Don Lancaster's

Tech Musings

October, 1995

More on magic sinewaves
Stepper motor driver chips
Another patent horror story
Mid-range Mensch computer
PCMCIA plug-in card resources

I just got yet another letter from somebody trying to "protect" the "idea" they have "invented" by getting a patent. As is typical nearly 100 percent of the time, their idea simply was not worth protecting. Their product has been available off the shelf from a high profile major supplier for several decades.

Yet they never heard of the leading company in the field! Nor the trade journals involved. Nor did they do an economic analysis of who would buy their product how. Or check into the excessive regulations in their target market. They also did not pick up on the fact that lots of potential buyers would prefer a zero cost all-software solution instead.

The patent, if issued, could end up totally worthless. First, their concept involves a completely obvious safety lockout device. Forgetting that you could buy one off the shelf, there are *centuries* of prior art involved. Not to mention being completely obvious to any practitioner in the field. Almost certainly, hundreds of other patents would encroach on the claims.

And it's not in the least clear what purpose their patent would serve once they actually got one. It would in no manner offer any "protection".

Urban lore appears to confuse the words "patent" and "product". These two are *totally* unrelated.

A *patent* is a sheet of paper which gives you the right to sue someone. Like a stock option, it is worthless unless exercised. A *product* is the useful item that goes out the door and makes a profit for you.

Patents have nothing whatsoever to do with today's successful product development! In any way, shape, or form. Most often, they are a totally unneeded sideshow. *Guaranteed* to cost you time, money, and sanity.

At least for most individuals and smaller startups the overwhelming majority of the time.

Do not even *think* about a patent unless you're (a) a long term industry insider person who is (b) aggressively subscribing to *all* the relevant trade journals, shows, and technical pubs, and who (c) has *thoroughly* done all their homework, generating (d) full production artwork and real working models currently in an advanced beta test of (e) a *genuinely* and *stunningly* **new** product that has a (f) gross sales potential of at least $12,000,000.00.

Actually that twelve mil figure is sorta low. That's only the theoretical breakeven. It is based solely on what percentage of final profits you are going to spend subsidizing attorneys and the patent system. The level at which a patent *may* start to overcome all of the hassles involved is more like a gross of forty million.

Trying to patent any million dollar idea is, of course, ludicrously insane.

In all my many years of running a helpline and developing hundreds of real-world products, *not once* have I *ever* found *any* individual or smaller startup that has genuinely profited from the patent system.

Yet I have thousands of examples of individuals very badly done in by patents. Even murdered by them in heart-attack-during-litigation cases. Putting my money where my mouth

