

## Old home tech tips: #2

By Brian Cook, October 11, 2011

From the numerous old houses that I have been testing for electrical safety there are some interesting observations that I hope you find of interest. These observations may aid in your testing procedures of electrical systems in older homes.

### 1. Standard test for ungrounded outlets may be inaccurate

The standard check that we all use with a Receptacle tester to see if a receptacle is grounded **may present false readings if a power bar is installed at that receptacle**. I recently observed in a number of houses that when some power bars are plugged into the receptacle being tested the tester will incorrectly present that circuit is grounded. See figures 1 & 2 below. *For an explanation see footnote<sup>1</sup>*



Fig. 1: Image shows standard check with "Receptacle tester" with the homeowner's Power bar plugged into the receptacle. The tester's red-light illuminates indicating receptacle is grounded.



Fig. 2: Upon unplugging the Power bar the tester now correctly presents that the receptacle is not grounded.

**Conclusion: When checking to see if a receptacle is grounded, any power bar plugged in that receptacle must first be unplugged.**

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According to information that I have gotten on line, Power bars use Metal-Oxide Varistors (MOVs), or inductor capacitor circuits for surge protection. In simple surge protectors these devices are connected across line to neutral. However in more elaborate power bars the surge protectors are connected across all three wiring combinations, including neutral to ground (providing protection in the event of a reverse polarity receptacle). An MOV is a type of voltage-dependent resistor, high resistance at normal line voltage. If its breakdown (clamping) voltage is exceeded its resistance drops dramatically, thereby shunting the high voltage spikes across the MOV, away from the downstream devices.

Both MOVs and capacitors do however have a small leakage current when manufactured. UL 1449 states leakage current neutral to ground of surge protection devices should not exceed 0.5 mA. Traditional neons however will illuminate with current as low as 0.35 mA. Also MOVs degraded each time they are triggered. Hence, if the surge protector is connected between ground and neutral the neon will illuminate when testing line to ground.

Power bar: [http://en.wikipedia.org/wiki/Power\\_strip](http://en.wikipedia.org/wiki/Power_strip)

Surge protection: [http://www.smartpowersystems.com/New/tbf\\_technology.htm](http://www.smartpowersystems.com/New/tbf_technology.htm)

Neon lamps: [http://efindon.server.hi-tech-media.biz/efindon/pdf/4x10\\_0803.pdf](http://efindon.server.hi-tech-media.biz/efindon/pdf/4x10_0803.pdf)

## 2. Check for bonding of appliances with a “Capacitive voltage sensor”: A wonderful test tool.

The capacitive voltage sensor (aka. non-contact voltage tester) not only proves useful in the detection of live conductors but in the **detection of ungrounded appliances and hard-to reach receptacles**. Simply touch the chassis of the appliance, a junction box, or even the cover screw of a receptacle with the voltage sensor. If appliance or receptacle is ungrounded the voltage sensor will sound. Note: Of course assure that user creates a sufficient capacitance to ground (E.g., if testing boxes/outlets/appliances on the third story of a wooden house, make body contact to a confirmed grounded device). *For an explanation see footnote<sup>2</sup>*

### Case study: Electrical fire due to handyman wiring of exhaust fan

I bring this test to note, as last week I was provided with a fire report from an insurance company, concerning a recent electrical fire. They asked if PowerCheck would have identified this electrical fault in advance of fire. It was a hazardous “handyman add-on” that resulted in the electrical fire. The wiring was behind the walls, not visible.

#### From fire analysis: Cause of fire:

- *“Poor wiring technique resulting in twisted and likely mechanically damaged conductors”*
- *“Excessive and unrestrained wiring subject to mechanical damage”*
- *“Overloaded circuit with a refrigerator connected, plus a light gauge lamp cord and switch hardwired into the circuit powering wall exhaust fan”.*

#### How could this hazardous wiring been identified in our examination protocol?

- With lamp cord energizing the exhaust fan, the exhaust fan was likely not bonded. The voltage sensor test applied on the chassis of the exhaust fan would likely have identified the exhaust fan as not bonded. Hence alerting home owner of hazard, and to repair circuit to code.



Fig. 1: Voltage sensor used to determine if exhaust fan is grounded. If sensor beeps, it is not grounded.

