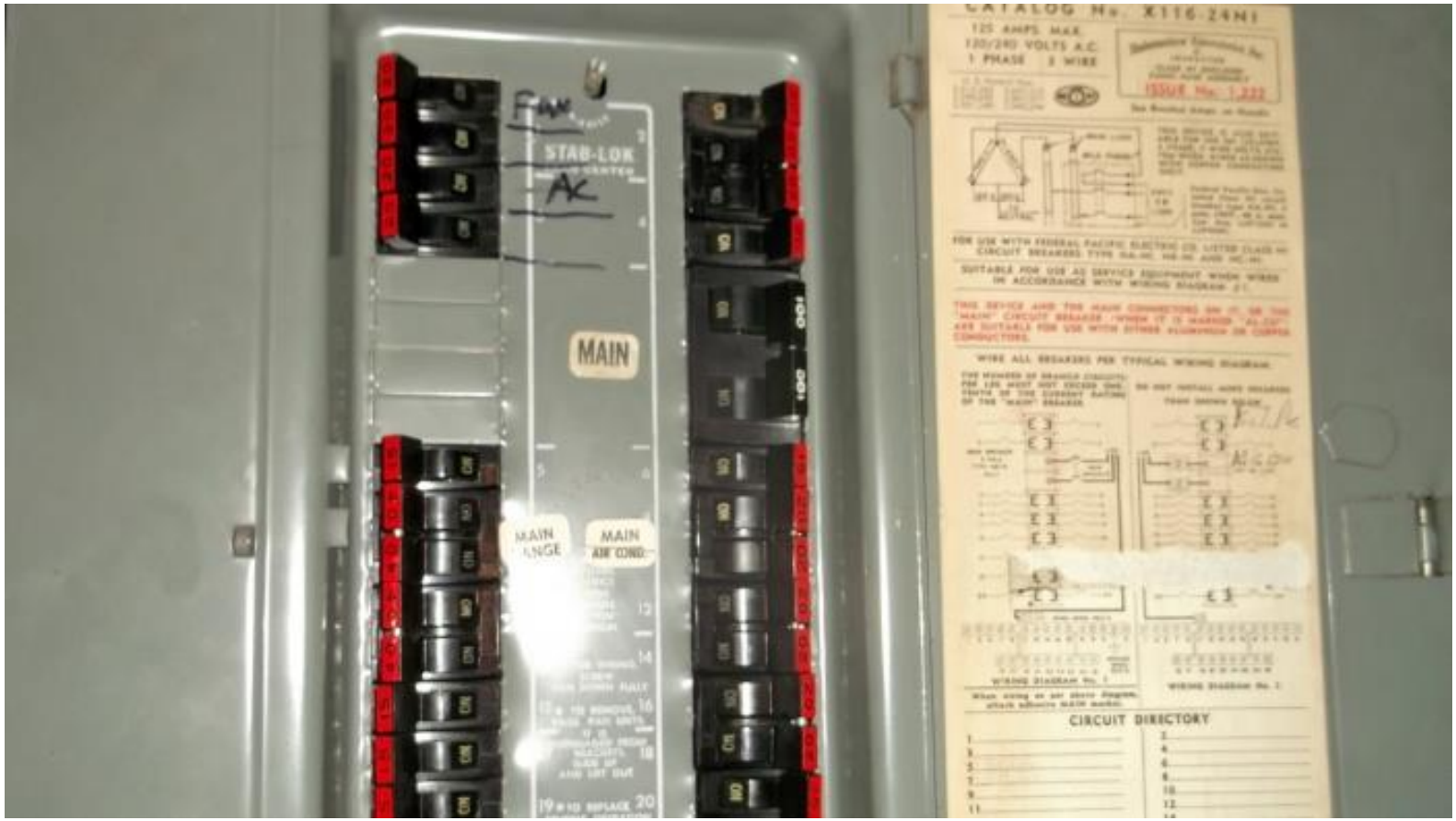
FPE committed testing fraud and a cover-up, labeling the breakers as meeting the UL standards

In 1983, the Consumer Product Safety Commission closed its two-year investigation and felt it impossible to create a product recall at the time

