

Don Lancaster's

Hardware Hacker

April, 1989

Refilling SX cartridges
Micropower regulators
More digital sinewaves
Mass teleportation card
Minimum order hassles

Boy, there sure has been a lot of helpline response to the solid state compass stuff we looked at two months ago. I guess I did mention that you can get fluxgate sensors off the shelf from *Radio Shack*. Meanwhile, the original "horses mouth" paper about all this is *Earth's Field Magnetometry* by W.F. Stuart, appearing in *Reports on Progress in Physics*, 1972, vol. 35, p.803 to 881. And you may also find *Recent Advances in Fluxgate Magnetometry* from the *IEEE Transactions on Magnetics*, MAG-8, #1, p.76-82 of more than passing interest.

One helpline caller has asked why magnetoresistive sensors couldn't be used. These are primarily to be used with very strong magnetic fields, and I don't think they are nearly sensitive enough for any compass use. Far and away the most off-the-wall winning entry in our fluxgate compass contest came from Dr. Dennis O'Leary who studies fish whose ears have built-in magnets. See his paper on *Magnets in guitarfish vestibular receptors*, over in *Experientia*, v. 37 (1981), p.86-87.

Several callers did give me some additional input on infrared filters. Apparently, unexposed 35 MM photo film works just fine. Years ago, I had a student learn this the hard way. He built a shaft encoder having the light transmission pattern exposed on a litho film disk. The trouble was the infrared light whipped on through the black parts just as easily as it went through the clear portions.

Some infrared response curves on their various plastics is available in a "PEL-ette" known as *Infrared Transmittance of Plexiglas Colors that are Opaque in the Visible Portion of the Spectrum*, available from the folks at *Rohm and Haas*.

Every once in a while a resource comes along which is absolutely and unquestionably in that "must have" category. This is certainly true of the *Signal* from the *Whole Earth Review* people. This is a master directory of virtually all communications resources, well done up in the style of the

original *Whole Earth Catalog* and costing \$16.95. No hacker can ignore this book. It is far too important.

As per usual, this is your column and you can get technical help and off-the-wall networking per the *Need Help* box. As is customary, many of the products and services mentioned do appear in the *Names and Numbers* color sidebar.

Let's start off with a loose end . . .

More on Digital Sinewaves

There was a surprising amount of interest in our recent digital sinewave stuff, and I apparently did forget to include one key technique. Thanks to Tim Green, another contest winner, for bringing this to my attention.

The idea is called *phase addition*, and its block diagram does appear in figure one. What you do is route a digital word to a D/A converter that is followed by a low pass filter, just like we did before.

Only this time, your digital word consists of the top 8 bits of a 24 bit adder/accumulator. At a constant and high clock rate, a fixed *phase increment* is added to the accumulator. For instance, a "1" input could advance

the phase count so slowly that you'll get a 1 Hertz sinewave, while a "2" would give you 2 Hertz, on up to the much larger numbers which give you much higher frequencies.

Advantages of the method are that you are directly synthesizing the final frequency, which eliminates all the hunting and the noise bandwidth of phase lock loops. Thus, your spectral purity can be extremely high. There is also no bad transient whenever you change frequency 1 just a smooth and unbroken transition.

For lower frequencies, a personal computer will work just fine, and it should be trivial to generate up to several kilohertz using an *Apple II*. You can do so in one Hertz or even smaller resolution steps.

To work at any higher frequencies, speed limitations on those hardware adder-accumulators can get to be a problem. One extremely expensive source of ultra-fast chips for this is *Stanford Telecommunications*, while slower and much lower cost kits are obtainable from *A&A Engineering*. One source of additional details is the *Radio Amateur's Handbook*. Do be sure your copy is 1986 or later.

