

Don Lancaster's

# RESOURCE BIN

number forty six

## New opportunities in power electronics.

**O**ur usual reminder here that the *Resource Bin* is now a two-way column. You can get tech help, consultant referrals and off-the-wall networking on nearly any electronic, *tinaja* questing, personal publishing, money machine, or computer topic by calling me at (520) 428-4073 weekdays 8-5 Mountain Standard Time.

US callers only, please.

I'm now in the process of setting up my new *Guru's Lair* web site you will find at (where else?) [www.tinaja.com](http://www.tinaja.com) This is the place you go for instant tech answers. Among the many files in our library, you will find complete reprint sets for all of the *Resource Bin* and other columns. Plus a brand new [Synergetics Consultant's Newtwork](#) & lots of links to unique web sites.

You will get the best results if you have both [Netscape Gold](#) and [Acrobat Reader 3.0](#) installed. This new reader does utterly amazing things online.

### Power Electronics

This month, I thought we'd take a look at a few new power electronics resources. All of a sudden, this rather staid and arcane field is exploding. Mostly thanks to several brand new tools, devices, and techniques. Many of which are easily explored by you individuals and tech startups.

So, there are now lots of brand new opportunities here.

Let us first look at a few exciting new developments you could directly profit from. Then we'll round out our survey with a look at those older and more traditional power resources.

### Magic Sinewaves

Electric cars, off-grid solar panels, induction motor speed controls, and home energy efficiency improvers all share a common problem: Cheaply, simply, and efficiently generate low distortion power sinewaves. Waves of carefully controlled amplitude and of

a precisely controlled frequency.

Usually, you will start off with a four-switch beastie called an *H-Bridge Drive*. The object of the game is to flip your four switches just so, creating a sinewave output. For best efficiency, you'll want to flip the switches as few times as possible per cycle. And you'd also like to consistently flip only *half* of the switches at once. For a further efficiency doubling.

There is a brand new game in town I like to call *Magic Sinewaves*. Magic Sinewaves are very long sequences of carefully selected repeating ones and zeros. They easily give you bunches of high quality sinewaves of most any amplitude and frequency.

Magic sinewaves whose harmonics can be forced to zero. Or else held to amazingly low values.

To use your magic sinewave, you simply stash a listing of them in a dollar PIC or another cheap micro. For level #85, you grab sequence #85 and shove it out one or more ports. Your delay between bits sets the frequency.

**NEXT MONTH: Don looks at several oddball and unusual phone and comm resources.**

Single, two, or three phase. Per your choice. It's all that easy.

Compared to the industry standard PWM (pulse width modulation) way of doing things, the magic sinewaves offer far less high frequency losses. Ridiculously so. As much as a 25:1 or higher improvement!

Heatsinks can be much smaller and all your power drivers much cheaper. Integration, offsets, nonlinearities, and noise totally vanish.

Magic sinewaves seem brand new because they've traditionally been so excruciatingly hard to find. At least before some brand new tools became

available. A typical magic sinewave is 384 bits long. There are more magic sinewaves than there are atoms in the solar system. So, finding them used to be worse than finding a needle in a multi-dimensional universe chock full of humongous haystacks.

A ferinstance: Hex \$1006 070E 1F87 FE3F FF7F FFFF is one quadrant of a 384-bit magic sinewave. This outputs 97.8% of your supply voltage. With a reasonable filter, your *total* harmonic distortion 3-17 is an astounding 0.031 percent! Even when *totally unfiltered*, the same sequence offers a negligible third harmonic of only 0.0065% and a fifth way on down at 0.0261%.

I'll call this one the Mother of all magic sinewaves. Well, at least this week. Better ones are arriving daily. The brothers and sisters in this series will give you 128 or more uniformly spaced amplitudes from zero to your full supply voltage.

I will be happy to mail you a free tutorial on magic sinewaves.

My [tinaja.com](http://tinaja.com) is the center of the universe for magic sinewave concept development. By myself, from math genius Jim Fitzsimons, and by other leading edge researchers. Start with that MAGSINT.PDF tutorial. Then go on to the dozens of other files. Just search under "magic".

