



BY HOWARD JOHNSON, PhD

Not your fault

Have you every turned on a light switch, only to see a bright flash just before the whole room plunges into darkness? You just tripped a circuit breaker. That failure scenario requires a light-bulb filament that has almost, but not quite, burned through. When you apply power to the bulb for the last time, a rapid wave of heat stress breaks the filament, sending fragments of broken filament flying around inside the bulb. A short fragment lodges across the power terminals inside the bulb, shorting those terminals together. In that shorted condition, the bulb draws far more current than its designed operating level. The filament shines blindingly white-hot in its last moment before the building circuit breaker pops, disconnecting power to the bulb. This scenario may sound unlikely, but you've probably seen it happen.

In the brief moment before the circuit breaker pops, the power-circuit load comprises three things in series: the hot wire leading to the bulb, the shorted bulb, and one neutral wire coming back (Figure 1). In the worst case, a voltmeter touching points A and B could read a voltage drop as high as 60V rms. Under those conditions, the wiring easily dissipates enough power to burst the wiring into flames and toast your whole building. The circuit breaker prevents that scenario.

In addition to circuit breakers, most civilized nations require the use of modern, three-pronged grounding outlets. In that applica-

tion, only the hot and neutral wires carry power currents. The green safety wire, or "third wire," merely connects the metallic chassis of each product to earth at the ac power entrance. Under ideal, no-fault conditions, the green safety wire carries no current. An inexperienced designer might therefore conclude that the green wires form a

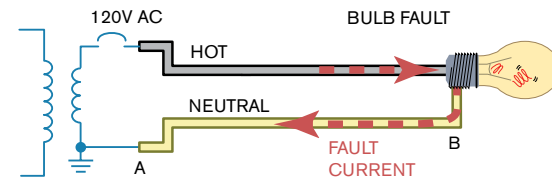


Figure 1 A broken filament creates a short circuit.

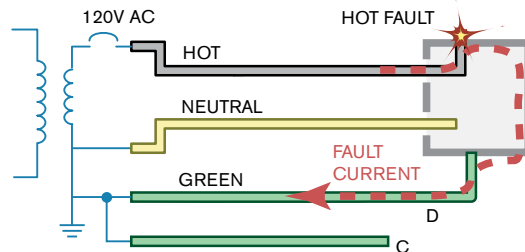


Figure 2 The green wires prevent the faulty chassis from remaining energized but do not prevent large voltages from appearing between points C and D.

single-point-ground reference system that provides a consistent voltage reference between different ac-powered products. It does not serve that function (Figure 2).

The box on the right represents an old vending machine with a metal body. One day, a hot wire inside the machine accidentally breaks free. It touches the metallic chassis, creating a potentially dangerous situation. Immediately, the product's green safety wire conveys a large fault current back to the power source. That action is the sole function of the green wire. The fault current trips the circuit breaker, shutting off power and possibly saving the life of the next person who wants a candy bar.

As the fault current surges through the green wire, other products plugged into the green-wire system at adjacent outlets C and D could experience voltage differences as large as 60V rms. Even though the original fault lies within the vending machine, if the surge blows out your equipment, you inherit all the blame. It would be better if you design gear that can sustain such extraordinary voltages without damage.

Suitable architectures for interchassis data transfer that can easily sustain 60V rms without disruption include well-balanced, transformer-isolated standards, such as Ethernet; fiber-based optical links; free-space IR (infrared) optics; and RF transceivers. You should use interfaces such as RS-422 that lack large common-mode immunity only between equipment that permanently connects to a common outlet or power strip. **EDN**

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