An estimated 2,800 fires / year result from FPE breaker malfunction

also see http://inspectapedia.com/fpe/FPE_History.php

# Federal Pacific breaker boxes include a red strip across the Stab-Lok breakers



# Home Fires … estimates based on last 5 yrs

~370,000 house fires/yr … >40% start in kitchens

~2700 deaths/yr …in 60% of cases, smoke alarms don't work

~12,000 injuries/yr

Most are smoke inhalation

Electrical cause

~23,000 home fires/yr

>500 electrocutions/yr

30,000 non-fatal accidents

7 children/day injured or killed "playing" with electrical receptacles

# Basics

Don’t guess - hire an electrician


5-15R

Pay attention to matching receptacles, plugs, wire size and breaker size

- Don’t mix 12 and 14 ga wire runs


5-20R

Use correct size circuit breaker or fuse

Replace damaged cords, cords with broken grounds, broken insulation …

- Pull the plug, not the cord

# Your Shop unfinished basement, garage, out-building

**Before you start any work, turn the power off – check twice – 1st to know the power is on, 2nd to verify it's off**

Extension cords

- Best … don't use them at all
- Recommend 14 AWG minimum
- Recommend type SE, SJ or SO cord, SJ is most common

# Your Shop unfinished basement, garage, out-building

Breakers, switches and outlets wear out

Replace with commercial quality

Protect yourself & your family – GFCI on outlets

Protect your property – AFCI on outlets (optional in shops)

# Residential vs Commercial grade


Roll over image to zoom in

Leviton

Leviton T5320-TMP 15 Amp 125V Tamper Resistant Duplex Receptacle, 10 Pack, Light Almond

242 customer reviews | 18 answered questions

Was: $10.90
With Deal: $8.72 ($0.87 / Piece) Prime
You Save: $2.18 (20%)

In Stock.
Ships from and sold by Amazon.com. Gift-wrap available.

Size: **10 Pack**

1 Count | 4 Pack | 6-Pack | **10 Pack** | 12 Pack | 24 Pack | 50 Pack

Color: **Light Almond**

- Shutter mechanism inside the receptacle blocks access to the contacts unless a two-prong plug is inserted, helping ensure hairpins, keys, etc., will be locked out
- TR symbol on residential receptacles assures they meet the 2008 NEC requirement

$1 each

$4-10 each

Roll over image to zoom in

Leviton

Leviton TBR15-T 15 Amp, 125 Volt, Narrow Body Duplex Receptacle, Straight Blade, Tamper Resistant, Commercial Grade, Self Grounding, Light Almond

Be the first to review this item

List Price: $11.89
Price: $9.76 Prime
You Save: $2.13 (18%)

**Note:** Available at a lower price from other sellers, potentially without free Prime shipping.

Only 2 left in stock (more on the way).
Ships from and sold by Amazon.com. Gift-wrap available.

Color: **Light Almond**

$11.06 Prime | $10.71 Prime | **$9.76 Prime**

- Impact-Resistant Thermoplastic Construction
- Back Wire and Side Wire Terminal Options
- Heavy-Gauge Zinc-Plated Steel Locked-In Wraparound Strap
- Brass Staked on Self-Grounding Clip
- Heavy-Duty Triple-Wipe Brass Contacts for Long Service Life

# Ground Fault protection
## GFCI, GFI, GFP …

Detects imbalance between current in the circuit and current through your body

0.006 amps max for 120V GFCI (you'll still get shocked)

Does not work if you touch the hot (black wire) and neutral (white wire) at the same time

3 types

- Receptacle with GFCI electronics built in (must be on the 1st outlet in the circuit)
- Circuit breaker with GFCI electronics – 120V and 240V
- Integral with an extension cord