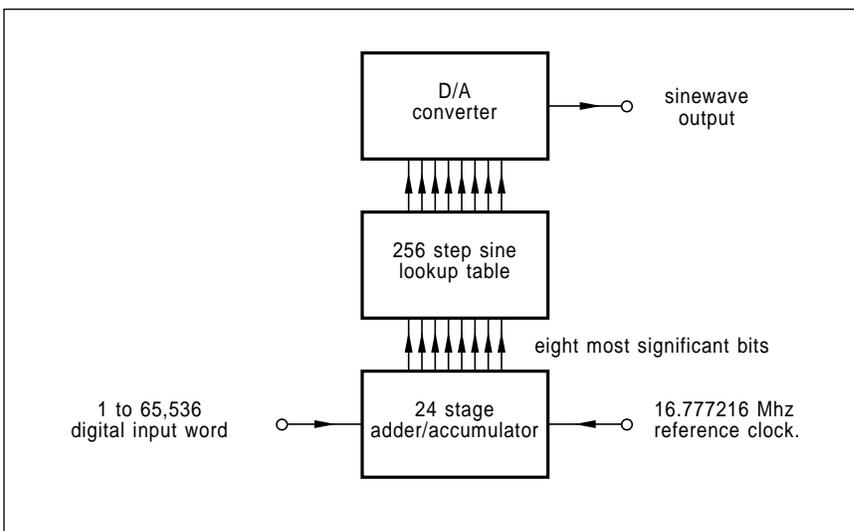


Fig. 1 – Digital sinewaves generated by phase addition. The input word sets how fast the waveform phase will advance, which in turn decides the directly synthesized output frequency. The values shown will generate from 1 Hertz to 65.536 KiloHertz in 1 Hertz steps.

Minimum Order Hassles

One of the biggest hacker helpline complaints concerns all those steep minimum orders that many of the electronics distributors seem to be insisting upon. The problem is bad and is getting much worse. How can you cope with it?

First, note that it just is simply not possible in this day and age for anyone to profitably offer the direct mail sales of electronic hardware if their average mail order ends up less than \$25. Those \$15 or \$25 minimums or any \$5 to \$8 below-minimum service charges from the "new age" good guy distributors are all necessary for their very survival.

On the other hand, several of the "old line" distributors have gone as high as a \$250 minimum order. Even worse yet, several of them now have an intolerable \$100 per line item minimum. Which means if you want a two cent part, you now have to buy 5000 identical ones at once, or else forget it.

The *Bell Electronics* people have just garnered a ZZZ rating and moved to the very summit of my *Synergetics* black list for their unacceptably high line minimums and all their outright arrogance. (All I wanted were a few jelly bean regulators) Unfortunately, these epsilon minuses are not alone.

The sad fact is that, if you are an individual hacker, the deck gets very much stacked against you. On the other hand, this just may end up as

the only game in town.

So, how can you cope with steep minimum orders? Here are a baker's dozen partial solutions . . .

(1) Plan Ahead. If you run in panic mode, you will almost always end up wasting money. Find the best dealer with the best source and the lowest minimums. Combine what you need with what you think you may need for other upcoming projects. Try to get everything from one or two suppliers, rather than a dozen.

(2) Try to always deal with a "new age" distributor, such as *Mouser*, *Active*, *DigiKey*, or *Jameco*, instead of using those "old line" houses such as *Schweber*, *Allied*, *Cramer*, *Newark*, *Bell*, or *Hamilton*.

(3) Fill out your minimum order with other goodies which you would someday like to play with.

(4) Rather than using a distributor, request free samples directly from Applications Engineering of the firm actually building the part. Use a laser printed or other business letterhead. Request only as many parts as you need, and tell them exactly what you are going to do with them.

(5) Check into your local walk-in surplus stores. Often you might find reasonable substitutes at incredibly low prices, especially on unadvertised odd lots. The savings can even make a 100 mile drive worthwhile.

(6) Build up your own personal inventory of "in stock" parts that you are likely to use in the future.

(7) Network with friends in a ham

or computer club, or with engineers or techs from an aerospace company or whatever. Be able to swap parts both ways. Become a resource for the other party.

(8) Move to Silicon Valley, where all of the 24-hour convenience grocery markets also carry all the other known types of chips. No minimum. Or, if you are too far away, always be sure to try *Radio Shack*.

(9) Naturally, we would hope you would always check out our *Radio-Electronics* advertisers first for any component part. That's why we put the bingo card in the magazine. But two other great sources for oddball components are the unique *Nuts and Volts* bargain shopper and all the distress merchandisers found in that classified ad section of *Electronic News*. While the latter *always* will have steep minimum line charges, the prices are often so ridiculously low that it may not matter.

(10) Aggressively subscribe to all the electronics trade journals, such as *EDN*, *Electronic Design*, *E.E. Times*, *Electronic Products*, and/or the *Electronic Component News*. You'll find lots of free sample offers in any of these, along with unique sources of supply. As usual, you get a complete list from *Uhlrichts Periodicals Dictionary* at your local library.

(11) Acquire an enormous junk box. Or better yet, a junk room or a junk building or two. Fill them with broken tv sets, dead VCR's, or whatever else trips your trigger. A dozen cubic yards or so should do for a bare bones start.

