GIRL, FAULT INTERRUPTED
whoami

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DISCLAIMERS

Ideas/research my own...
Story time!
Supply Acquisition
Circuit Interrupts around the house
≠ Purposes

GFCI: Intends to prevent Electric Shock

AFCI: Intends to prevent fires
Code Requirements

**GFCI’s**

- Bathrooms/Indoor wet locations
- Garages/storage areas/non habitable areas/unfinished basements
- Outdoors/Compartments accessible from outside the unit/Rooftops/Pools/Hot tubs
- Crawl spaces at or below grade level
- Kitchen [dish washer, Refrigerator]
- Laundry Areas

**AFCI’s**

- Kitchens
- Family Rooms
- Dining Rooms
- Living Rooms
- Parlors
- Libraries
- Dens
- Bed rooms
- Sun rooms
- Recreation Rooms
- Closets/Hallways
- Laundry Areas
- Or similar rooms
Ground Fault Circuit Interrupt

GFCI

5-30 mA
25-40 ms
Arc Fault

Circuit Interrupt

AFCI
GFI Demos 😊
Magic Smoke - Closed

https://www.youtube.com/watch?v=wdIDoE3rV9M
Internal Spark

https://www.youtube.com/watch?v=E-fKU9MvDjg
Close range Outlet trip

https://www.youtube.com/watch?v=21UeF_cHRxU
Close range Outlet trip

https://www.youtube.com/watch?v=7yw-DV2URE0
GFCI Outlet Trip through RF

https://www.youtube.com/watch?v=IpzHTYNK52Y
Across Walls

https://www.youtube.com/watch?v=30t50Hs0pZM
“Remote”

https://www.youtube.com/watch?v=fKxL1MMLe0I
Magic smoke

https://www.youtube.com/watch?v=Nt6HiCsAKhw
Flaming flying components 😊

https://www.youtube.com/watch?v=S16zuJACdds
Result
Fried GFCI

https://www.youtube.com/watch?v=dnlJeaKOugc
AFCI Breakers vs. HAM Radio

https://www.youtube.com/watch?v=JsILD0Fce1s
0:22 & 5:47
ARRL Helps Manufacturer to Resolve Arc Fault Circuit Interrupter RFI Problems

TAGS: amateur radio transmitter, ARRL Lab, gruber, online ham radio

11/19/2013

The ARRL Lab has worked with a manufacturer of arc fault circuit interrupter (AFCI) breakers to resolve complaints that Amateur Radio RF was causing certain breaker models to trip unnecessarily. Like the more common ground fault circuit interrupter (GFCI), the AFCI is a safety device. Primarily designed to detect problems that could result in a fire, AFCIs detect potentially hazardous arc faults that result from often unseen damage or poor connections in wiring and in extension cords and cord sets.

"Several months ago we started receiving reports from amateurs that when they transmitted, their AFCI breakers were tripping," said Mike Gruber, W1MG, the ARRL Lab’s EMC specialist. He notes that the issue has been a topic of online ham radio discussions as well as on homeowner sites; it seems that stray RF is not the only thing that can cause a "nuisance trip" of an AFCI. Gruber pointed out that the National Electrical Code (NEC) already requires AFCIs in some household circuits, but not all US jurisdictions have adopted the requirement.
So what’s going on?
Electromagnetism
It MHz...
Resonance ♩

Defined by: Resistance, Inductance & Capacitance

A coil will resonate to its fundamental frequency (or harmonics)

US AC works @ 60 Hz
Low Power GFI

Figure 1. GFI Application Circuit (Three-Wire Outlet)

* Value depends on transformer characteristics.
SCR’s
Silicone Controlled Rectifiers

**SENSITIVE GATE SCR**

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<th>RD26 (Plastic)</th>
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<tr>
<td><strong>K</strong></td>
<td><strong>A</strong></td>
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<tr>
<td><strong>G</strong></td>
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<td><strong>C</strong></td>
<td><strong>K</strong></td>
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<table>
<thead>
<tr>
<th>On-State Current</th>
<th>Gate Trigger Current</th>
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<tr>
<td>0.8 Amp</td>
<td>&lt; 200 µA</td>
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**Off-State Voltage**

- 200 V + 600 V

This series of Silicone Controlled Rectifiers uses high performance PNPN technology. This part is intended for general purpose applications where high gate sensitivity is required.

**Diagram:**
- Anode
- Gate
- Cathode
- Motor
- SCR under test
- AC source
- Breakover voltage
- Breakover voltage
- Trigger threshold

**Acronyms:**
- DIAC: Diode-Activated Rectifier
- SCR: Silicon Controlled Rectifier
Ceramic Capacitor

- 0.01 uF
- Overheating, over current, short-circuit
GFI Power Outlets
## Patents

<table>
<thead>
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<th>Year</th>
<th>Brand</th>
<th>Country</th>
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Other scenarios...
Relevance?

• RFI can be accidental or intentional
• RFI is wireless and fingerprint free
• Annoying DoS/Neighbor trolling
• Services/Devices that matter: Medical Equipment
Recent GFCI News 😞

Electrocution causes death of 8 year old boy

July 28th, 2014 – Lake Conroe, Texas

He said investigators discovered the faulty wiring on the dock at the Piney Shores Resort near League Line Road where the boy sat before falling in the water feet first. The boy was only in the water about 15 seconds before his father pulled him from the lake and began CPR. The boy was later pronounced dead at Memorial Herman Hospital in Houston.

According to Nancy Mikeska, the Montgomery County Sheriff’s Office requested the city inspect the dock as part of the investigation. Mikeska said the resort and the dock are in the city limits.

"Inspectors inspected the dock and made a determination that the wiring was not to city code and was dangerous and shut the power off to the dock," she said. "The GFCIs appeared to malfunction and continued to run hot."

Suggested Solutions

• Test your GFCl’s often
• Update to newer Circuit Breaker Patents
• Back ups:
  – Power Generators
  – Batteries
  – Manual Overrides
• Grounded FC encasing
LIVE Demos
Acknowledgements

• Carlos Abad
• Larry Averitt
• Michael Demeter
• Rafael Jauregui
• Habteab Yemane
• Michael Reams
• Chris Mitchell
• Laplinker ♡
Bloopers

https://www.youtube.com/watch?v=3RvvFFfQZt8
Thanks