Custom consulting, a co-developer program, sine analysis & synthesis, source code, and ready-to-run chips are all available. Call or write me for more info on this multi-million dollar opportunity. Or use my email address from the end blurb.

### Car Alternator Steppers

The price of power stepper motors is dropping. There certainly are lots of bargains right here in *Nuts & Volts*. But scant few people realize that a car alternator can be converted into a fair to middlin' power stepper at very low cost. And local availability.

That very same alternator can also become a switched reluctance motor or a servo. Generally what you do is dc power the rotor, converting it into a "permanent" magnet. You will then sequence your stator coils to create a stepper. Or apply suitable sinewaves for a switched reluctance drive.

Uh, a "three phase" stepper motor may seem a little weird, compared to those usual 2-phase and 4-phase ones.

But it works like a champ.

You will get best results by using a current drive scheme. Details on this in most stepper drive ap notes.

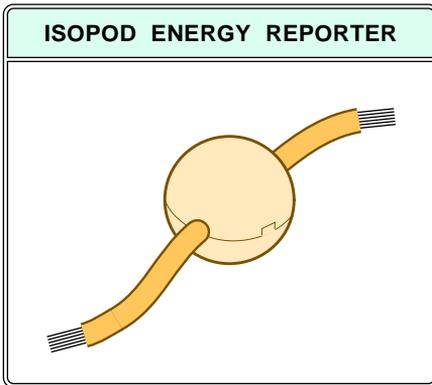
*John Rees* markets an outstanding self-produced video on converting car alternators into power steppers. He also takes you step-by-step through building a humongous programmable sign router using car alternators for three axis control.

Additional details on car alternator steppers are shown in NUTS34.PDF, HACK47.PDF, and EMERGOP3.PDF.

### Isopod Current Monitors

Home energy efficiency starts with knowing exactly how much ac power gets used for what. But measuring the main and branch ac currents can end up a horrible mess. Involving safety regs, electricians, and rewiring.

Here's a little gadget that I've got an in-house research project going on. I like to call it the...



The isopod snaps onto one of your incoming power lines right at your weatherhead. This is basically a self-powered current transformer and a short range transmitter.

The simplest version transmits a digital signal burst every now and then. One that identifies the Isopod, your current zero crossing, and how much current is being consumed.

A nearby receiver gathers in the digital current burst and routes it to a microcontroller, modem, or personal computer. A local line reference gives the voltage. By comparing the phase

angle of your current zero crossings against the voltage, both the real and reactive power can be found.

Other isopods can be snapped onto branch circuits or even made part of individual appliances. One place they should be super handy is for fixing air conditioning intermittents. A fancier unit could include a receiver so they speak only when spoken to.

For full home energy management, dozens of Isopods could be spotted in appropriate places. Leading to greatly reduced home electric bills.

More on Isopods in NUTS34.PDF, HACK47.PDF, and EMERGOP3.PDF on *tinaja.com*. Hard copy reprints and custom consulting is also available.

### PostScript Robotics

I sure get an amazing number of helpline callers wanting to build their own two-axis or three-axis robotic systems. For everything from printed circuit drills to milling machines, to embroidery setups, animation stages, and silk screen cutters.

Regardless of what these do, I like to call them *flutterwumpers*. Well, a flutterwumper moves something that chops or spits against a piece being worked. Under computer control.

As I may have mentioned once or thrice before, there is this general purpose computer language known as *PostScript*. PostScript is *absolutely ideal* for *all* flutterwumpers. Because of the ease with which it can handle graceful curves and typography.

Usually, you'll apply a two-step process. You use a PostScript printer or GhostScript shareware on a PC to generate your artwork and curves or such. Bring the full power of all the world's fonts, Illustrator, Acrobat, Photoshop, scads of CD-ROM clip art, and lots more to the table.

Your printer or your program then generates an output text file in a very simple control language. One which ridiculously minimizes all the smarts needed by your actual flutterwumper. While you could use *Gerber* format or the HPGL graphics language for the output, all you'll often really need is simple serial commands. Such as "U" for up and "D" for down. Or "N" for North and "S" for South.