(12) Hamfests, particularly the big regional ones, have outstanding parts bargains and zero minimum orders. Ask for full details at your local ham club, or, once again, do see *Nuts and Volts* for a listing.

(13) Combine your order with that of another hardware hacker. Or start your own "buying club".

Low Power Regulators

The folks at *Maxim* have added yet two more low power regulator chips to their line. The MAX644 steps up a single alkaline cell as weak as 0.9 volts up to a fixed and regulated 5.0 volts. The MAX645 gives the same treatment to a 2.4 volt lithium cell.

Figure two shows you the simple

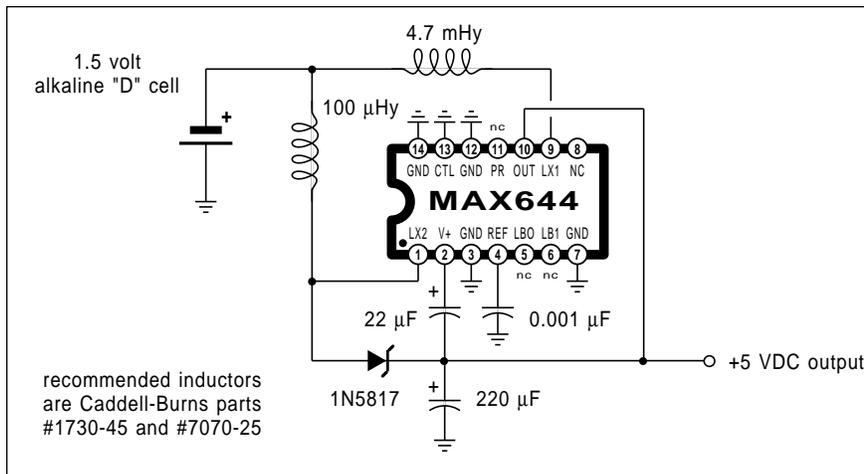


Fig. 2 – This simple switching regulator steps up a single alkaline cell to give you a fixed +5 volt output at 50 Milliamperes. An external pass transistor can be added for more output current.

circuit involved. The secret is to have *two* switching regulators. The first regulator generates around 12 volts or so at a very low current for internal use. This high voltage gives enough MOS transistor base drive to allow very high efficiency.

While the circuit is quite simple, careful selection of the inductors and the Schottky diode are needed for maximum efficiency.

The typical efficiency is in the 75 percent range. Currents up to 50 mils are directly available, while an external pass transistor may be added for higher current needs.

Refilling SX Cartridges

As we have seen in past columns, a profitable business can be built up centered around refilling toner cartridges for copiers and laser printers. Many recent hacker helpline requests have been for methods to refill those *Canon SX* cartridges as used in the *LaserJet II* and the *LaserWriter II*.

Sadly, there is now as much as a 15:1 cost penalty in per-page toner costs when using those newer *Canon SX* laser printers over the older *CX* engines. On the older *CX* cartridges, you were able to buy cartridges for five bucks out of your Sunday paper and refill them up to seven times, bringing all your toner costs down into the 0.33 cents a page range that is cost competitive with jiffy offset printing services.

Unfortunately, those *SX* cartridges do use a highly abrasive toner, combined with drums that are intolerably scratch sensitive.

So, while you can in fact reload *SX* cartridges, at present, you just can not even remotely approach those *CX* cartridge economics. So, do consider this a progress report where I'll bring you up to date on what can and cannot be done at the present.

While it is difficult to even get a second *SX* reload, you can sometimes do so with the following tricks and techniques. Firstoff, you *immediately* remove the factory toner and give it to your friendly neighborhood diesel mechanic for use as a valve grinding compound. Replace it with a good quality third-party refill toner.

Second, be certain to use a drum lubricant, such as *Pixie Dust* or its equivalent. Do a very light dusting

