

Re: Multimeter damaged when powered from regulated power supply.

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Source: <http://sci.tech-archive.net/Archive/sci.electronics.basics/2006-01/msg01493.html>

- *From:* "Chris" <cfoley1064@xxxxxxxxxx>
 - *Date:* 31 Jan 2006 09:34:46 -0800
-

Geogle wrote:

> Thanks to all help with ascii schematic, here are the figures again. In
> the DMM, I assume
> that HV probe is protected with respect to the Probe GND. But GND
> itself is not protected
> from the supply gnd. So adding the zener/filter cap must be good enogh
> to protect the whole thing. Caution has to be taken to see that the
> entire thing is treated as a live circuit.
> In that way the battery thing may be more dangerous thing because
> changing the battery
> means, in case you forget to disconnect the probe you are in danger. (
> Just a thought!).

>
>
> First Picture:

> . DANGER HIGHVOLTAGE

> .----- .-----.

> . L || 9V || Probe HV

> . |||

> . ||| 7107 Mtr |

> . MAINS | 9 V |||

> . | Supply |||

> . |||

> . || 0 || Probe GND

> .-----|-----

> . N -----'-----'

> (created by AACircuit v1.28.6 beta 04/19/05 www.tech-chat.de)

>
>
> Second Picture:

> . DANGER HIGHVOLTAGE

> .----- .-----.

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```
> . L || 9V || Probe HV
> . -----
> . |||
> . ||| 7107 Mtr |
> . MAINS | 9 V |||
> . | Supply |||
> . |||
> . || 0 ||Probe GND
> . -----|-----|-----|-----|
> . N -----' | '-----' |
> . ||
> . | Elec. Cap |
> . | \ |
> . |-----|]-----|
> . | /+ |
> . ||
> . ||
> . ----->z-----|
>
> Zener
>
>
> (created by AACircuit v1.28.6 beta 04/19/05 www.tech-chat.de)
>
> Third Picture:
>
> . Equivalent Circuit.
> .
> .
> . L
> . -----| |
> . ||
> . | Leakage Cap | Leakage Cap
> . ----
> . ----
> . ||
> . ||
> . ||
> . GND || GND
> . ||
> . ||
> . |+ |
> . === z Zener
> . /-\ A
> . ||
> . ||
> . ||
> . N ||
> . ----- |.
>
> On The assumption that HV Probe is already protected in DMM
```

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- >
- > Additional protection only for Probe GND
- > with respect to Supply GND
- >
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Hi, Geogle. Thing2 and Thing3 won't do the job — you'll still damage your meter.

- 1) Your 9V power supply is not sufficiently isolated from the line unless you've got a transformer with electrostatic shield.
- 2) There is no direct meter internal connection between the 9V battery negative and the meter negative probe. You're just adding another problem by connecting the two with a cap and zener.
- 3) Most cheapie meters can be damaged by applying line voltage to the probes with the battery disconnected, or with the battery power off. Since it takes anywhere between tenths of milliseconds and a few milliseconds for the input filter cap of your 9V supply to get charged up by the transformer, you're leaving yourself open to meter damage there, too.

One of life's ancient principles is that you may not always get what you pay for, but you always pay for what you get. Line-powered bench DMMs cost more than battery-operated handheld DMMs for a reason, and it's not just more accuracy.

If you open up a good benchtop DMM or look in the service manual, you'll see that quite a bit of care has been taken to provide good isolation between the line and the meter circuit power supply. You'll also note that most bench DMMs specify a maximum voltage between the probes and GND (usually between the negative probe and GND).

Many benchtop DMMs also have input circuitry that presents a high limiting input impedance when they're unpowered.

Let's look at this from a cost standpoint, which is where I think you're coming from. Using the Digi-Key catalog, I find that an Energizer 9V Industrial Alkaline battery will cost \$2.34 for 625mA-h at 9V. Six "D" Industrial Alkaline batteries in series will cost \$8.28 for 20,500 mA-h at 9V.

According to this measure, you'll replace the 9V batteries 32 times for each replacement of the 6 "D" batteries. Of course, the mA-h ratings for both are based on a 25mA load, and the mA-H ratings are for drawdown to 60% of nominal voltage. Both of these would favor the larger D battery, and I'm sure the actual replacement ratio will be somewhat lower than 32:1. The cost ratio, though, is only 3.5:1. 9V batteries are a relatively expensive way to run something. You'll easily save over 80% of the cost of running the meter by using 6 D

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batteries in series. If you've got an old 7107-based meter that uses a several mA, you'll be replacing batteries twice a year at worst. Most of your job is done easily.

To do this relatively safely, start by snapping a 9V battery clip with flying leads onto the 9V battery clip in the meter (note that red and black will now be bass-ackwards). Drill a small hole in the meter battery cover to allow the flying leads to be snaked through (you can later fill this hole with epoxy if you want to return the meter to regular service).

Purchase a thermoplastic (NOT metal!) project box bigger than the meter, and also purchase two 3-cell D battery holders. Mount the battery holders in the box, and drill a hole for the meter wires such that the wires will fit through when the meter is affixed to the box. I lined it up so the bottom of the meter was flush with the bottom of the project box, so it could be stood up on end for visibility. I also mounted a small stand on the bottom of the box to keep it from tipping over (the D batteries tended to make it a little top-heavy).

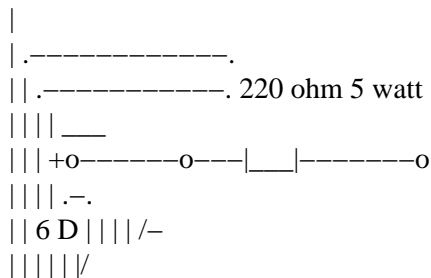
Now either use epoxy glue or ty-raps to affix the meter permanently to the project box. Install the 6 D batteries. Screw closed the cover on the project box. Turn the meter on. You're done.

I've been where you are now. This works.

And this setup with the meter and plastic project box is just as safe as the meter with the manufacturer-recommended 9V battery, if you know what you're doing with electricity. You wouldn't try to replace the enclosed battery on a meter while it's measuring line voltage either way, no matter what some might say. Other than that, it just looks kind of clunky.

Standard legal/moral/ethical disclaimers apply. Affix a visible warning on the meter/plastic project box stating that hazardous voltages may be present inside, if you so choose, or if you're dealing with fresh grads who don't know which side of the soldering iron is hot.

And if you really want to work hard to protect your cheapie meter, use a series 220 ohm 3 watt wirewound in series with the red probe, and place a line voltage rated MOV between the red and black probes.



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```
||| DMM | MOV | | DUT
|| Batteries |||
||| / |
||| - / |
||| ' - '
||| -o-----o-----o
|||
|| '-----'
| '-----'
```

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Good luck
Chris

• **References:**

- ◆ **[Re: Multimeter damaged when powered from regulated power supply.](#)**
◇ From: Geogle
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◇ From: Phil Allison
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