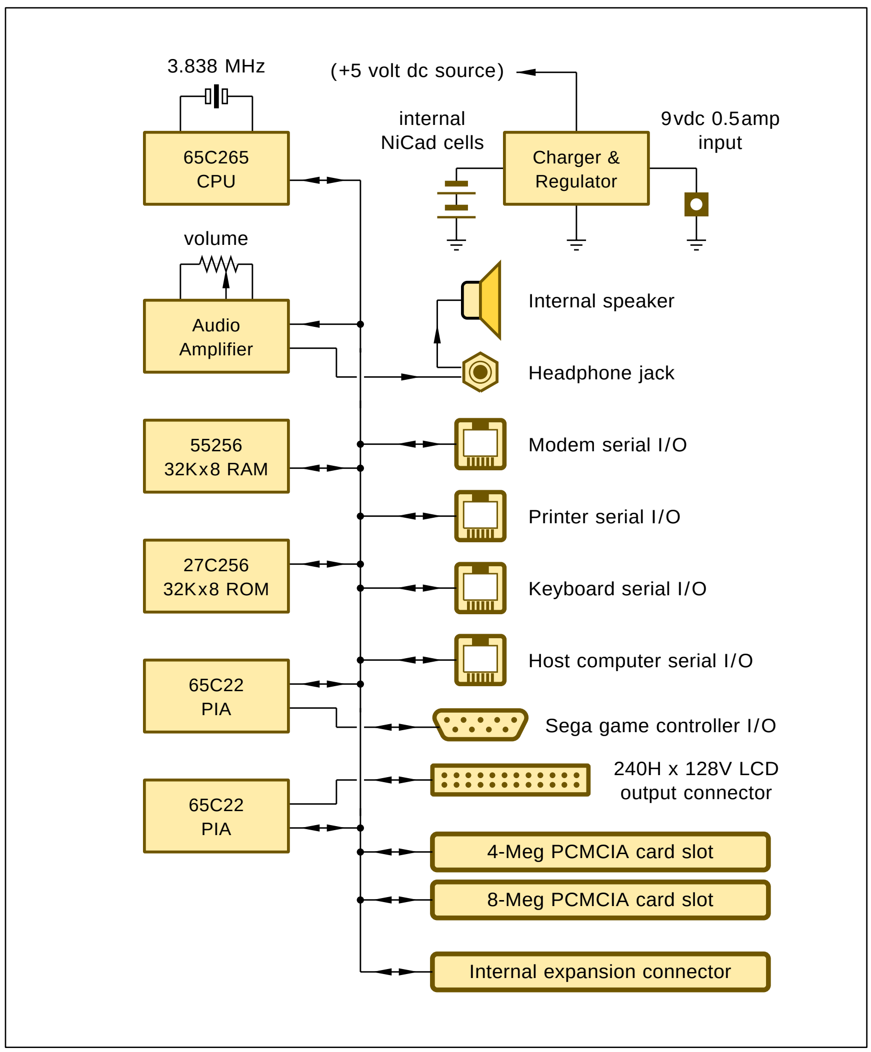

Fig. 1 – INTERNAL ARRANGEMENT of the Mensch Computer. This one is easily customized for a wide variety of mid-range needs.

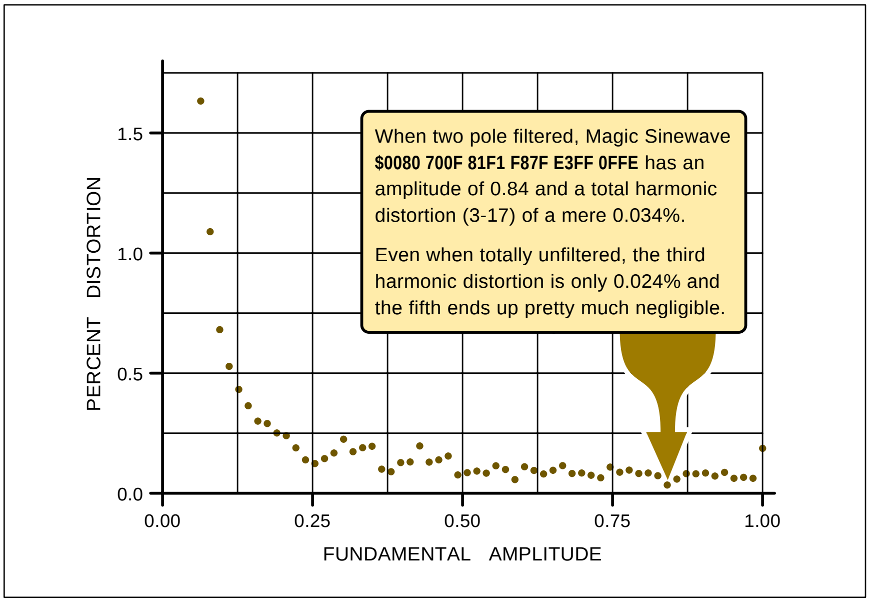

Fig. 2 – SOME PRELIMINARY 384-BIT MAGIC SINEWAVES which combine high efficiency and really low harmonic distortion.

is, a free ISMM II if you can find me *any* exception.

For a check list of when patents and patenting *may* make sense, look at WHEN2PAT.PDF you will find on *www.tinaja.com* For lots of working and proven real world alternatives, pick up my *Case Against Patents*.

The Mensch Computer

What do you use when the BASIC Stamp is too wimpy and a laptop PC is clearly gross overkill? There's lots of emerging uses for a no-nonsense and easily customized experimenter's mid-range computer. Especially one that can be battery powered.

Enter that new *Mensch Computer* from *Western Design Center*. Sort of a reincarnated *AIM-65* with touches of *KIM-1* and *Apple IIGS* thrown in.

Figure one shows details.

The computer itself is a sturdy 1-1/2 by 7-1/2 by 10 inch block. Three pounds worth. Most of the weight is from the rechargible battery. There's four telephone-style serial ports. For keyboard, printer, modem, and a host PC programming link.

Two PCMCIA card slots might get used for additional memory, as data recorders, for floppy disk substitutes, modems, or even a GPS receiver.