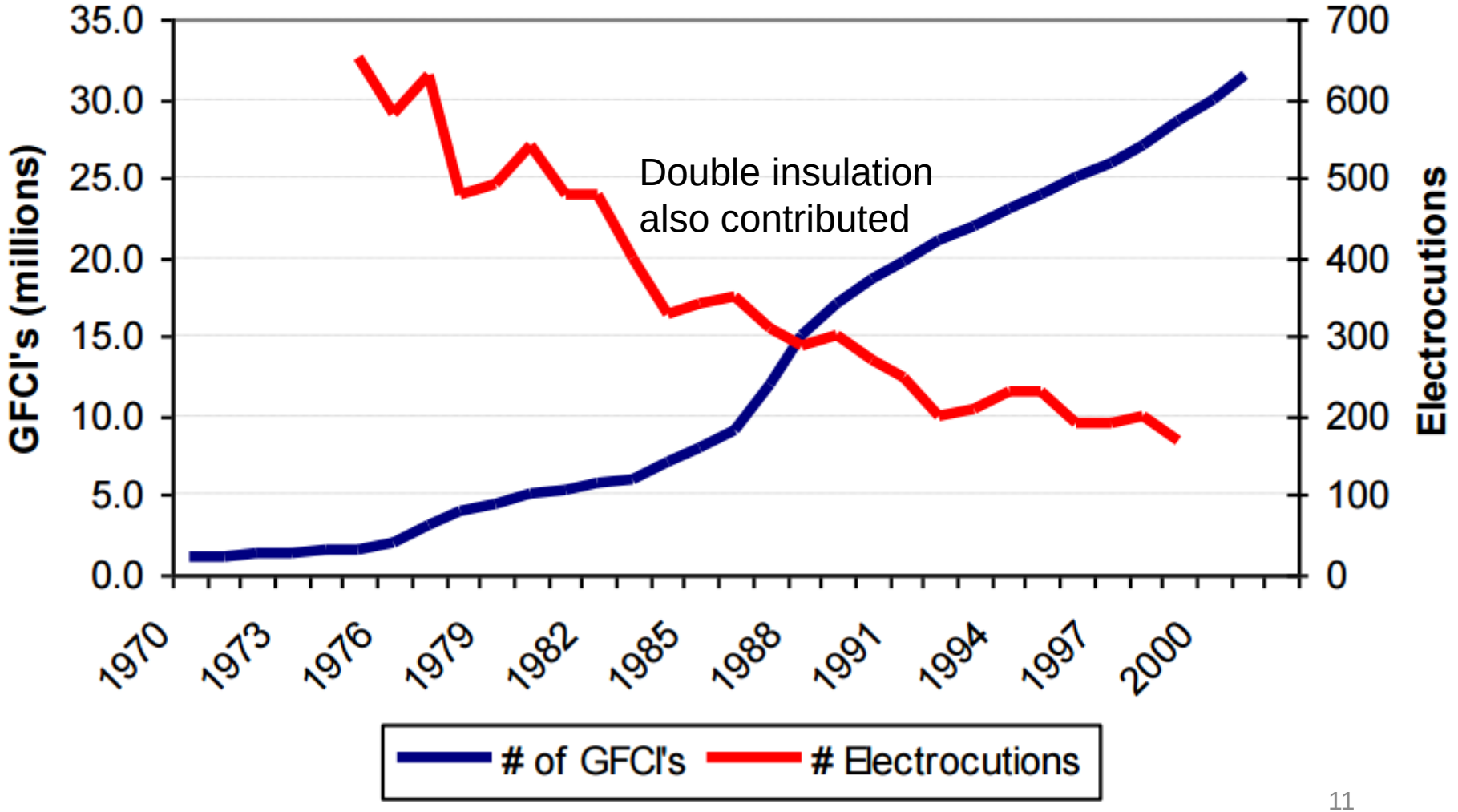
# The problem

| | Current (mA) | |
|---|---|---|
| | Men | Women |
| Cannot be felt | 0.4 | 0.3 |
| Mild tingling | 1.1 | 0.7 |
| Shock – not painful | 1.8 | 1.2 |
| Shock – painful | 9 | 6 |
| **Let-go threshold** | 16 | 10 |
| Muscles immobilize | 23 | 15 |
| Ventricular fibrillation (3 sec) | 100 | 100 |

Most GFCIs trip at 5 mA and 0.035 sec

# Electrocutions Associated With Consumer Products

Appliances and power tools



# Arc Fault protection

Relatively new - 1999

Protects against fires caused by arcs (50,000/yr)

- Nails through wires
- Damaged cords and internal appliance damage
- Damaged extension cords
- Loose connections

