Caution, Grounding Pads and Sheets: Being Grounded Is Not Equal to Zero-Field Exposure

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Building biology home wiring systems—market with a future. However, this area is also filled with lots of charlatans who may bring this entire branch into disrepute. As an example, we will show in this article what it is about grounding pads and sheets.

"Ground the grounding pad and simply relax." In order to have such or similar advertising thrown at you, you need not go on a cheap cruise anymore these days. Internet advertising and product catalogues of bedding manufacturers bring them directly to our electropolluted homes. We are talking about grounding sheets and pads here. They are meant to ward off the dangers of electromagnetic pollution in your own bed and, at the same time, to substantially improve your sleep quality. As proof of its physical shielding effectiveness against alternating electric fields, body voltage measurements are provided. Because when a person lies on or is covered by such an electrically conductive and grounded sheet or pad, his or her body voltage—measured with reference to ground potential—is going to be greatly reduced.

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One of the manufacturers, for instance, advertises its product with the slogan "safe and secure." In the following article, we wish to take a close-up look at grounding products for beds, following the motto "critical analysis, verification, and knowing what truly is going on."

Advertising and even expert reports by an international research foundation, which are gladly provided, cite the reduction in body voltage (also referred to as capacitive coupling) as the sole criterion for the effectiveness of the grounding application. Subsequently, this reduction is directly equated with an improvement in sleep quality. Such statements make potential health-conscious customers believe that the use of a grounding sheet or pad will also help reduce the alternating electric field exposure in sleeping areas, emanating from electric installations, wiring, and devices of the electricity supply.

Interestingly enough though, while many distributors have made explicit claims about this kind of field reduction in the past, they now tend to mention the reduction in body voltage only. Have distributors and "experts" realized in the meantime that they were treading on very thin ice?

The "Crucial Difference" between Electric Voltage and Field Strength

In the following discussion, we show that the flat-out equating of a reduction in body voltage with the reduction in alternating electric field strength is not permissible and may lead to completely wrong conclusions about the "remediation" quality of a sleeping area.

Alternating electric fields are emitted from all electric wiring, cables, and appliances that have an alternating voltage applied or are energized, respectively. In the case of the common electricity supply, the alternating voltage of the outer conductor is 230 V [in Europe, and 120 V in North America] against ground potential at a frequency of 50 Hz [in Europe, and 60 Hz in North America]. Since the voltage source is connected to ground potential back at the electricity provider, the electric field spreads from an energized conductor or device towards ground potential.

This ground or earth potential—as its name implies—is at ground but also at all the electrically conductive components that are intentionally or not so intentionally connected to this ground potential. This is done intentionally, for example, when the electric wiring system of an entire building is connected to an equipotential bonding bar, which is meant to prevent the build-up of unacceptably high contact voltages. However, shielding for the reduction of ELF or RF fields must also be included in this equipotential bonding.

The strength of the electric field building up in a given space depends on

* Voltage
* Distance between energized conductor/ device (field source) and items or surfaces at ground potential (low potential terminal).

The higher the voltage, the higher the electric field strength. And the farther high potential terminal (field source) and low potential terminal are apart, the lower the electric field strength. When an electrically conductive object is moved into a field (this can be e.g. a person's body that is highly conductive due to its high water content), this object or body will couple to the electric field and establish a potential subject to its location in space or—when measuring against ground potential of the low potential terminal—a respective voltage, that is, the body voltage (Figure 1).

If the body is located close to the field source, a high body voltage will be measured. If it is, however, located close to the low potential terminal, a low body voltage will be measured.

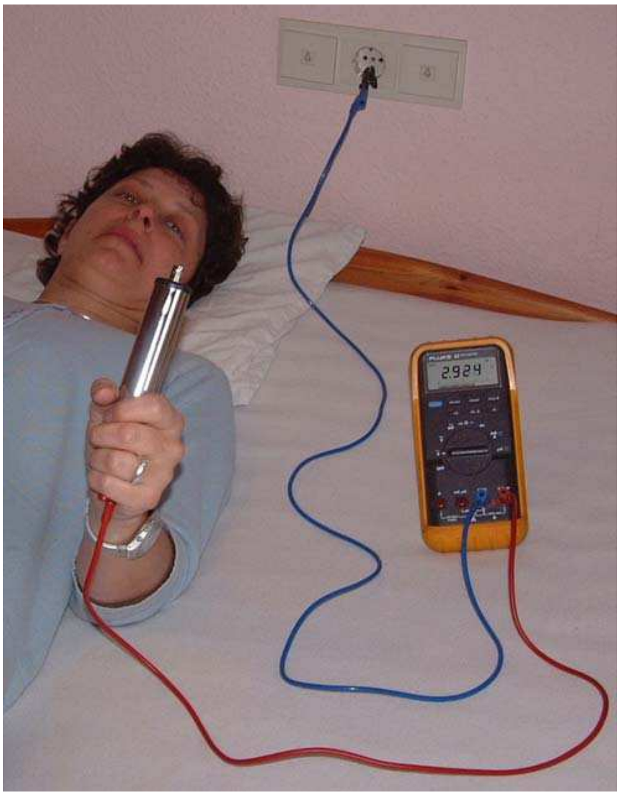

Figure 1: Body voltage testing against ground potential with a digital multimeter

Directly at the grounded surface area, the voltage reading will be zero. (For the above observations, the electric field strength was not changed.)