All of which lets you reduce your flutterwumper intelligence down to a one dollar microcontroller. That new *Basic Stamp* from *Parallax* is ideal for this sort of thing. For higher speed and performance, you can step up to those *Scott Edwards PIC Tools*. Or use

## POWER ELECTRONICS RESOURCES

<b>Adobe PostScript</b> PO Box 7900 Mountain View CA 94039 (800) 833-6687	<b>C&amp;H Sales</b> PO Box 5356 Pasadena CA 91107 (800) 325-9465	<b>Grainger</b> 2738 Fullton St Chicago IL 60612 (312) 638-0536	<b>Measurement &amp; Control</b> 2994 W. Liberty Avenue Pittsburgh PA 15216 (412) 343-9666	<b>PCIM</b> 2472 Eastman Ave #33-34 Ventura CA 93003 (805) 658-0933	<b>Scott Edwards</b> 964 Cactus Wren Lane Sierra Vista, AZ, 85635 (520) 459-4802
<b>Allegro Micro Systems</b> Box 15036 Worcester MA 01605 (508) 853-5000	<b>Dialog Information Svcs</b> 3460 Hillview Avenue Palo Alto CA 94304 (415) 858-2700	<b>Harris Semiconductor</b> Box 883 Melbourne FL 32902 (407) 724-7000	<b>Motion Control</b> 800 Roosevelt Road E408 Glen Ellyn IL 60137 (708) 469-3373	<b>Power Transmission Design</b> 1100 Superior Avenue Cleveland OH 44114 (216) 696-7648	<b>SGS-Thomson</b> 1000 East Bell Road Phoenix AZ 85022 (602) 867-6259
<b>American Science &amp; Surplus</b> 3605 Howard Street Skokie IL 60076 (708) 982-0870	<b>Jim DuBois</b> 330 State Road 101 Amherst NH 03031 (603) 673-3645	<b>Herbach &amp; Rademan</b> 401 East Erie Avenue Philadelphia PA 19134 (215) 426-1700	<b>Motion Magazine</b> Box 6430 Orange CA 92613 (714) 974-0200	<b>Powerex</b> Hillis Street Youngwood PA 15697 (412) 925-7272	<b>Siliconix</b> 2201 Laurelwood Road Santa Clara CA 95054 (800) 554-5565
<b>Analog Devices</b> PO Box 9106 Norwood MA 02062 (617) 329-4700	<b>Edmund Scientific</b> 101 E. Gloucester Pike Barrington NJ 08007 (609) 573-6250	<b>IEEE Power Electronics</b> 445 Hoes Lane Piscataway NJ 08855 (908) 981-0060	<b>Motor Techniques</b> 120 S. Chaparral Court #200 Anaheim CA 92808 (714) 283-1123	<b>PowerTechniques</b> 120 S. Chaparral Ct #200 Anaheim CA 92808 (714) 283-1123	<b>Small Parts</b> PO Box 4650 Miami Lakes FL 33014 (800) 220-4242
<b>Appliance</b> 1110 Jorie Blvd CS 9019 Oak Brook IL 60522 (708) 990-3484	<b>EPRI Journal</b> PO Box 10412 Palo Alto CA 94303 (415) 855-2000	<b>International Rectifier</b> 233 Kansas Street El Segundo CA 90245 (310) 322-3331	<b>Motorola</b> 5005 East McDowell Road Phoenix AZ 85008 (800) 521-6274	<b>Radio Research Insts</b> 584 N Main St Waterbury CT 06704 (203) 753-5840	<b>Surplus Traders</b> PO Box 276 Alburt VT 05440 (514) 739-9328
<b>Appliance Manufacturer</b> 29100 Aurora Road #200 Solon OH 44139 (216) 349-3060	<b>Fair Radio Sales</b> PO Box 1105 Lima OH 45802 (419) 227-6573	<b>Linear Technology</b> 1630 McCarthy Blvd Milpitas CA 95035 (408) 432-1900	<b>National Semiconductor</b> 2900 Semiconductor Road Santa Clara CA 95052 (800) 272-9959	<b>John Rees</b> Rt 1 Box 1551 Sautee GA 30571 (706) 865-5495	<b>Synergetics</b> Box 809 Thatcher AZ 85552 (520) 428-4073
<b>AST Servo Systems</b> 115 Main Road Box 97 Montville NJ 07045 (201) 335-1007	<b>Galco</b> 26010 Pinehurst Drive Madison Heights MI 48071 (800) 521-1615	<b>Maxim</b> 120 San Gabriel Drive Sunnyvale CA 94086 (800) 998-8800	<b>Northern Hydraulics</b> PO Box 1499 Burnsville MN 55337 (800) 533-5545	<b>SAE</b> 400 Commonwealth Drive Warrendale PA 15096 (412) 776-4841	<b>Texas Instruments</b> PO Box 809066 Dallas TX 75380 (800) 336-5236
<b>Burdens Surplus Center</b> PO Box 82209 Lincoln NE 68501 (800) 488-3407	<b>GEnie</b> 401 N. Washington Street Rockville MD 20850 (800) 638-9636	<b>McMaster-Carr</b> Box 54960 Los Angeles CA 90054 (213) 692-5911	<b>Parallax</b> 3805 Atherton Road #102 Rocklin, CA 95765 (916) 624-8333	<b>Sensors</b> 174 Concord St Peterborough NH 03458 (603) 924-9631	<b>Ulrichs Dictionary</b> 121 Chanlon Road New Providence NJ 07974 (908) 771-7714