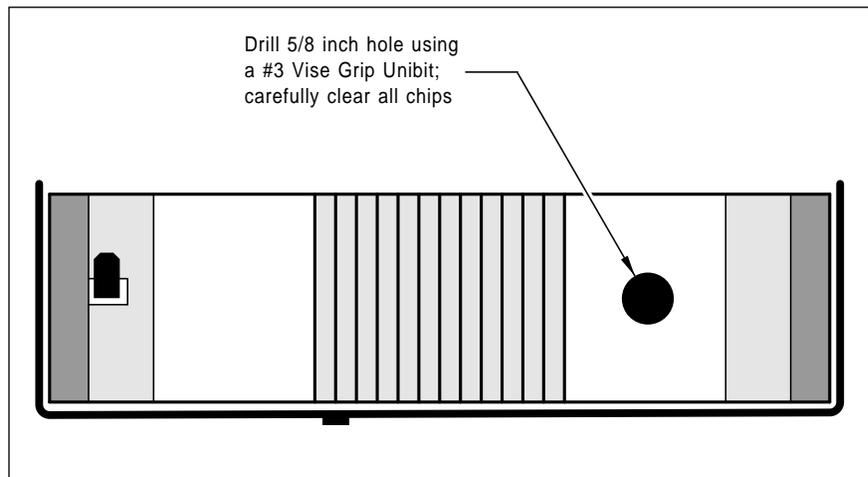


Fig. 3 – Adding a fresh toner filling hole to a *SX* cartridge.

after every refill.

There are two refilling methods, the *Punch and Go* and the *Total Teardown*. I very much prefer punch and go, since this delivers far and away the lowest per-page toner cost to the end user. We charge \$22 for local *SX* refills. Since this is a remote rural area, I can get away with such an outrageously high price. You can do the job by yourself for as little as \$7.50 and three minutes time.

The *SX* cartridge needs modified before you can refill it. Using a Vise Grip #3 *Unibit* and a very slow drilling speed, you drill the two holes as shown in figures three and four. Drill upside down and be very careful to remove the single chip that the unibit provides. These two holes are then capped with a nickel *Caplug* or else some very aggressive tape.

There are three major steps to the refilling process. You first open the holding tank hole and carefully shake out the excess toner. Do this outside and avoid breathing any of the toner. You'll then reseal your holding tank hole, open the fresh toner tank hole,

and pour in a bottle of refill toner.

Finally, you remove the old fusion wiper wand and peel and stick a new wiper pad in place.

Another tip: keep the green toner dial advanced all the way to nine for any and all rough drafts and for all internal use documents. Note that the *higher* the number, the *less* toner you will use. Cartridge life can easily be doubled with this simple technique.

I currently recommend using *Lazer Products* to supply toner, pixie dust, wiper pads, and drum recoating.

Mass Teleportation

The rate at which science and technological fact is outpacing science fiction continues to utterly astound me. Nowhere is this more apparent than in the emerging field of mass teleportation.

The exciting center of all that has recently been happening is in that outstanding *International Journal of Teleportation and Mass Transfer*. In particular, do check out Barfoot and Gentry's tutorial material way back in Volume XVIII, on pages 1146-1198

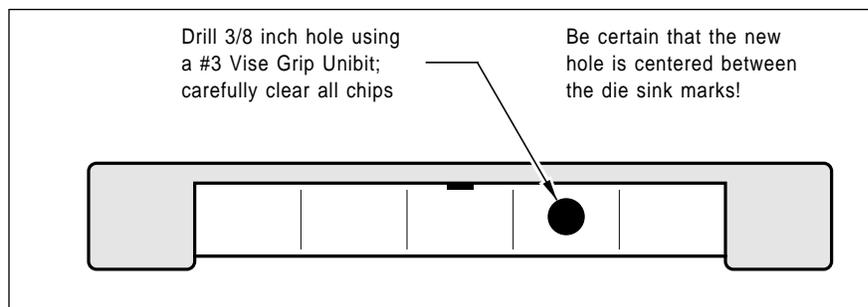


Fig. 4 – Adding the spent toner emptying hole to a *Canon SX* cartridge.

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along with their extremely detailed bibliography. Next, for plenty of the hands-on construction details, check out Checiski, Colcord, and Elden's medium budget project on pages 1245-1277 of the same issue.

It sure is refreshing to see a very scholarly journal that always remains simple, practical, and yet quite easily understood by lay people. It looks like the technology to watch is the *quark-muon* dissociation and regeneration process.

So, I guess I was not too overly surprised when Marcia Swampfelder shipped me her latest two peripheral cards for the old Apple II Plus, her MTT-T1 mass transference transmitter, along with her MTT-R1 mass transference receiver. Marcia is a tad on the conservative side, so she insisted on using the illegal monitor entry points that precludes the use of these cards on newer Apples or other personal computers.

The pricing is rather attractive at \$68.50 for the MTT-T1 and a mere \$43.50 for the separate MTT-R1. You can order direct from Marcia.

Anyway, you first plug your transmitter card into one Apple II Plus and as many as four receiver cards into four receiving Apple II Plus computers. Any object that gets placed in the transmitter's dissociation chamber then will appear reconstructed in the receiver's regeneration chamber.