In the homogenous field of a plate capacitor, the electric field is the same at all points in space. The potential or voltage, however, passes through all values from zero to the maximum potential of the applied voltage, depending on the distance to the grounded plate. Generally speaking, the electric field strength represents the spatial change of the potential, that is, the potential gradient in space.

Measuring Electric Fields

The potential-free testing method is used for measuring electric field emissions that may be given off by a range of sources and whose contributing proportions and intensities are unknown. Thus the three-dimensional, isotropic field probe measures the electric field in such a way that the field itself is not influenced (Figure 2). For comparison measurements, this method accurately records both the changes in the field source (e.g. voltage increase) and changes in the low potential terminal (e.g. spatial relocation of the ground potential due to the addition of large, grounded surface areas).

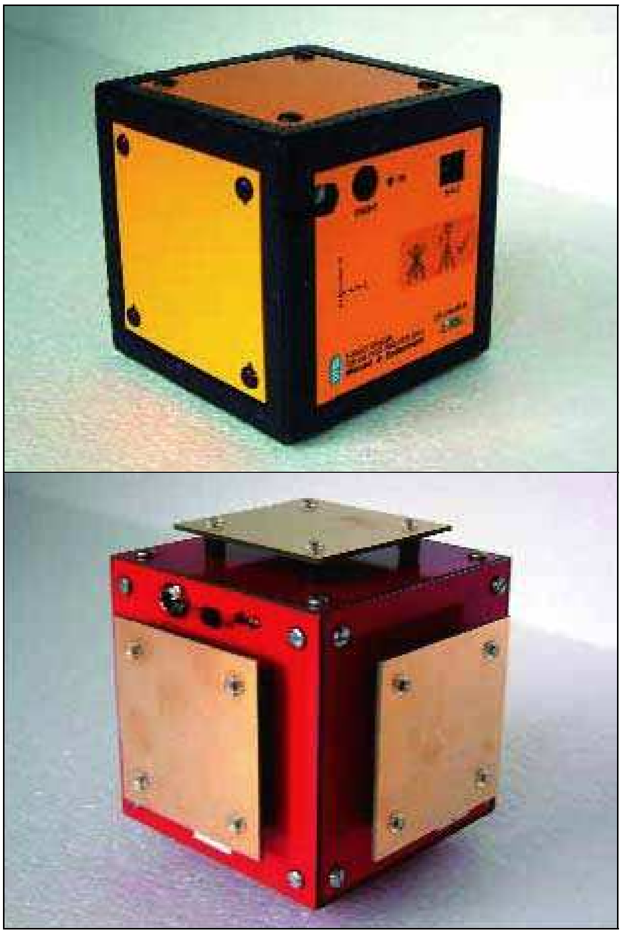

Figure 2: Potential-free, 3-D E-field probes, also referred to as "cube sensors" due to their shape; in order not to have a metal cable interfere with the electric field, the connection to the data analysis and display unit is provided by a several-meter long fiber-optic cable, thus ensuring correct measurements of the electric field in any situation

Top: Narda Safety Test Solutions
Bottom: ROM-Elektronik

In contrast, testing methods with reference to ground potential are not suited for recording changes at the low potential terminal—and that exactly because of their reference to ground potential.

Shielding Electric Fields

In order to shield against external alternating electric fields, an electrically conductive material is needed:

- Either as a complete enclosure (a so-called Faraday's cage). In this case, the inside of the "cage" is field-free—and that without any grounding.
- If the enclosure is not complete but only individual sides are shielded, the shielding surfaces need to be grounded. In this case, the electric field builds up between the source and these shielding surface areas as the low potential terminal. The space behind such a shielding surface area is field-free then, but only as long as there is no other field source in this shielded space.

Shielding Sleeping Areas

As an example, let's have a closer look at a sleeping area. Whether an electrically conductive and grounded sheet or pad does have a shielding effect or not—or whether, in some cases, the electric field strength may even actually go up—depends on the relative location of the field source (high potential terminal), person, and low potential terminal (grounded sheet/pad) to each other.

Figure 3a shows the case, in which the field source is located below the bed. Above and below the person lying in bed, an electric field strength can be measured (E_{u1} below the person, E_{o1} above the person). A digital multimeter attached to the person shows a body voltage U_{k1}, measured with reference to ground potential.

