EMF from GFCI-Protected Electrical Outlets

by Andrew Eriksen, MS

Electrical wall outlets in wet areas can be a shock hazard. The National Electric Code, NEC, therefore requires the use of GFCI-protected outlets in kitchens, bathrooms and any other place that may be wet.

These GFCI-protected outlets emit electromagnetic radiation (EMF) in small amounts. Nine different models were tested to see if some are better than others.

It must be stressed that all the tested models emitted low levels of EMF, much less than many other sources found in a common home, so there should rarely be reason to remove or replace them. However, choosing a low-emitting GFCI is a prudent measure and encourages manufacturers to make low-emf a design criteria.

These tests were conducted in May 2007, using both GFCI's that meet the new 2006 standard, as well as some earlier models that were still on the shelves of hardware stores.

What are GFCI's?

GFCI stands for Ground Fault Circuit Interrupter, which means it will shut off the outlet if it detects a ground fault, such as when a person is being shocked.

The GFCI is a special electrical outlet with built-in electronics that has two buttons on the front panel: one to test that it works correctly, the other to reset it if it has been triggered.

The GFCI continuously monitors how much electricity runs on the two current-carrying legs of the electrical outlet. When all is fine, the electrons that go out on one leg will return back on the other leg of the electrical cord plugged in. Thus, it is in balance. If a person was receiving an electrical shock from faulty wiring, some of the electricity will go through the person instead of returning to the outlet. There will then suddenly be an imbalance, which the GFCI-protected outlet will notice and shut off the power within milliseconds.

A common method of detecting this imbalance is to have two coils wound together in opposite directions inside the GFCI. When the circuit is in balance, the electromagnetic fields from the coils are the same strength and cancel each other out. If there is an imbalance, one coil will generate a stronger field so they no longer cancel each other out. This force can be used to trigger the breaker.

As GFCI's become more and more sophisticated, more electronics are built into them. Newer models have indicator lights to alert the user of problems. In some models, a green light is on all the time when the GFCI is working properly. In other models there is a red light that comes on when there is a problem. These indicator lights seem like unnecessary overkill and they may require a little built-in transformer, which will generate a little EMF.

Future versions of GFCI's may be able to detect other problems, such as arcing from worn-out wiring, which would require more electronics.

Test Method

Nine GFCI models were purchased from local hardware stores. Five brands are represented, produced by four different manufacturers. These were tested with a gaussmeter for low-frequency emissions and an AM radio for high-frequency emissions. The gaussmeter used was the TriField model from Alpha Labs, which can measure EMF up to about 100 kilohertz, though less accurately in the high end of its range.

A simple AM radio from Radio Shack was used for the high-frequency measurements in the range of about 1,000 hertz to 2 mega hertz. The dial on the radio was set where no station could be heard and then it was noted if putting it close to the GFCI produced any static crackling.

The gaussmeter and the AM radio were in turn placed on the face plate of the GFCI being tested, and moved around until the highest reading was found.

Measurements were done with both the GFCI on (as it normally would be) and in the off, or "triggered" position (as when the TEST button has been pressed).

The test was done in a place with very low ambient EMF levels to avoid outside interference with the results. The ambient levels were checked with the TriField meter, while the quality of the electrical line was tested by holding the AM radio up against an electrical cord and hearing no crackling.

Results

A wide variety of low-frequency emissions were measured, ranging from 0.04 milligauss (4 nanotesla) to 12 milligauss (1.2 microtesla), with most in the 1-5 milligauss range (0.1 – 0.5 microtesla).

It was noted that some of the GFCI's had lower low-frequency emissions when they were tripped (i.e. the TEST button was pressed). Also, for three of the brands, the 20 amp version had lower emissions than the 15 amp version. Only the Ace brand had higher emissions for the 20 amp version.

Five of the tested GFCI's emit high-frequency EMF, but only one does it when in normal use. Four of the GFCI's only emit high frequency EMF when they are tripped. Those are the same models that have a red fault light, and they are all produced by the same manufacturer, Pass and Seymour.

Since a simple AM radio was used to detect high-frequency EMF, it was not possible to record an objective measurement, though it was noted that the Designers Edge model produced less static than the other static-producing models.

Conclusion

In all the tests, the emissions dropped off sharply within inches of the GFCI. In normal use, any of these models should work fine. The most concern should be in areas where humans would be within a foot of the GFCI-protected outlet for prolonged time.

It is probably more important to avoid high-frequency EMF than low-frequency EMF, in choosing a GFCI model. This is because high-frequency EMF appears to have a stronger biological effect, and also may be radiated further.

Historically, the GFCI models produced by Cooper have been the ones recommended for the electrically sensitive, and the two tested models are still a good choice, though also the most expensive.

The Cooper brand is currently carried by Ace hardware stores, which also sell other brands, including their own store brand. If the store doesn't carry Cooper, they should be able to order them.

The Cooper brand is also available on-line from www.electricsupplyonline.com.

If one wishes to go a step further, the outlets could be equipped with a switch to turn off the power when not in use. With new construction, that is easily done using a "two-gang" electrical wall box, with a switch in one side and the GFCI in the other side.

Brand	Size	Model	EMF GFCI on	AM crackle GFCI on	EMF GFCI off	AM crackle GFCI off	Comments
Ace brand (by Pass & Seymour)	15A	3192515	3.5mg	No	2.5mg	Yes	Marked: “2006UL”red light when tripped
Ace brand (by Pass & Seymour)	20A	3192523	12mg	No	3mg	Yes	Marked: “2006UL”red light when tripped
Cooper Peachtree City, GA	15A	XGF15V	1mg	No	1mg	No	Marked: “meets new UL943”
Cooper Peachtree City, GA	20A	XGF20V	0.6mg	No	1mg	No	Marked: “meets new UL943”
Leviton Little Neck, NY	15A	Smartlock Pro No. 7599	8mg	No	8mg	No	Marked: “meets 2006 UL”
Leviton Little Neck, NY	20A	Smartlock Pro No. 7899	5mg	No	5mg	No	Marked: “meets 2006 UL”
Pass & Seymour Syracuse, NY	15A	1594-1CC10	6mg	No	3mg	Yes	Marked: “meets 2003 UL” displays a red light when tripped. No longer produced.
Pass & Seymour Syracuse, NY	20A	2094-1CC10	3mg	No	1.5mg	Yes	Same as above
The Designer’s Edge Bellevue, WA	20A	L-3202LED	0.04mg	Little	0.03mg	No	Produced in 2006, may not meet new standard