A game paddle port for the *Sega* compatible six-button arcade pad. An internal speaker, volume control, and headphone jack. A 20-pin connector for the removable stand-alone LCD text and graphics display.

There are no parallel ports as such, but you could easily use the PCMCIA slots for data acquisition, industrial control, or CAD/CAM. An expansion connector is also provided.

The Sega I/O is reprogrammable. So, there's lot of ways to pick up a few extra data lines.

The black and white LCD display provides a 240 H by 128 V resolution. Which is enough for fairly interesting graphics or 16 lines of 40 characters each. With some sneakiness, you can extend this to 21 lines of 60 smaller characters. Or mix the two.

One recommended keyboard is the *Spacemate* by *Key Tronic*. Full size and 85 keys, but no numeric keypad.

Any serial comm keyboard or keypad could be used instead.

Any old stock 12 volt, 0.5 amp ac supply adaptor provides power. An "adding machine" thermal printer is an extra cost option.

No video, color, floppies, or hard drives. Purposely.

The 16-bit CPU is a 65C265, a 6502 descendant having a 16 meg address space having exceptionally powerful addressing modes. Also internal to the computer is 32K of EPROM and 32K of system RAM. Up to 12 megs of additional memory can be picked up in the PCMCIA slots.

The rest of the internal circuit is mostly two parallel interface chips. Plus the usual "glue" items such as a speaker amplifier, charger, regulator, and a low batt detector.

Battery use is optional. There's an automatic recharge every time you plug the Mensch into the wall.

The micropower CPU firmware has several battery saving modes. Battery life is mostly set by the display activity and the peripherals.

Development work is easiest done using assembly tools already in place for the *Apple IIGS*. Development by cross-porting from a PC is possible. Fairly extensive subroutine libraries are built into the firmware.

The quantity pricing for the Mench computer by itself is well under $200. The computer lists for $365. Or $895 including display and keyboard.

Western Design Center has a very aggressive developer program. They definitely welcome your designs and suggestions. Free literature packages are available.

Be sure to give them a call.

1. Pick the number of bits per word. 384 is often a good choice.
2. Pick an amplitude *n* based on the number of ones per word.
3. Pick a desired number of efficiency-setting transitions.
4. Calculate the number of clumps *k*. This is *one-half* the number of transitions for even solutions.
5. Generate a list of all possible sums of *k* integers that total *n*.
6. For each entry on the list, fit it to a *n(1-sine)* function. Then select the one with the lowest classic Fourier series distortion.
7. Optionally "anneal" the final clumps by jittering their positions.
8. Compile and plot the results.

Fig. 3 – THE ALGORITHM that I'm now using to find magic sinewaves.

This Month's Contest

I am not sure exactly what I'll be doing with my Mench computer just yet. Improving my helpline data base (now mostly a humongous notebook), serving my *Synergetics Consultant's Network* service, finding new magic sinewaves, and designing CAD/CAM flutterwumpers come to mind.

The beauty of this system is the ease with which it can become most anything from a game to an email terminal to a data acquisition system to a survey instrument to a personal organizer to a special calculator.

Key *Western Design* watchwords are *user empowerment*.

But why don't you tell me instead? For this month's contest, just tell me what you would use a Mench for. As usual, there will be a dozen or more *Incredible Secret Money Machine II* book prizes going out to the better entries. Plus the all-expense-paid (FOB Thatcher, AZ) *tinaja quest* for two going to the best of all.

In addition, I will pass along the more interesting entries to the design engineering team at *Western Design Center*. At their discretion, they may or may not award Mench computers and development systems to several of the more promising entrants.

Send your *written* entries directly to me here at *Synergetics*, and not to Western Design Center or **Electronics Now** editorial. Let's hear from you.

More Magic Sinewaves

I've been doing a lot more with the magic sinewaves we looked at a few columns back. There are several *very* exciting new opportunities here.

Megabuck ones even.

Your key secret to induction motor speed controls, auto electronics, solar energy interface, power conservation, uninterruptible line conditioning, and related power electronics is just this: Come up with a cheap and efficient source for variable voltage, variable frequency power sinewaves.

All done by suitably flipping some ordinary "H-bridge" switches from a fixed direct current supply.

Preferably flipping only *one-half* of the bridge at any time.

A *magic sinewave* is a repeating long serial string of ones and zeros. Picked to give a variable fundamental frequency and amplitude. Along with harmonics that are either zero or of tightly controlled low values.