The effective range does depend on the telephone line in use, but for your average quality voice grade line, you can teleport objects as far as 500

miles using one receiver, 200 miles using two receivers, 100 with three, and 50 miles with four receivers. The poorly understood methodology of *conjugate phase decongruence* does prevent you from reliably using more than four receivers, regardless of the distance. Even on local loops.

The Apple power supply and baud rate considerations both limit the size of the teleportation chambers. Those chambers found on the MTT-T1 and the MTT-R1 are slightly larger than a quarter. In the usual demo of these cards, you insert a quarter into the chamber on the MTT-T1 card, and it will reappear intact approximately 12 minutes later on the MTT-R1.

For a real "Golly Gee Mr. Science" demo, you permit four regeneration cards to serve each dissociation card. The single quarter you placed in the dissociation chamber will simultaneously reappear in all four of the receiving cards, again in the twelve minute dissociation-regeneration interval. Put another way, the quad demo returns a dollar in change for every quarter that is invested.

Figure five shows you the MTT-T1 transmitter card. The teleportation chamber is optical fiber coupled to an *Atascotia Industries* 100 milliwatt tunable ultra-violet solid state laser. I don't know whether the \$2.75 price or the 67 percent optical efficiency is the most outstanding feature of this new component. The rest of the card consists of all the usual RAM, ROM, CPU, and I/O stuff, all done up in Marcia's highly conservative style.

Marcia reports that virtually all of her current production is going to all the importers of specialty herbs and spices. Her new teleportation system eliminates all of those long delays at customs, besides allowing her users to set all of their own international currency exchange rates.

You can contact Marcia directly for additional info.

New Tech Literature

A new *Microelectronic Data Book* just arrived today from *Mitel*. It is chock full of telecommunications chips, and includes bunches of useful ap-notes. Two other recent arrivals are the *Linear Circuits Applications* from *Texas Instruments*, and that *MOS Products Catalog*, from *Gould*, who recently bought out *AMI* and all the chips described in the book.

Some interesting new strain gauge products are now available from *BLH Electronics*. In particular, their SR-4 should be useful for weighing scales or whatever. And *Sharp* has a new *LCD Units* booklet on liquid crystal displays and their drivers.

Tektronix has a new *TEK Direct* catalog and several free videotapes out. Their oscilloscope prices do start under \$700, and are much better than those of any other manufacturer.

Unusual and quite high quality audio kits are available from the *Old Colony Sound Lab*. As a caver who exclusively uses carbide for light, I guess I've disqualified myself from commenting on the apparent stupidity of still continuing to use vacuum tubes in this day and age. Oh well.

ColorEase is an unusual and quite messy process that lets you create your own full color "real ink" instant transfers that may be professionally applied to virtually any surface.

Two interesting new trade journals include *ID Systems* on bar codes and such, along with *Sensors*, intended for the robotics crowd.

Turning to my own products, if you are at all into designing active electronic filters, check out my *Active Filter Cookbook*. If you are into high quality text or graphics of any style, be sure to look at all my PostScript stuff, especially the *PostScript Show and Tell*. Finally, remember that we now have fully updated and edited *Hardware Hacker* bound reprints.

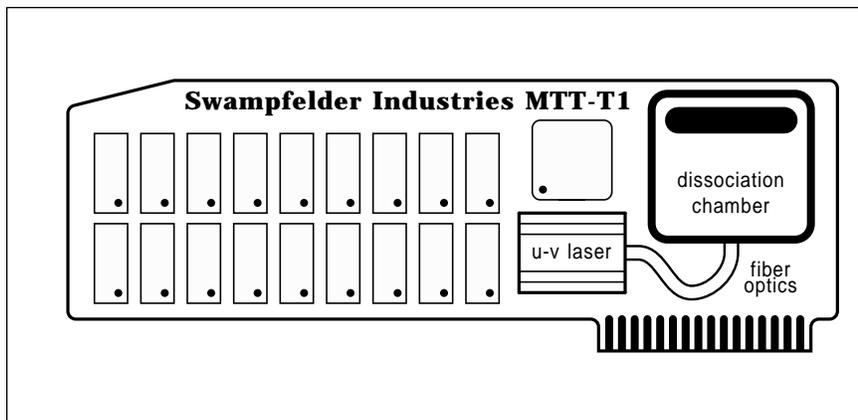


Fig. 5 – Pictorial of the mtt-t1 mass teleportation transmitter unit for the Apple II Plus. The solid state 100 milliwatt ultra-violet laser chip gets optical fiber coupled to the dissociation chamber. The telephone connection is made on the other side of the card.