HARDWARE HACKER

VGA adapter for the Mac LC, computer monitors, flyback, shielding, and GPS navigation resources.

DON LANCASTER

It seems I did miss an obvious source in our recent *Tesla and High Energy Resources* sidebar. This is the *Tesla Society* up in Colorado, who runs a great museum and now offers annual Tesla and nontraditional energy conferences. Their *High Energy Enterprises* division has lots of books and videotapes.

These range the gamut from hard-to-find and genuinely useful research materials on down (*way* on down) through bunches of "Boy-a-whole-flock-of-them-flew-over-that-time!" pseudoscience titles.

On the other hand, if you are into antigravity, the 1000 miles per gallon carburetors, Russian weather control conspiracies, *Reed* motors, all those pangalactic happy faces on Mars, or zero point scalar energy, these books and videos are definitely for you. This is *most* fascinating reading and watching, either way.

Actually, I'll freely admit that I firmly now believe in one trilateral conspiracy. That's the one involving the first, second, and third laws of thermodynamics. But that's just me. And if you want to prove me wrong, just show to me any simple and independently verifiable experiment that anyone can reliably duplicate.

Some more info on wavelets: The *Wavelets* book offered by *Jones and Bartlett* is at long last in print. And a major new tutorial just came out in the October 1991 IEEE-SP *Signal Processing* magazine on pages 14–38.

Shields and shielding

These have been popular topics lately on our helpline, so perhaps it is time to go over some fundamentals. You can *shield* something electronic either to keep objectionable signals from getting out or getting in. For instance, on any light dimmer, you might want to suppress the horrible AM radio interference caused by a triac suddenly turning on. On a low-level audio circuit, you might want to prevent power-line hum and noise from getting to you.

If you do know ahead of time that you're going to have interfering noise or signals present, one very powerful technique is to change over to fully *balanced* circuits. They sense only the *differences* between their inputs, rather than any absolute values with respect to ground. Thus, any *common mode* interfering signals that bounce both inputs up and down together will automatically be rejected. Or at least suppressed. Several fancy audio studios have even gone to totally balanced power lines to dramatically reduce their hum and noise problems.

There are usually two paths that interference can travel. One is with *radiated* energy, which can propagate directly through space to emit from or interact with your circuit. The other is *conducted* energy, which enters along your power connectors and input or output cables.

Since separate tricks are needed to deal with any radiated or conducted energy, step one is finding out *which* path is the one you will want to deal with first.

The radiated energy interference will usually have two components. They are that "E" or *electric* field, which largely concerns itself with induced *voltages* and that "H" or *magnetic* field, which creates induced *currents*. Once again, you have to know *which* field component you are going to suppress before you pick a proper method.

Any old conductor should usually block an E field. One obvious hacker choice that works well are boxes built up out of double-sided printed-circuit board. See Fig. 1.

But there are gotchas. At lower frequencies, there is the lack of a well-developed *skin effect*, which causes an E field to penetrate *deeper* into a conductor. Thus, *thicker* shields are needed to suppress *lower* frequencies. Say 20 mils for an AM broadcast band use or 80 mils for the high ultrasonic frequencies.

A shield can also act as a shorted turn to any nearby inductor, possibly lowering the Q and detuning. A slot or other continuity break can sometimes help this problem.

While some small shield holes are often tolerable, any poor contacts are definitely not. A continuous solder bead or else lots and lots of individual screws may be needed for really high shielding effectiveness.

It's very important that unintended currents don't ever run through any shields. Unwanted signal drops can often end up in *series* with your input signals, making things much worse rather than better. Which is also why you should keep all your digital and analog grounds separate.

The H fields can be blocked by use of any strongly magnetic materials. These materials are said to have a very high *permeability*. The simplest magnetic shield is a piece of scrap sheet steel from the air conditioning shop or trailer hitch works. But things get messy in a hurry if you need lots of magnetic attenuation.

Those special and fancy shielding materials are optimum only in certain thicknesses and over a specific frequency range. Worse yet, some of these cannot be cut or drilled without a complex reannealing process. And

NEED HELP?

Phone or write your **Hardware Hacker** questions directly to:

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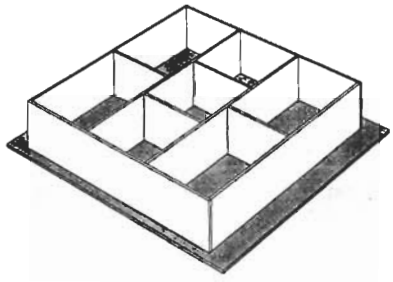

FIG. 1—SIMPLE E-FIELD SHIELDS for radio-frequency hacker projects are easily built up from pieces of double-sided printed circuit board stock.

too strong of a magnetic field could *saturate* a shield, making it useless.

To be effective, a magnetic shield should completely surround the volume it is protecting.

A good free booklet on all of the fundamentals of magnetic shielding is available from *Amuneal*, while other sources of custom shield materials now include *Advance Magnetics* and *Magnetic Shield Corp.*

Conducted interference can be best eliminated by some blocking filter. These filters should freely pass the signals of interest, but present a high series impedance and a low shunt impedance to all others. *Murata-Erie* is one good source.

The *ferrite bead* is a remarkably cheap and super effective interference suppressor. As Fig. 2 shows us, you simply hang them on a wire or else run a turn or two through them. Ferrite beads act as a broadband high-frequency lossy transformer. There are various materials and sizes, again depending on frequency. Sources of ferrite beads include *Fair-Rite*, *FerriShield*, *Ferroxcube*, *Intermark*, and *Siemens*.

One *very* little known ferrite bead gotcha: Do *not* ever cast a ferrite bead in epoxy or otherwise constrain it so it cannot move. The beads *must* be able to physically change their size slightly, or else the performance will sharply degrade.

Two trade journals that involve themselves with shields and shielding are *Electronics Test* and *Compliance Engineering*.

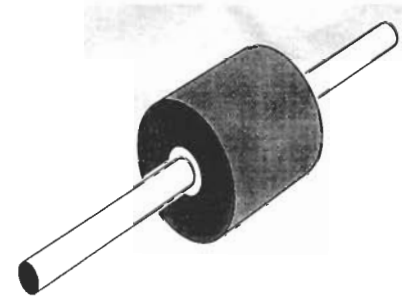

FIG. 2—FERRITE BEAD interference suppressors are simply slipped onto any conductor. The ferrite beads behave as lossy and broadband high-frequency transformers. Multiple turns can also be used.

GPS RESOURCES

Ashtech
390 Potrero Avenue
Sunnyvale, CA 94086
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CIRCLE 301 ON FREE INFORMATION CARD

Bancomm
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San Jose, CA 95119
(408) 578-4161
CIRCLE 302 ON FREE INFORMATION CARD

GPS World
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Eugene, OR 97440
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CIRCLE 303 ON FREE INFORMATION CARD

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960 Overland Court
San Dimas, CA 91773
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CIRCLE 307 ON FREE INFORMATION CARD

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(800) TRI-MBLE
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Wallkill, NY 12589
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Steve Hansen
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Jones & Bartlett
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Magnetic Shield Corp
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Bensenville, IL 60106
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Management Roundtable
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Brooklyn, NY 11235
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Smyrna, GA 30080
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Santa Clara, CA 95054
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