Compared against traditional PWM *pulse width modulation*, these magic sinewaves can be far more efficient, can allow much less heatsinking, use cheaper parts, produce far less high frequency energy, can provide much cleaner waveforms, and end up vastly more "microcontroller friendly".

To use a magic sinewave, you look its sequence up in a table and shove it out a port. The frequency can be separately set by picking a suitable dwell time between output bits. Most of the job is easily done by a dollar PIC or other low-end micro.

The magic sinewaves are brand new because the good ones have been so excruciatingly hard to find. Things do not begin to get interesting until you get up into the 200+ bit range. And there's a *lot* of possible 200 bit

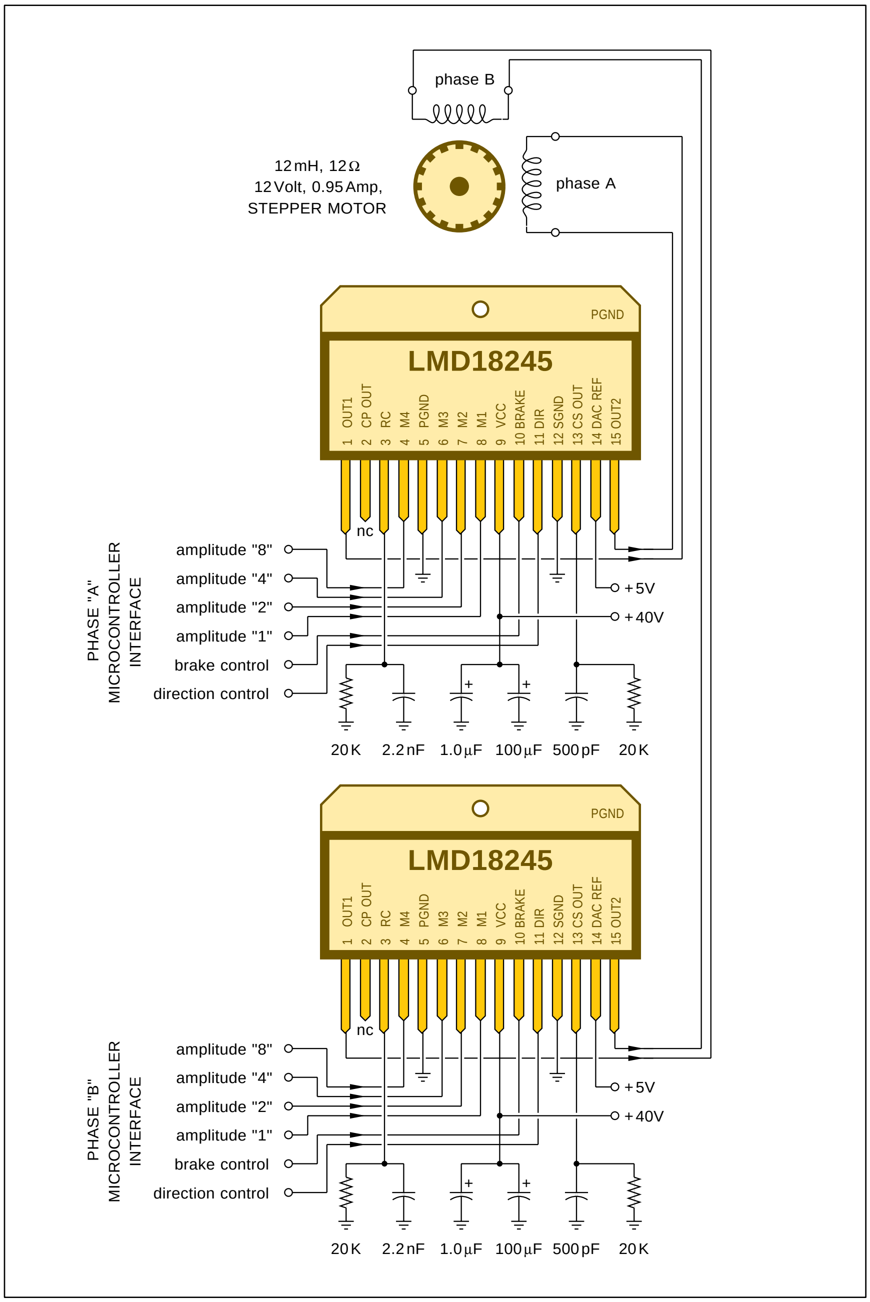

Fig. 4 – A HIGH PERFORMANCE stepper motor driver. Component values must be closely matched to the stepper.

