circuit. There are no upper limits on the number of general duty receptacles on any one branch circuit in dwelling units.

Old code: a Branch/Feeder AFCI has the ability to detect and neutralize a parallel arc fault, which is the unintentional flow of electricity between two separate wires. There are three types of parallel arc faults: line-to-line (hot to hot), line-to-ground, and line-to-neutral. The Branch/Feeder AFCI was permitted by the 1999-2005 NEC.

New code: a Combination AFCI (CAFCI) delivers 5 kinds of protection:

1) Parallel protection – Just like its Branch/Feeder counterpart, Combination AFCI can detect and neutralize parallel arc faults.
2) Series Protection – A series arc fault is the unintended flow of electricity over a gap within a single wire. These arc faults were not detectable until advanced technology allowed the development of the Combination AFCI breaker.
3) Ground protection – Arcing between a single conductor and a ground line.
4) Overload protection.
5) Short circuit protection

Old code AFCI breakers are still out there. Be sure your AFCI breakers are Combination AFCI (CAFCI) breakers. (Combination parallel and series fault, that is). A parallel fault is an arcing from the hot conductor to either the ground or grounded conductor. Causes include cable staples too tight or a screw or nail too long, which shorts between the cable conductors. A series arcing fault is an open in any current carrying conductor that is arcing. This includes any cords connected to the circuit, brushes in motors in appliances that arc and faulty switches that arc. The newer code compliant CAFCI devices will open the circuit for any of these conditions.

While AFCI protection is required for the entire branch circuit, GFCI protection is required only for the load to be connected. GFCI breakers are more expensive than GFCI receptacles. GFCI receptacles can be wired to protect the circuit wiring and receptacles "downstream" from the GFCI receptacle. This is why electricians used the GFCI receptacle whenever possible, it is significantly less expensive.

Typically, in the past, electricians would purchase a circuit breaker to protect the conductors, and install GFCI receptacles only where needed. The new code will not allow this anymore, except for circuits that only supply unfinished basement areas, attached or detached garages, outdoor lighting and receptacles, accessory buildings and bathrooms.

Receptacles in the garage are required by Section 210.52(G)(1) to be fed by a separate circuit, with no other outlets outside of the garage. This means, this circuit may also supply garage lighting outlets, without AFCI protection, if there are no garage lighting switches inside the house. Of course the receptacle outlets in the garage will still need GFCI protection (210.8(A)(2)), and be located at least one per car parking space.

The Dual Function Circuit Breaker combines Class A 5mA GFCI and Combination Type AFCI, protecting against both Arc Faults and Ground Faults. This, along with the new Self-Test feature, makes it the first in class in electrical safety for homeowners.

Before the development of Dual Function Circuit Breakers, the only option to comply with this code was to pair an AFCI circuit breaker with a GFCI receptacle. The Dual Function Circuit breaker combines these two devices into one solution that provides both cost savings and less hassle in installation and maintenance.

I hear from contractors that a **Dual CAFCI/GFCI circuit breaker** is actually less expensive than the CAFCI circuit breaker, and absolutely less expensive than purchasing an CAFCI breaker and a GFCI receptacle.

It is still code compliant to install GFCI receptacles on the countertops, in the laundry and outdoors. It is just more expensive.

Ground-fault requirements in dwelling units is found in Section 210.8(A). All 120 volt, 15 and 20 amp receptacles located at these locations require GFCI protection for personnel.

1) Bathrooms
2) Garages and accessory buildings
3) Outdoors
4) Crawl spaces
5) Unfinished basements
6) Kitchen countertops
7) Within 6 feet of a sink (**including the kitchen sink**)
8) Boathouses
9) **Within 6 feet of any bathtub or shower stall**
10) **Laundry areas** (in unfinished basements or not)

Receptacle outlets under the sink now require both CAFCI and GFCI protection. Receptacle outlets behind the refrigerator require CAFCI protection plus, if within 6 feet of the sink, GFCI protection, regardless of the single or duplex configuration. Receptacle outlets in bathing rooms now require both CAFCI and GFCI protection. Laundry areas anywhere in the house now require both CAFCI and GFCI protection for all 120 volt 20 amp receptacle outlets, regardless of the single or duplex configuration.

Section 210.8(D) requires GFCI protection for dishwasher outlets (receptacle outlets or hard-wired outlets). CAFCI protection is also required for kitchens.

Note areas that require or may require both types of protection: Kitchen countertops, dishwasher outlets and laundry areas always, and sometimes a refrigerator or garbage disposer receptacle. It would be economical to use the dual CAFCI/GFCI breaker for these circuits. Note as well, that appliances now require a disconnecting means, as they no longer have a rotary switch with a distinct OFF position. This can be achieved with a switch on the wall or use of a cord and receptacle. Either way, requires CAFCI protection, and if within 6 feet of the sink, or atop the counter, GFCI protection.