2 kinds of arcs

- Arc across 1 broken wire (series)
- Arc from hot to neutral or ground (parallel)

# How AFCI works

The electronics detect electrical current at characteristic arcing frequencies, around 100 kHz, which are sustained for more than a few milliseconds

A combination AFCI breaker provides protection against parallel arcing (line to neutral), series arcing (a loose, broken, or otherwise high resistance segment in a single line), ground arcing (from line, or neutral, to ground), overload protection and short circuit protection

Based upon an established threshold, the AFCI can be triggered to quickly react and de-power a circuit if dangerous arcing is detected

When installed as the first outlet on a branch circuit, AFCI receptacles provide series arc protection for the entire branch circuit and parallel arc protection for the branch circuit starting at the AFCI receptacle

AFCI receptacles may be used on any wiring system, but must be on the 1$^{st}$ receptacle in the circuit

Roll over image to zoom in

## Leviton AFTR1-W SmartlockPro Outlet Branch Circuit Arc-Fault Circuit Interrupter Receptacle, 15-Amp, 120-volt, White

55 customer reviews | 9 answered questions

List Price: $28.99
Price: $24.95 Prime
You Save: $4.04 (14%)

**Note:** Available at a lower price from other sellers, potentially without free Prime shipping.

In Stock.
Ships from and sold by Amazon.com. Gift-wrap available.

Color: **White**

Size: **15 Amp**

15 Amp | 20 Amp

- Identifies potentially dangerous arc-faults and responds by interrupting power
- Easily installs as replacement for standard receptacle TEST and RESET button on receptacle face for localized testing
- Tamper-Resistant – shutter mechanism inside the receptacle helps prevent access to the contacts unless a two-prong plug is inserted
- Meets or exceeds UL requirements for tripping time for both series and parallel arcs
- Can be used to meet NEC requirements for Arc-Fault protection in new circuits, circuit modifications or extensions, or replacement receptacles

~$25 each

~$40 each


Square D by Schneider Electric

## Square D by Schneider Electric QO115CAFIC QO 15-Amp Single-Pole CAFCI Circuit Breaker

29 customer reviews | 7 answered questions

Price: $37.99 Prime

**Note:** Available at a lower price from other sellers, potentially without free Prime shipping.

Only 4 left in stock.
Sold by Direct Supply Store and Fulfilled by Amazon. Gift-wrap available.

Size: **1 Space**

- QO 15 Amp single-pole Combination AFCI circuit breaker
- Plug-on design, easy to install
- Compatible with QO load centers, CSED's and NQOD panel boards
- Rated for 120 Vac
- Rated for 10,000 AIR

› See more product details

**Used & new** (43) from $22.00 & FREE shipping.

# A good option

Combination GFCI / AFCI breakers

~$45 - $50 each

## Type CH (3/4-inch) dual purpose arc fault/ground fault circuit interrupter

### Description

The 2014 National Electrical Code® (NEC®) expands the required use of combination arc fault protection to kitchens and laundry areas. The existing requirement for ground fault protection is unaffected by the new requirements, creating scenarios where a dual purpose AF/GF circuit breaker is the most efficient device for meeting code.

Eaton's Type CH (3/4-inch) dual purpose AF/GF is available in 15 A and 20 A ratings. Eaton has also included a diagnostic LED trip code indicator that displays six different codes to assist in troubleshooting.