PCMCIA MEMORY CARD RESOURCES

AMP
PO Box 3608
Harrisburg PA 17105
(800) 522-6752

Anabooks
11848 Bernardo Center Dr #110
San Diego CA 92128
(800) 462-1042

Focus Microsystems
1735 N First Street Ste 307
San Jose CA 95112
(408) 436-2336

Globe
1159 US route 22
Mountainside NJ 07092
(800) 227-3258

GPS World
859 Willamette St
Eugene OR 97440
(503) 343-1200

Greystone Peripherals
130-A Knowles Drive
Los Gatos CA 95030
(408) 866-4739

Hyundai
510 Cottonwood Drive
Milpitas CA 95035
(408) 232-8000

IC Card Systems & Design
6151 Powers Ferry Road NW
Atlanta GA 30339
(404) 955-2500

Mobile Media
1977 O'Toole Avenue Ste B207
San Jose CA 95131
(408) 428-0310

Omega Micro
440 Oakmead Parkway
Sunnyvale CA 94086
(408) 992-1100

Panasonic IC Memory Cards
1 Panasonic Way
Secaucus NJ 07094
(201) 348-7000

PCMCIA Association
2635 North First Street Ste 209
San Jose CA 95134
(408) 433-2273

Robinson Nugent
PO Box 1208
New Albany IN 47151
(812) 945-0211

Sparky Solutions
13534 Myren Drive
Saratoga CA 95070
(408) 867-8540

Surface Mount Technology
17730 W Peterson Rd
Libertyville IL 60048
(312) 362-8711

Swart Interconnect
340 Roebling Road
South San Francisco CA 94080
(415) 588-8651

Sycard Technology
1180-F Miraloma Way
Sunnyvale CA 94086
(408) 749-0130

TDK
136 New Mohawk Road
Nevada City CA 95959
(916) 478-8421

numbers to thoroughly explore.

Great heaping bunches, even.

Let us see. We started off here a few columns ago with a listing of 210 bit magic sinewaves that had *zero* harmonics 2 through 10. I expanded on this with several 420 bit solutions which I published in the June 1995 *Circuit Cellar* and in MAGICSIN.PDF on my *www.tinaja.com* .

Meanwhile, a math genius by the name of Jim Fitzsimons suggested a "minimum harmonic energy" scheme. Where you make each bit contribute as much of its energy as possible to the fundamental.

Which leaves all bits with neither the energy nor much inclination to generate lots of strong harmonics. While all odd harmonics are present, these are often amazingly weak.

Any magic sinewave trades off its length against the amplitudes you can get, the jitter, the harmonic distortion (with and without filtering), and how many efficiency-robbing transitions are needed. Optimizing everything at once gets real tricky in a hurry.

I'm now working with "minimum harmonic energy" synthesis on 384 bit words. There's some compelling reasons to use a bit length that is a multiple of 96. First, you'd like each of your four sine quadrants to end up identical. Especially if you are going to fit lots of amplitudes into a tiny address space. Second, you'd like a multiple of three for any three phase power applications.

And third, you'd sure like all three of those phases to be working on the same *bit position* in an 8-bit word at any given time. Otherwise your code will get too hairy. 3 times 4 times 8 gives you 96. This also easily handles single-phase systems.

The solutions for 96 and 192 don't give enough amplitudes and require high distortions. 288 is marginal for low end apps. And values above 384 might raise the system clock rates. Or limit frequency choices.

Through a disgustingly sneaky *half bit offset* trick, you could make each one in your 384-bit word count *twice*. Giving you a seven bit or 128 level low jitter amplitude resolution. From 0 to 100 percent of supply power. In more or less uniform steps.

Figure two shows us the distortion levels for one collection of 384 bit by 16 transition magic sinewaves. And optimized *both* for low distortion *and* for best efficiency. Note that filtered *total* harmonic distortions average 0.1 percent or less!

One really useful 384 bitter has a quadrant of hex 0080 700F 81F1 F87F E3FF 0FFE. Using a two pole filter, the *total* distortion for harmonics 3 through 17 is a mere 0.034%. Even with no filtering, the third harmonic is way on down at 0.025% and the fifth is utterly negligible.

Only 15 or 16 single switch events are needed per quarter cycle. A PWM circuit might need up to 192 *double* switching events. For *twenty five* times the switching losses.