A typical, new construction, 1300 square foot with full unfinished basement, attached garage, single family dwelling electrical panel would be code compliant with the following circuit breakers:

1) 1-200 amp main (2 pole)
2) 1-50 amp range receptacle (2 pole)
3) 1-30 amp clothes dryer receptacle (2 pole)
4) 1-20 or 30 (or more) amp AC compressor (2 pole)
5) 1-15 or 20 amp Air Conditioning circulating fan
6) 1-15 amp basement lighting
7) 1-15 amp basement receptacle(s) (receptacles do need GFCI)
8) 1-15 amp basement boiler or furnace
9) 1-20 amp well pump (1 or 2 pole)
10) 2-20 amp bathroom receptacles (2 bathrooms) (receptacles do need GFCI)
11) 2-20 amp bathroom exhaust fan/heat/light fixtures
12) 1-15 amp garage receptacles (receptacles do need GFCI)
13) 3- 15 amp CAFCI's for the general lights and receptacles (bedrooms, living, hallways)
14) 2 or more- 20 amp dual CAFCI/GFCI's for the countertop receptacles
15) 1-20 amp CAFCI for the dining room receptacles
16) 1-20 amp CAFCI for the refrigerator receptacle
17) 1-20 amp CAFCI for the built-in microwave receptacle
18) 1-15 amp dual CAFCI/GFCI for the dishwasher
19) 1-15 amp dual CAFCI/GFCI for the disposer
20) 1-15 amp dual CAFCI/GFCI for the compactor
21) 1-20 amp dual CAFCI/GFCI for the laundry

If mini-split AC or heat pumps are used, CAFCI breaker protection is required, as there is an outlet inside the living area. If gas is available, #2 and #3 are not needed, although they may be supplied anyway. Breaker #11 may not be present. Breakers #14 through #17 could be replaced with only 2-20 amp CAFCI/GFCI kitchen circuits and still meet the minimum requirements (210.52(B)(1)). Breakers #18 through #20 for these built-in kitchen appliances may not be present at this time.

It is perfectly acceptable to have GFCI receptacles connected to CAFCI protected circuits. It is just as acceptable to have both types of protection in one device: the dual CAFCI/GFCI breaker.

I wonder if the manufacturers are intentionally attempting to encourage all CAFCI circuit breakers to be dual CAFCI/GFCI by pricing them cheaper?

Arc-fault and Ground-fault Requirements for Dwelling Units

A lot more branch circuits in new dwelling units are required to be Arc-fault and/or Ground-fault protected under the 2014 NEC.

A **Ground Fault Circuit Interrupter** (GFCI) was designed to protect people and equipment from electrical shock. An **Arc Fault Circuit Interrupter** (AFCI) was designed to detect arcing faults in the wiring, appliances and equipment, thereby preventing electrical fires. Two totally different types of protection in very similar looking devices; read the fine print, check for the NRTL marking.

Looking at AFCI requirements first: The 2014 NEC Section 210.12(A) **requires AFCI protection** for electrical circuits in most all areas of dwelling units. The shorter list is areas not requiring AFCI protection: unfinished basement areas, attached or detached garages, outdoor lighting and receptacles, accessory buildings and bathrooms are not required to be fed via an AFCI protected circuit. However, the electrician will often feed these areas by extending an existing branch circuit which is required to be AFCI protected. It is perfectly fine to provide AFCI protection to areas that do not require it.

Arc faults arise from a number of situations, including:

1) Damaged wires
2) Receptacle breakage
3) Neutral leads pinched to grounded metal box
4) Worn electrical insulation
5) Loose electrical connections
6) Shorted wires
7) Wires or cords in contact with vibrating metal
8) Overheated or stressed electrical cords and wires
9) Misapplied/damaged appliances

AFCI protection is required to protect the entire branch circuit (with some exceptions for the first section of unspliced cable). Generally, the most cost effective way of achieving this is to install an AFCI circuit breaker in the panel. The 2014 NEC has also extended AFCI protection to circuit with devices (switches, dimmers, etc.) in the specified areas. A switch located in the hallway feeding outside lighting or garage lighting will now require the entire circuit to be AFCI protected.

Section 210.12(A) lists 6 different methods of achieving code compliance. For new construction, only the first method (combination-type arc-fault circuit interrupter installed as a circuit breaker) is the practical choice. The other 5 choices are viable options, but should only be rarely used.

Circuit coverages are computed the same way as always (3 VA per square foot of dwelling area served: 220.12, 220.14(J)). A 15 amp circuit at 120 volts can supply 1800 VA. AT 3 VA per square foot this yields 600 square feet of floor area per required general lighting load circuit. This combines both room lighting outlets and general purpose receptacle outlets. Several rooms can be combined onto one branch