any of the fine applications info from *MicroChip Technology*.

Fundamentals of PostScript appear in *STARTUP.PDF* and *SPEEDUP.PDF*. For more info on flutterwumpers, see *FLUTWUMP.PDF*, *FLUTOOLS.PDF*, or else *NUTS19.PDF*.

### New Integrated Circuits

Prices of power semiconductors are dropping dramatically. We are also seeing the low level circuits combined on-chip with the power output stages for further economics.

Newer power MOS transistors are now cheap to buy and easy to use. They are vastly easier to drive than an older bipolars or Darlington. Besides being less likely to blow up.

One neat trick with some power MOSFETs: It's a simple matter to put 10,000 identical MOS transistors on the same chip. You use 9999 of these for your main load circuit. And then take the last one and sense your current through it. This current will be 100 microamps *per amp* of load current. All of which can give you a "lossless" current sensor. One which requires nothing in series with the bulk of the main load current.

*National Semiconductor* has free samples of their LMD18245 H-Bridge Driver. Besides their lossless current sensing, this includes a current drive (for higher speeds and more power), and the ability to power down to one of sixteen levels. Forward or reverse. Easily driven from any micro.

Full details on this low cost power stepper driver in *MUSE93.PDF*.

*Texas Instruments* also has several interesting *Power+Arrays* chips. These work well as drivers or predrivers for alternator steppers.

Other places to search for power electronic solutions do include *Maxim*, *Linear Technology*, *Siliconx*, *Motorola*, *Analog Devices*, *Allegro*, *SGS*, *Harris*, and *International Rectifier*.

The really big power semis (such as those used for locomotives) are made by supply houses that keep changing their names. For instance, that old Westinghouse operation is now called *Powerex*. Check out their *Applications and Technical Data Book* on their new *Intellimod* power modules.

### Surplus Bargains

I recently discovered *Jim DuBois*, an incredibly great new source for lots of stepper motors, rotary tables, gantrys,

drivers, precision stages, and such. Apparently Jim visits the failing New England aerospace firms, scooping up these gems when and as found.

An example: A complete X-Y table including steppers for around \$100. A tiny fraction of the initial cost. Jim has a free flyer available on request.

Needless to say, you should also be on a first paw basis with your local junkyard dog. Share a bowl of Purina every now and then. Or maybe even a rawhide chew.

And tune yourself into both the local and statewide auction scene.

My favorite older surplus source for big mutha iron is *C&H Sales*. AC and DC motors, steppers, hydraulics, pneumatics, and the bits and pieces needed to put it all together. Most at very good prices.

Other sources for the heavy stuff do include *Burden's Surplus Center* and *Northern Hydraulics*.

Two other lighter favorites are *Fair Radio Sales* for military electronics, and *American Science & Surplus* for lots of oddball smaller items.