**Conclusion: Without question, we must be looking for all indicators of handyman add-ons. The capacitive voltage sensor used to detect ungrounded appliances is a test that should definitely be included in a PowerCheck electrical examination.**

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<sup>2</sup> Using the voltage sensor to detect no grounding is just an extension of the voltage detection of live conductors. When in contact with an ungrounded device the voltage sensor creates a path to ground, via capacitance. If the box/receptacle/metal chassis of appliance is grounded, no current will flow through the sensor. However if the junction box is *not* grounded a small micro current will make its way through this series of capacitors to ground, sounding the voltage sensor.

[http://www.myflukestore.com/crm\\_uploads/fluke\\_voltage\\_detectors\\_-\\_understanding\\_capacitive\\_voltage\\_sensors\\_-\\_how\\_voltage\\_detectors\\_use\\_your\\_bodys\\_conductivity\\_application\\_note.pdf](http://www.myflukestore.com/crm_uploads/fluke_voltage_detectors_-_understanding_capacitive_voltage_sensors_-_how_voltage_detectors_use_your_bodys_conductivity_application_note.pdf)

### 3. Indication of wiring type behind receptacle, and GFCI protection as a solution.

Using a receptacle tester provides a quick-and-easy way to determine if outlet is ungrounded. As so often found in older houses, NMD has been tapped on to knob-and-tube for the installation of a new outlet, creating a hazardous situation. For some reason, the NMD bond conductor is usually connected to the receptacle, but not connected upstream.

A quick measurement of voltage, line to ground will determine if this is the case:

- If a voltage measured line to ground-pin of receptacle is less than line to neutral (I have been seeing values anywhere from 10 to 60 V), then one scenario is that NMD is tapped on to knob-and-tube. Of course, there is the scenario that the NMD is continuous back to panel, but there is a break in the bond conductor circuit. In either case it requires attention.  
*Explanation:* If an NMD bond conductor is connected at the receptacle but not upstream, a voltage is induced on to the bond conductor from the line conductor in the cable.
- If 0 V is measured line to ground, then it does not preclude that all is okay, as the receptacle could be wired with twin-wire lamp cord for example.
- **Conclusion:** In either case: GFCI protection of receptacle, as per CEC rule 26-700(8) is not a solution; either bond circuit repaired if applicable, or circuit re-wired.

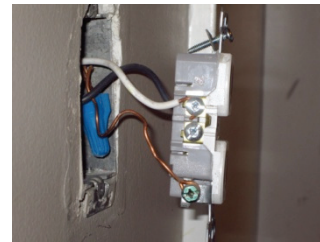


Fig. 1: Identification of ungrounded 3-prong receptacle with receptacle tester

Fig. 2: Voltage measurement line to ground, indicating a bond conductor is connected at receptacle

Fig. 3: Examination confirms measured values: Modern Lumex behind receptacle: Either a bad ground connection, or a tap off of an ungrounded wiring system.

### 4. Additional test: Cold water pipe bonding

If there is any indication that the copper water-supply piping system has been cut and replaced with a section of PEX pipe (*crosslinked polyethylene*), it may be worthwhile to check that the downstream side of the copper piping is bonded (eg., copper plumbing in washing machine area). It is a simple check, just measure resistance between cold water line and a confirmed ground (e.g., washing machine/dryer receptacle). Should read 0 ohms.

Case study: In two of two houses where I noticed sections of copper pipe replaced with PEX (likely for the repair of leaks), I checked for bond near ground clamp and by washing machine. In both cases copper piping by ground clamp was bonded, but by washing machine was not.

I believe the repair procedure is simply for a licensed electrical contractor to install a jumper of #6 Cu across the PEX, under permit.

## NOTES

1. **Receptacle grounding:**

In reference to receptacle grounding we are referring to the bonding of a receptacle grounding screw to the bonding screw of the box and to the bonding of the receptacle and the metal box to ground.

2. **Use of GFCI protection per Rule 26-700(8):**

The Code is clear that the GFCI is not intended to be used as bonding means, and that provision of Rule 26-700(8) is only intended to provide a minimum level of protection against electric shock in existing residential installations without bonding conductor. The use and limitations of GFCI protection of ungrounded receptacles is presented in the attached bulletin, *"Knob and tube wiring in residential Installations"* Ontario ESA, May 2009, (see section, "Receptacles in existing knob and tube installations", foot of page 2).