

An off-the-shelf meter for measuring body amperage: A new gold standard for epidemiologic studies?

[Sam Milham](#)

Page 237 | Published online: 26 Jun 2017

•

- <https://doi.org/10.1080/15368378.2017.1336101>

•

An off-the-shelf meter for measuring body amperage: A new gold standard for epidemiologic studies?

A Fluke 287 true RMS multimeter can measure body amperage between an ECG patch over the sternum and an outlet ground or a true ground.

Surprisingly, there isn't a single reference to directly measuring body amperage in the electromagnetic field (EMF) literature.

Every place of the hundreds measured that had high ambient magnetic fields had high body amperage. However, many places with non-incandescent lighting and/or high ground current levels had low magnetic fields and high body amperage levels. The magnetic fields in air under a 500 kV power line paralleled the body amperage readings but were measureable at a distance from the line where the body amperage levels had disappeared.

Using $V = IR$, an average body resistance of 500 ohms, and a voltage measurement can give a predicted amperage measurement. In a typical example, the predicted amperage was 292 μA and the measured amperage was 270 μA .

Body amperage is (30-100 μA) in rooms with fluorescent lights mounted on low ceilings, and was as over 300 μA standing on the pavement at a public outdoor farmer's market due to high ground currents. Both places had low magnetic fields (<0.2 mG). Body amperage increases with decreasing distance from fluorescent lights. The currents disappear when the lights are shut off and can be blocked with a Faraday cage.

In an Electric Power Research Institute (EPRI) paper about contact current and cancer risk, Kavet et al. ([2000](#) Kavet, R., Zaffanella, L. E., Daigle, J. P., et al. (2000). A possible role of contact current in cancer risk associated with residential magnetic

fields. *Bioelectromagnetics*. 21:538-553. [[Crossref](#)], [[PubMed](#)], [[Web of Science](#)®], [[Google Scholar](#)]) wrote: "... level of contact current (modeled) 18 uA produces average electric fields in tissue along its path that exceed 1 mV/m. At and above this level the NIEHS Working Group (1998) accepts that biological effects relevant to cancer have been reported in numerous well programmed studies".

Since there are high body amperages in many places with low magnetic field levels, it is possible that we were measuring the wrong thing in most of our past EMF epidemiology studies. The Hydro Quebec study (Armstrong et al., [1994](#) Armstrong, B., Thériault, G., Guénel, P., et al. (1994). Association between exposure to pulsed electromagnetic fields and cancer in electric utility workers in Quebec and France. *Am. J. Epidemiol.* 140:805-820. [[Crossref](#)], [[PubMed](#)], [[Web of Science](#)®], [[Google Scholar](#)]) showed a 15-fold increased risk of lung cancer in workers exposed to pulsed high-frequency magnetic fields. Risk ratios this high are rarely seen in studies using power frequency magnetic fields as an *exposure* metric. The cancer incidence risk ratios were near 10 for a number of cancers in the teachers at a California school and were strongly associated with classroom levels of high frequency voltage transients (Milham and Morgan [2008](#) Milham, S. and Morgan, L. L. A new electromagnetic exposure metric: high frequency voltage transients associated with increased cancer incidence in teachers in a California school. *American Journal of Industrial Medicine.* 51:579-586. [[Google Scholar](#)]). The meters used in most of the measurement-based epidemiologic studies have

narrow bandwidths. The IREQ and EMDEX meters have bandwidths from 40 Hz to 1 kHz, while the AMEX has a bandwidth of 25 Hz to 1.2 kHz (IARC monographs V. 80, tables 8, 9). The EMDEX meter failed to detect 10 Hz magnetic fields near a spinning radial tire, while an FW Bell gauss meter could (Milham et al., [1999](#) Milham, S., Hatfield, J., and Tell, R. (1999). Magnetic fields from steel-belted radial tires: Implications for epidemiologic studies. *Bioelectromagnetics*. 20:440-445.[\[Crossref\]](#), [\[PubMed\]](#), [\[Web of Science ®\]](#), [\[Google Scholar\]](#)).

The Fluke 287 has a 100 kHz AC bandwidth (Fluke manual). Since fluorescent lights are everywhere, and since many residences and public places have high body amperage readings because of ground currents, there is a need for new studies of 1000 homes, offices and workplaces measuring body amperage.

Future measurement-based EMF epidemiologic studies should include a body amperage measurement.

References

- Armstrong, B., Thériault, G., Guénel, P., et al. (1994). Association between exposure to pulsed electromagnetic fields and cancer in electric utility workers in Quebec and France. *Am. J. Epidemiol.* 140:805-820.

[\[Crossref\]](#), [\[PubMed\]](#), [\[Web of Science ®\]](#)

,

[\[Google Scholar\]](#)

- Kavet, R., Zaffanella, L. E., Daigle, J. P., et al. (2000). A possible role of contact current in cancer risk associated with residential magnetic fields. *Bioelectromagnetics*. 21:538-553.

[\[Crossref\]](#), [\[PubMed\]](#), [\[Web of Science ®\]](#)

,

[\[Google Scholar\]](#)

- Milham, S., Hatfield, J., and Tell, R. (1999). Magnetic fields from steel-belted radial tires: Implications for epidemiologic studies. *Bioelectromagnetics*. 20:440-445.

[\[Crossref\]](#), [\[PubMed\]](#), [\[Web of Science ®\]](#)

,

[\[Google Scholar\]](#)

- Milham, S. and Morgan, L. L. A new electromagnetic exposure metric: high frequency voltage transients associated with increased cancer incidence in teachers in a California school. *American Journal of Industrial Medicine*. 51:579-586.