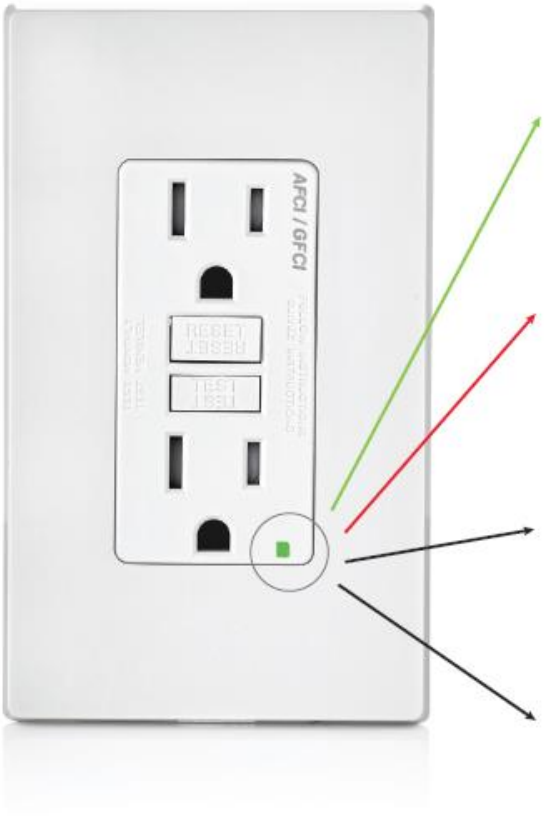
### Design features

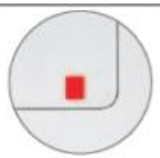
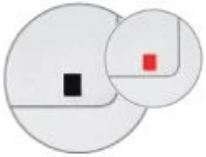
- Lifetime trip code retention
- Overvoltage protection
- Continuous self-test of electronic components
- Diagnostic LED trip code indicator displays most recent trip code
- Two position "ON/OFF" handle
- Trip flag clearly indicates tripped breaker in panel
- Single, accessible point of reset

# A new option from Leviton AFCI / GFCI receptacle

## Status Indicator Light

Leviton Dual Function devices feature an AFCI/GFCI Status Indicator Light which provides a simple, intuitive visual indication to the user of the status of GFCI and AFCI protection. This is a convenient way to check the level of protection at-a-glance.




| Status Indicator Light | Load Power | Status/Action | RESET Button Status |
|---|---|---|---|
|  Solid GREEN | ON | Device is in normal working state | SET - Button in |
| | OFF | Line and load wires are reversed; reinstall with corrected line and load connections | TRIPPED - Button out |
|  Solid or constant flashing RED | ON | Press TEST button and RESET button. If RED indication continues or will not RESET, replace device | SET – Button in |
| | OFF | Device has tripped and the self-test function detects a potential problem, press RESET. If RED indication continues or will not RESET, replace device | TRIPPED – Button out |
|  Off and Flashes RED twice every 5 seconds | OFF | AFCI trip – press RESET, if device continues to trip, contact an electrician | TRIPPED – Button out |
|  Off | OFF | GFCI trip – Press RESET, if device will not reset, there is no power on the circuit | TRIPPED – Button out |

# GFCI and AFCI testing

Most require monthly testing and documentation using the test button

Typical receptacle warranty is 1-2 years

Typical breaker warranty is life of the equipment

# Smoke detectors

Have to use heat or smoke to fully test function

Pushing test button only checks battery & electronics

Three types of detectors

- ionization & photoelectric for smoke
- heat (usually a melting fuse)

Keep away from kitchens to avoid false alarms

Replace smoke detectors every 10 years per NFPA 72

- Failure rate data (detectors, not batteries)
  - 30% at 10 years
  - 50% at 15 years