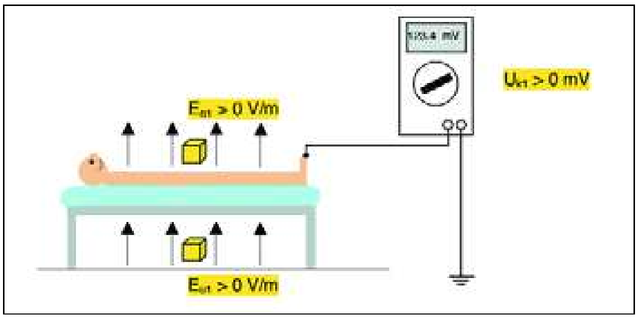

Figure 3a:
Initial situation: field source below bed

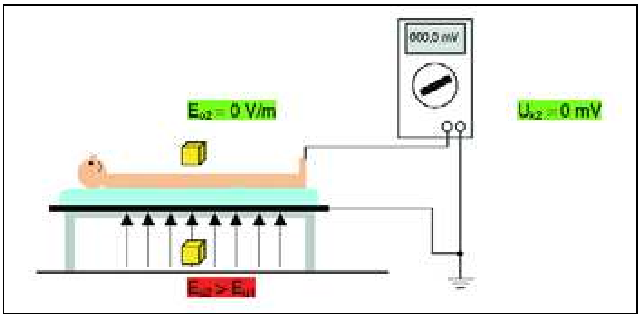

Figure 3b:
Field source below bed, grounded pad under mattress

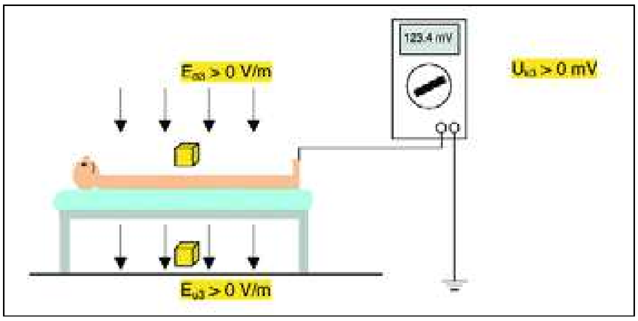

Figure 3c:
Initial situation: field source above bed

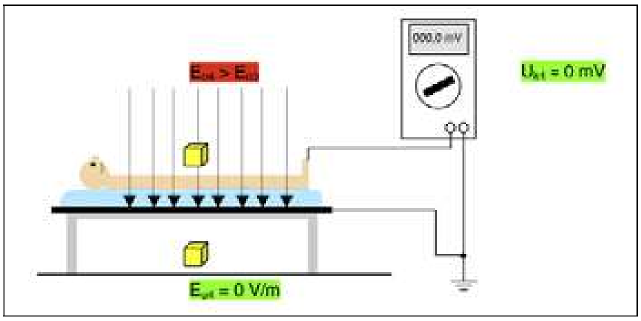

Figure 3d:
Field source above bed, grounded pad under mattress

When a conductive pad is placed under the person and grounded, as shown in figure 3b, the space above the pad including the space the person is lying in—at least theoretically—would be field-free (E_{o2} = 0). Below the pad, the field strength increases in comparison to figure 3a because the grounded pad shortens the distance between field source and ground potential. The body voltage—ideally—decreases to zero or, in real life, to a value close to zero because now the body is located in close proximity to a surface area that is at ground potential, causing the body potential to also be "pulled" toward zero. In this case, we can speak of a successful remediation as demonstrated by the measurement of the electric field strength. This statement also seems to be supported by the body voltage measurement.

In figure 3c, the field source is now located above the bed. An electric field (E_{o3} or E_{u3}) can be measured above and below the person as well as the body voltage U_{k3}.

When a "grounding pad" is again placed underneath the person, as shown in figure 3d, we realize that the "wrong side" has become shielded. The space below the bed is truly field-free now. Yet across the space where the person lies, the field strength increases! In this case, the grounding pad is contraindicated, resulting in a worsening of the field situation! A body voltage measurement, however, shows the same result as in figure 3b since it will only respond to the potential, which is the same in both cases.

Conclusion

When grounding sheets or pads are used simply on a hunch—without taking actual measurements of the existing field situation with an appropriate testing method— there is a high likelihood of not improving the situation but making it worse and increasing the field exposure in the sleeping area.

Body voltage testing, including any other type of testing method that works with a ground reference, is not suitable for correctly monitoring changes in field strength due to introducing grounded conductive surface areas to the field. Whenever such testing methods are applied to the above-discussed field situation, this is regarded as a serious professional blunder. The decrease in body voltage does not necessarily indicate a decrease in the electric field strength.

What is more, the use of an electrically conductive and grounded sheet or pad may actually pose a considerable risk to the person lying in bed. Thus in the event of a broken PEN conductor (PEN: combined protective earth (PE) and neutral (N) conductor), a fatal contact voltage may develop in an outdated power system (TN-C system, two-prong outlet) when the person lying in bed makes simultaneous contact with both the grounding pad and a metal fixture of e.g. a bedside lamp, which is connected to the protective earth via the power cord (protection class I, protective grounding of metal casings). This is another reason why any customer should think twice about installing grounding pads.

Only qualified electricians are allowed to install grounding for any type of shielding. Because of the potentially substantial risks involved, the electric wiring system should certainly be equipped with a ground fault circuit interruption system (trigger currents 5 mA in USA/ Canada, 30 mA in other countries).

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