WHITE PAPER

GFCI Compatibility with High-Frequency Appliances: Addressing Real-World Electrical Safety

Electrification is happening all around us with more and more devices becoming completely electric. At the same time, energy saving programs are also evolving, forcing these devices to be more efficient. The combination of these two events has led to equipment, for instance home appliances, using advanced energy efficient components such as high frequency (HF) switching power supplies. These power supplies convert AC to DC more efficiently while operating at much higher frequencies compared to traditional linear power supplies which operate at 60Hz.

A consequence of this is that traditional safety devices, such as ground fault circuit interrupters, need to be modernized. GFCIs that don't filter out HF noise, can be fooled into thinking there is a dangerous condition, and interrupt current unnecessarily, when appliances leak HF current to ground as part of their normal operation.

HF and the Human Body

Current flowing through the body can have different physiological effects based on the amperage, frequency, and duration of the current flow.[1,2] If even small amounts of current were to flow through the body, at 60Hz, it can lead to ventricular fibrillation and cause electrocution.[1] GFCIs are designed to detect this and interrupt power well below dangerous levels to protect users. But as frequency increases, the ventricular fibrillation threshold also increases,[2,3] and is less of a danger. UL943, the safety standard that governs ground fault circuit interrupters, was recently updated to address this very issue. An optional section was added to the standard defining the current trip limit for frequencies over 60Hz (see Figure 1).

Interoperability Defined

This new standard for current trip limits establishes where GFCIs *shall not* trip due to high frequency current leakage based on where appliances may now operate. If an appliance leaks current *below* the line, an HF-rated GFCI will not interrupt power. If the appliance leaks current *above* the line, introducing a hazard to humans, a GFCI should trip as designed to protect the user.

Leviton's HF GFCI Technology

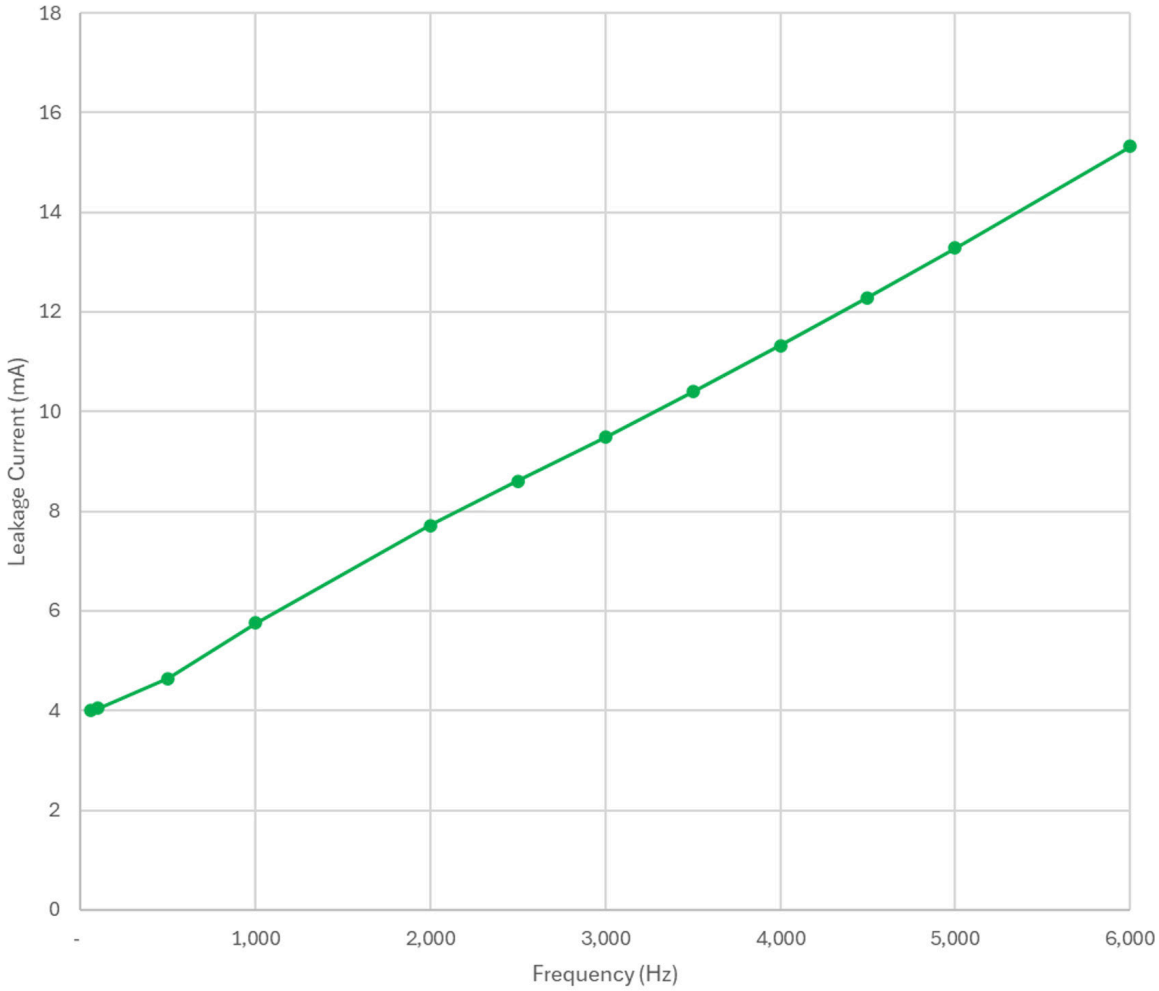
Leviton's entire line of SmartlockPro GFCI Receptacles are designed to meet this new standard while keeping users safe. Most modern appliances can operate at multiple frequencies simultaneously. If any HF ground leakage is detected that also has a 60Hz component, Leviton's SmartlockPro GFCI receptacles will continue to trip, protecting users from the unintended current flow, while filtering out this HF noise. Leviton's response to this new HF standard helps to reduce unwanted tripping while maintaining the highest safety standards.

1. Fish RM, Geddes LA. Conduction of electrical current to and through the human body: a review. Eplasty. 2009 Oct 12;9:e44. PMID: 19907637; PMCID: PMC2763825

2. Kroll, Mark & Koch, Michael & Panescu, Dorin & Perkins, Peter & Paupert, Marc & Pratt, Hugh. (2024). Effects of Frequency on the Ventricular Fibrillation Threshold: Implications for Updated Safety Standards. 10.13140/RG.2.2.17468.65928

3. Dalziel, Charles & Ogden, Eric & Abbott, Curtis. (1944). Effect of Frequency on Let-Go Currents. American Institute of Electrical Engineers, Transactions of the. 745 - 750. 10.1109/T-AIEE.1943.5058642

Figure 1: UL943 HF Trip Limit



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Leviton Manufacturing Co., Inc.
201 N Service Rd, Melville, NY 11747
Telephone: 1-800-323-8920 • FAX: 1-800-832-9538
Tech Line: 1-800-824-3005 (M-F 8AM-10PM; Sat 9AM-7PM; Sun 9AM-5PM)