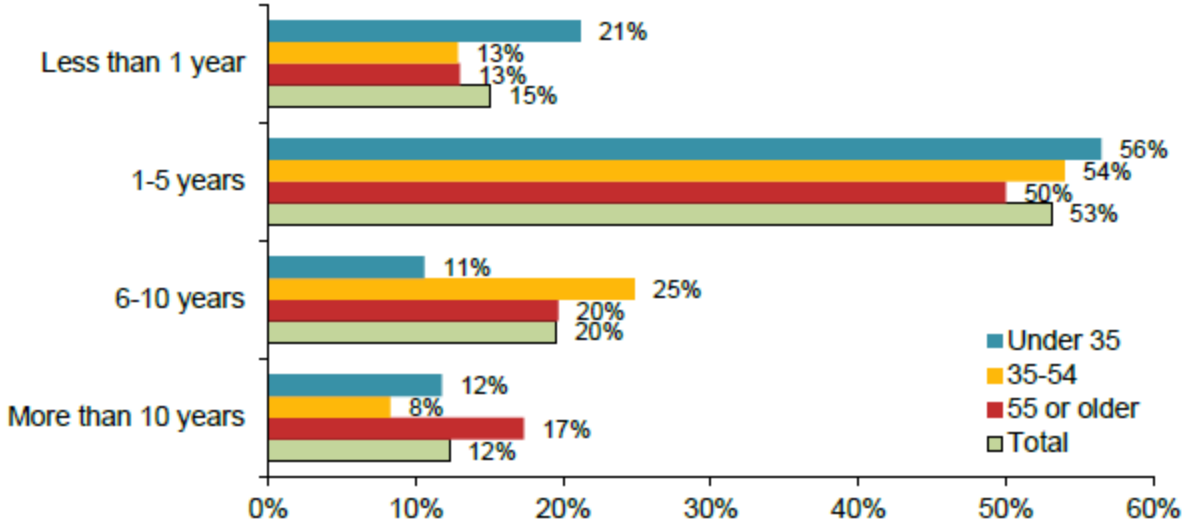
## SMOKE ALARM AGE

Smoke alarms are appliances, just like toasters, televisions and furnaces. Unlike other appliances, these devices function quietly in the background. Its alarm, in response to a real smoke situation or to testing, is the only evidence that it works. A stereo that does not play will not lead to tragedy, but a smoke alarm that fails to sound in a fire, could.

Roughly half of the smoke alarms collected as inoperable and studied in the National Smoke Detector Project were more than 10 years old, hence older than the currently recommended replacement age.[54] Alarms designed solely to detect smoke should be replaced every 10 years.

**Older individuals are more likely to have smoke alarms more than ten years old.**
A survey done for NFPA in 2010 found that in 12% of homes with smoke alarms, the smoke alarms were more than 10 years old.[55] Figure 25 shows that when the householder is 55 or older, 17% of the smoke alarms were more than 10 years old.

**Figure 25. Age of Smoke Alarm by Age of Individual in Homes with Smoke Alarms: 2010**




Source: Harris Poll® National Quorum. National Fire Protection Association – Smoke Alarms, September 2010.

First Alert

# First Alert BRK 3120B Hardwire Dual Photoelectric and Ionization Sensor Smoke Alarm with Battery Backup

4.5 ▾ 281 customer reviews | 58 answered questions

List Price: ~~$49.99~~

Price: $19.97 Prime

You Save: $30.02 (60%)

In Stock.

Ships from and sold by Amazon.com.