Once you start synthesizing long magic sinewaves, there are all sorts of heplful games you can play. By *predistorting* you can force certain problem harmonics to zero. Possibly shifting energy higher in frequency where it is more easily filtered. You can also *anneal* in which you jitter the bits around a little and see if any of the results get better. Annealing can significantly assist most of the low amplitude magic sinewaves.

And by *clumping*, you can reduce all the transitions without hurting the

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distortion all that much. A clumping can be based on an intelligent *prebias* that encourages a one if you have a previous one, and vice versa.

But a newer and better approach to clumping is to simply list all possible integer clump combinations that sum to the desired amplitude. Then pick the best one. See SUMINTS.PS for some working code.

Figure three shows the algorithm I'm currently using to discover good magic sinewaves. So far, it gives you good results. But not yet the best.

Some filtering is often needed with any magic sinewave. Typically, your motor inductance can give you the first pole for your filter. Results are dramatically improved if you can use a two pole lowpass filter that drops off at -12 decibels per octave. And cutting off at the second harmonic.

Even *unfiltered* harmonic energy could get reduced with longer magic sinewaves. Or by permitting extra transitions per cycle.

What does all this mean for you? There is now a brand new "magic" way to produce power sinewaves that looks like a *very* promising route to solve some rather sticky problems.

Judging by what's happened so far, there are even more exciting magic sinewaves waiting in the wings. All that is needed is the time, effort, and funding to isolate them.

My preferred tool for this leading edge work is that incredibly superb general purpose PostScript computer langauge. Helped along, of course, by my good old Apple IIe.

PostScript handles 384 bit words with aplomb. You simply put them into strings and then manipulate the strings. It takes around a thirtieth of a second to find all the harmonics of any magic sinewave.

In fact, we're sort of having a race. Jim is using absolute mathematical rigor on a gonzo supercomputer. And I'm intuitively "shaking the box" to see what falls out of an Apple IIe. As of last night, the Apple was at least temporarily in the lead.

Much more on all of this is on the *magic sinewaves* library shelf of my *www.tinaja.com* You will find dozens of the latest files here. Including a new MSINPROP.PDF development proposal. All of those actual magic sinewaves using the algorithm from figure three are in MS384X16.TXT and SINTOOLS.PS.

By the way, magic sinewaves can sometimes be used to eliminate the capacitor in certain two-phase motors such as those used in air conditioning blowers. But on the other hand, you should avoid using magic sinewaves with any capacitor or other high pass filtering device.

I have now got some brand new ready-to-run hardware. Including a three phase system in less than 200 machine language instruction bytes! And lots of source code that can be made available. On a consulting or a codeveloper basis.

Give me a call if you want to tap this big bucks opportunity.

A New Stepper Driver

National Semiconductor has been generous with free samples lately. Embarrasingly so, even. Especially their LM45 temperature sensor, the ADC16071 Sigma-Delta converter, or the LMC6001 and LMC6462 op amps.

The usual way you pick these freebies up is with the postcards in *E.E. Times*, *EDN*, *Electronic Design*, and similar trade journals. Much more on this in my *Resource Bin* and *Blatant Opportunist* reprints.

Their LMD18245 stepper motor drive chip is interesting. Figure four shows us additional details on this 3 ampere, 55 volt device.

There are several problems when driving a stepper motor. The first is efficiently sensing the motor winding current. National uses the "lossless" scheme in which they parallel 4000 or so identical output transistors and then sense the current through only *one* of them. Giving a scale factor of a quarter mil per amp.

The second is to use *current* drive. When you attempt voltage driving a stepper, you'll get into time constant problems that very much limit speed and power. Using current drive, you apply your full supply voltage to the

NAMES AND NUMBERS

Central Semiconductor
145 Adams Avenue
Hauppauge NY 11788
(516) 435-1110

Scott Edwards
964 Cactus Wren Lane
Sierra Vista, AZ, 85365
(520) 459-4802

GEnie
401 North Washington Street
Rockville MD 20850
(800) 638-9636

Hitachi
2000 Sierra Point Pkwy
Brisbane CA 94005
(415) 589-8300

Key Tronic
PO Box 14687
Spokane WA 99214
(509) 928-8000

Micrel Semiconductor
1849 Fortune Drive
San Jose CA 95131
(408) 944-0800

Ming Engineering
17921 Rowland Street
City of Industry CA 91748
(818) 912-9469

Motorola
5005 East McDowell Road
Phoenix AZ 85008
(800) 521-6274

National Semiconductor
2900 Semiconductor Road
Santa Clara CA 95052
(800) 272-9959