Rounding out the surplus scene is *Edmund Scientific*, *Herbach & Rademan*, *Surplus Traders*, *Radio Research*, and the rather pricey *AST Servo Sales*.

Much more on surplus sources in NUTS06.PDF on [www.tinaja.com](http://www.tinaja.com)

### Grainger and Galco

The most obvious source for nearly anything electrical is *W.W. Grainger*. Who have outlets in most larger cities. Grainger is especially big on electric motors and pumps. Plus a stunning variety of light bulbs and fixtures. A large catalog is available.

For more info on lamp and lighting resources, see MUSE95.PDF.

The leading distributor of old line power electronics components is the little known supplier by the name of *Galco*. They do publish a free *Galco Gazette*, besides offering a fat catalog to potential volume customers.

Two other firms anyone in power electronics has to know about: *Small Parts* has everything your hardware store has never heard of. They sell in small quantities at reasonable prices. They are the greatest robotics source anytime ever. They'll also custom cut metal and plastics for you.

Good old *McMaster-Carr* is sort of a universal industrial hardware source. Their distinctive yellow catalogs can be found industry wide.

### PCIM

The leading power electronics trade journal seems to be *PCIM*, formerly *Power Control and Intelligent Motion*. It is free to qualified subscribers. Their competitors are *Motion* and *Motion Control*. Also try *MotorTechniques* and *PowerTechniques*. But these two may have recently folded.

Meanwhile, Penton has just come up with the brand new and somewhat misnamed *Power Transmission Design* magazine. This one also centers itself on motion control subjects. Your two finest classic mechanical design trade journals, of course, remain *Machine Design* and *Design News*.

The IEEE has scads of publications that at least touch upon power. Their *IEEE Transactions on Power Electronics* is the biggie. But other Transactions to check are Automatic Control, Energy Conversion, the Industrial Electronics, Power Devices, Industry Aps, Robots & Automation, and Vehicular Tech.

Two other organizations to check are the *Electric Power Research Institute* and *SAE*. The car folks.

There's lots of other trade journals I have found rather useful for power electronics. *Appliance* and *Appliance Manufacturer*, ferinstance. Or, at the other end of the problem, *Sensors* or

### Measurement & Control.

I didn't get much of a chance to check those power electronics online resources by column deadline time. Mostly because Magic Sinewaves are so obsessive that I've been spending as much as twenty hours a day on them. Just barely squeaking by on column deadlines. But *Gopher* and the usual CD directory search services can lead you to useful sites.

As usual, you can find out anything about anything by using the *Dialog Information Service*. Found on *GENie*, elsewhere on line, or by way of your local library. Your best info source for insider magazines is *Ulrichs*.

### Home Power

Of the hobby or newsstand mags *Home Power* is really coming on strong with homebrew power electronics. Particular for alternate energy, solar and wind power, and especially home built electric cars.

And, of course, you'll start seeing more and more higher power projects right here in our *Nuts & Volts*. Also be sure to check out *Electronics Now* and *Circuit Cellar*.

### This Month's Contest

For our contest this month, just tell me about any new or unusual power electronics resource which I do not already know about. Especially tune me into any useful online sites.

There will be a largish pile of my new *Incredible Secret Money Machine II* books going to the dozen or so better entries, plus an all-expense-paid (FOB Thatcher, AZ) *tinaja quest* for two that will go to the very best of all

Let's hear from you. ♦

---

*Microcomputer pioneer and guru Don Lancaster is the author of 33 books and countless tech articles. Don maintains his no-charge US tech helpline found at (520) 428-4073, besides offering all of his own books, reprints, and consulting services. Don also has two free catalogs full of his resource secrets waiting for you. Your best calling times are 8-5 on weekdays, Mountain Standard Time.*

*Funding and time constraints restrict this helpline service to US callers only.*

*Don is in the process of setting up his Guru's Lair at <http://www.tinaja.com>*

*Full reprints and preprints of all Don's columns and ongoing tech support appear here. You can reach Don at Synergetics, Box 809, Thatcher, AZ 85552. Or send any messages to his US Internet address of [don@tinaja.com](mailto:don@tinaja.com)*