Item Package Quantity: **1**

Service: **Get professional installation** Details

**Item only**

Include installation
+ $167.95

See more

# backup

# The problem

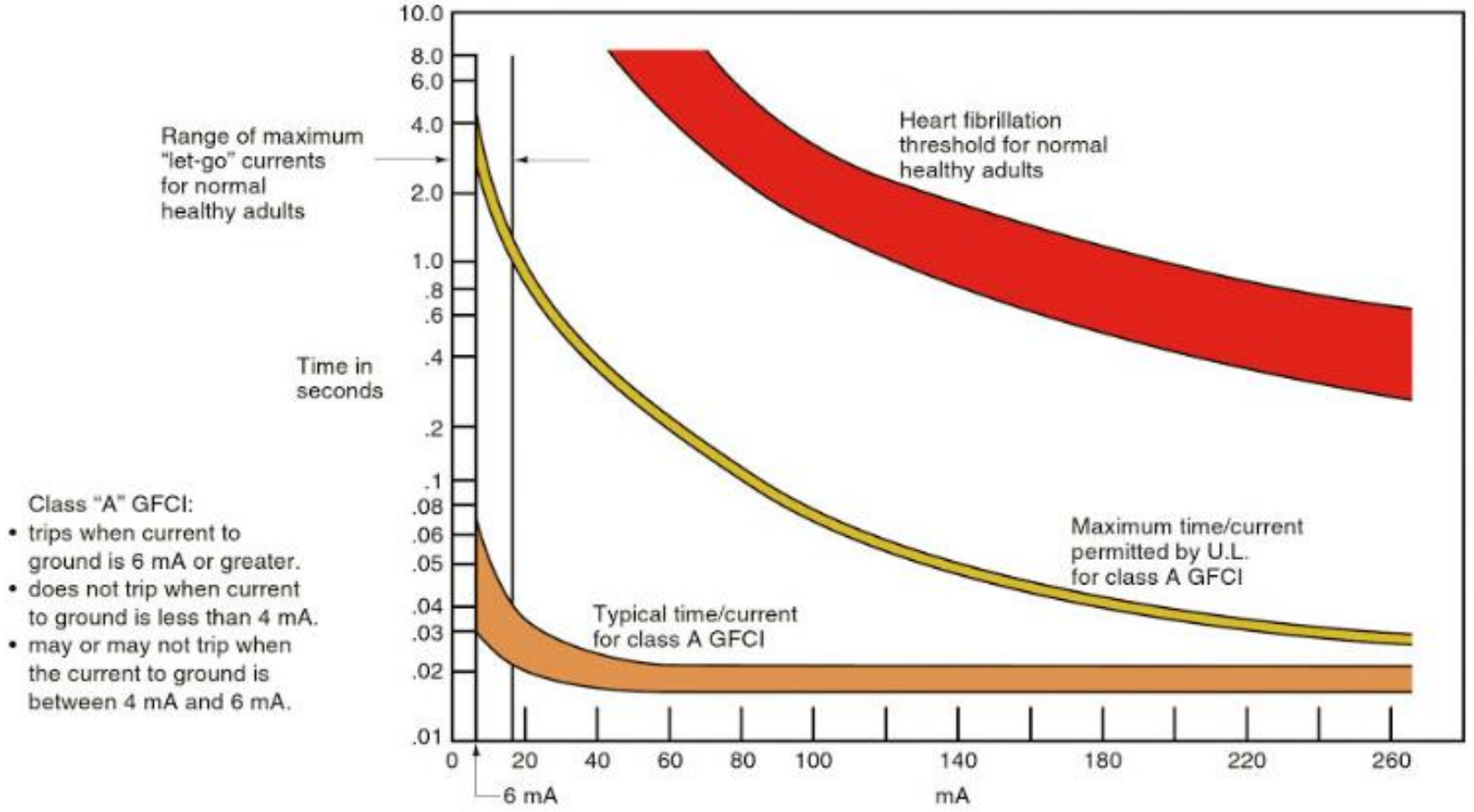
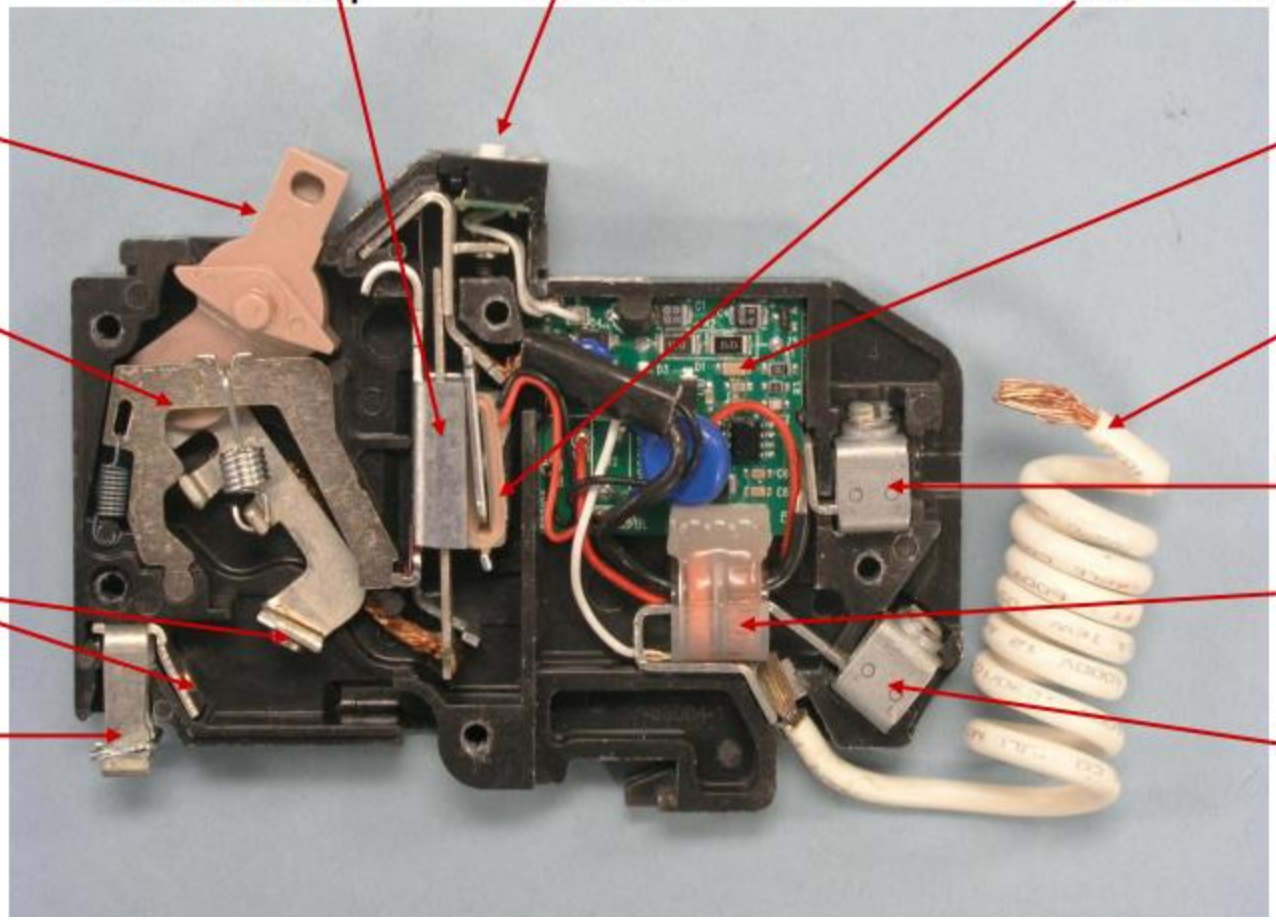