Ozen Sound Devices
225 Broadway
New York NY 10007
(212) 962-3232

PAIA Electronics
3200 Teakwood Lane
Edmond OK 73013
(405) 340-6300

SGS Thompson
1000 East Bell Road
Phoenix AZ 85022
(602) 867-6259

Surplus Traders
PO Box 276
Alburg VT 05440
(514) 739-9328

Synergetics
Box 809
Thatcher AZ 85552
(520) 428-4073

Temic
PO Box 54951
Santa Clara CA 95056
(408) 970-5700

Western Design Center
2166 East Brown Road
Mesa AZ 85203
(602) 962-4545

stepper winding. With *zero* current limiting resistance.

That inductance of your stepper winding should cause your current to ramp up at the usual $\Delta i/\Delta t = e/L$ rate. When you reach the desired current level, you'll quickly turn your drive power off. You repeat this process many times per stepper phase.

A third problem is that you will usually want higher currents when you are stepping than when you are holding. National handles this with an on board four-bit D/A converter. Which lets you set your stepper drive current to sixteen possible levels.

Including zero.

As with any coil, you'll *never* want to suddenly stop the current. Doing so will generate destructive voltage spikes. Problem four involves safely shutting down the drive. To do this there is a *brake* input that effectively shorts the stepper winding, letting the current safely decay to zero.

A separate *direction* input lets you decide which end of the H bridge gets positive supply current.

The wide TO-220 package includes power drivers. Some heat sinking is required. A pair of chips are needed for two-phase stepper motor use as shown. This chip and others in the family may also be used in DC motor drives. External MOS transistors can be added for higher voltages.

A PIC chip is ideal to control the LMD18245. Suitable interfaces are offered by *Scott Edwards Electronics* with his *Pseudo Stamp*.

Yes, the new magic sinewaves will interface beautifully to several chips in this series for ac motor drive apps.

PCMCIA Card Resources

I've been getting quite a few calls on the "memory cards". Credit card plug-ins which first started life as laptop memory inserts. But they now include modems, MIDI drivers, data acquisition systems, new CAD/CAM driver interface, Ethernet comm, and even GPS receivers. So I guess we're due for a resource sidebar.

These are correctly called *PCMCIA* cards. Short for *Personal Computer Memory Card Interface Association*. The best starting point is the *PCMCIA Developer's Guide*. A book and disk combination available from *Sycard Technology* at $90 list. One second source for texts on cards and flash memory is *Anabooks*.

The leading industry trade journal is *IC Card Systems & Design*. The other names on our list are mostly suppliers of support hardware and test systems. Plus various cards.

Let me know if you want to get into more details on all the pinouts, timing, and similar specs.

New Tech Lit

From *Hitachi* a pair of new data books on *Wireless Communications* and *Optoelectronics*. Through *Micrel Semiconductor*, a new data book on *Analog Power Integrated Circuits*. From *Temic*, a catalog on *RF IC's for Wireless Applications*. Temic is a renamed *Telefunken*. A data book on surface mounted transistors and such is offered by *Central*.

A *Power Factor Correction* guide is offered by *SGS-Thomson*. Speech modules suitable for toys and other low end applications are offered both from *Ozen Sound Devices* and *Ming Engineering*. Ming also has its new *Electronic Products Catalog* having some great breadboarding stuff in it. Wall adaptors at ultra low costs in infinite variety are available by the zillions at *Surplus Traders*.

PAIA Electronics has a brand new Theremin kit.

Motorola has a free sample pack including dozens of their new BRT *Bias Resistor Transistors*. These are your choice of a NPN or a PNP along with a pair of integrated resistors. Mostly for "RTL" glue logic, LED drivers, and such.

For the fundamentals of digital integrated circuits, check into my *TTL Cookbook* or *CMOS Cookbook*. Either by themselves or as part of my *Lancaster Classics Library*. See my nearby *Synergetics* ad for details.

As is usual, instant help answers, preprints and reprints of most of my stories and all referenced files are available on www.tinaja.com

You'll also find our consultant's network and scads of annotated hot links here. Come visit.

Most of the mentioned resources will show up either in the *Names & Numbers* or *PCMCIA Memory Card* sidebars. Be sure to check here first before calling our tech helpline.

Let's hear from you. ✦