**FIGURE 6-1** The time/current curve shows the tripping characteristics of a typical Class A GFCI. Note that if you follow the 6-mA line vertically to the crosshatched typical time/current curve, you will find that the GFCI will open in from approximately 0.035 second to just less than 0.1 second. One electrical cycle is 1/60 of a second (0.0167 second). An air bag in an automobile inflates in approximately 1/20 of a second (0.05 second).

# What's in the GFCI?

## (Circuit Breaker)



# Current carrying capacity of cords

Type SE – extra hard usage
Type SJ – hard usage (most common)
Type SO – extra hard usage

At temp less than 86 deg F
16 ga  13 amps if less than 50 ft long, 10 amps if over 50 ft
14 ga  18 amps if less than 50 ft long, 13 amps if over 50 ft
12 ga  25 amps if less than 50 ft long, 18 amps if over 50 ft

If temp is up to 90 deg F, use a derate of .91
If temp is up to 105 deg F, derate is .82

# NEMA Receptacle and Plug Chart

| | VOLTAGE | LINE NO. | 15 AMPERE RECEPTACLE | 15 AMPERE PLUG | 20 AMPERE RECEPTACLE | 20 AMPERE PLUG |
|---|---|---|---|---|---|---|
| 2 Pole 2 Wire | 125V | 1 | 1-15R  | 1-15P  | | |
| | 250V | 2 | 2-15R  | 2-15P  | 2-20R  | 2-20P  |
| 2 Pole 3 Wire Grounding | 125V | 5 | 5-15R  | 5-15P  | 5-20R  | 5-20P  |
| | 250V | 6 | 6-15R  | 6-15P  | 6-20R  | 6-20P  |
| | 277V | 7 | 7-15R  | 7-15P  | 7-20R  | 7-20P  |
| 3 Pole 3 Wire | 125/250V | 10 | | | 10-20R  | 10-20P  |
| | 3 ϕ Δ 250V | 11 | 11-15R  | 11-15P  | 11-20R  | 11-20P  |
| 3 Pole 4 Wire Grounding | 125/250V | 14 | 14-15R  | 14-15P  | 14-20R  | 14-20P  |
| | 3 ϕ Δ 250V | 15 | 15-15R  | 15-15P  | 15-20P  | 15-20P  |
| 4 Pole 4 Wire | 3 ϕ Y 120/208V | 18 | 18-15R  | 18-15P  | 18-20R  | 18-20P  |