HARDWARE HACKER

More on Omnicrom; genlocking video images; v/f converters; the Postscript language; an easy printed-circuit process

By Don Lancaster

Lots has been happening on the *Omnicrom* front since we last looked at this exciting new process that lets you cheaply get full-color from the toner image provided by a copier or laser printer. First and foremost, the *Kroy Sign Systems* people have taken over production, marketing, and distribution of this material in the U.S. This should mean much better availability and considerably lower prices. The new name is "Kroy Kolor." There are also some new goodies now available that include binding and laminating materials, plus all sorts of sign holders. For samples and more details on all this, contact Randy Bailey at Kroy.

Quite a few Hardware Hacker readers have been using a plain old iron to fuse the Omnicrom sheets. To do this, you either work upside-down or else place a sheet of paper or a muslin or cotton pressing cloth between the iron and the transfer sheet. I skipped this critical step and ended up with a gorpy mess.

Two other tips: A clay-coated and smooth paper works best, provided that the toner itself will stick to the paper. An obscure paper called "Paloma Matte" by *Butler Paper* performs very well. For the sharpest image, be sure to quickly separate the sheets after fusion.

We'll look at another "mess with the toner" product that ridiculously simplifies hacker printed-circuit boards shortly. But first . . . .

Tell me about genlocking.

Genlocking is the missing ingredient to letting personal computers truly interact with "real" video from a VCR, cable, CD disk, or studio. A genlock lets you synchronize and lock one video source to another so they can be superimposed, windowed, or whatever.

For instance, a home-video freak might use his personal computer for titling, cuts, fades, and video wipes. A couch potato might unknowingly use a genlock to watch nine channels at once. An educator might use genlocking to overlay computer-generated text over a full-resolution video picture. A scientist might do the same for crosshairs, image processing, or feature identification. Cable people routinely use genlocking to overlay fixed or crawling ads and public service messages.

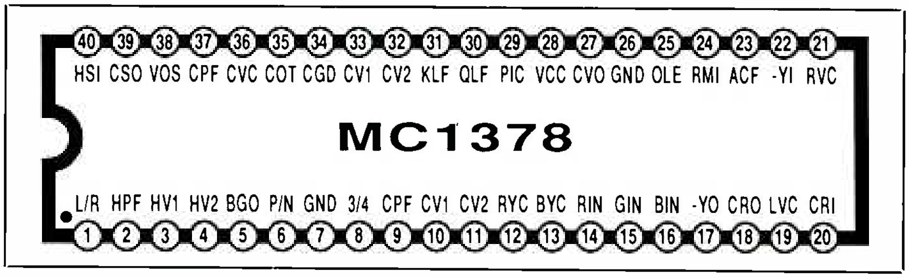

Fig. 1. A Motorola integrated circuit for genlocking by synchronization.

In a TV studio, there are countless uses of genlocking. One of the oldest and neatest is the "chroma key" process that saves having to make large color maps and such. No, that weather turkey is not pointing to a map. He is pointing to a bright blue square on the wall. The map is on a color slide. When the chroma key circuits see bright blue, they switch to the map. When they see an arm, they switch back to the weather turkey.

Now, genlocking must be and should have been the centermost feature of all personal computers since day one. Yet, except for a limited genlock on the Amiga and a full genlock on some Sony microcomputers that are totally unknown outside of a TV studio, none of the more popular personal computers have very much in the way of genlocking available. With video on CD ROM just around the corner, this is totally inexcusable.

There are two main ways to handle genlocking. With a true genlock you absolutely and positively synchronize both systems so that their scan rates, line position, and sync pulses are identical.

While the true genlock has traditionally been complex but fairly cheap, there are all sorts of problems on a personal computer. Not the least of these is that most personal computers do not use interlace and have standards different from broadcast-quality TV. Another problem is providing the fast locking needed to track a VCR or other jittery outside video source.

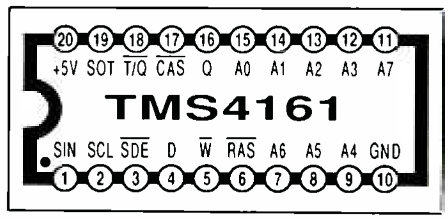

Fig. 2. A Texas instruments integrated circuit for genlocking by frame grabbing.

The second method is called "frame grabbing." With a frame grabber, you store an entire picture or two from the one system and play it back to the second. You can easily get from one set of wildly different video standards to another, and no actual locking of the local source is needed. This used to take a humongous and ridiculously expensive analog or digital memory. Today, of course, large digital memories are trivial and nearly free.

Fortunately, there are at least two new integrated circuits available that greatly simplify the genlocking process. And, while not cheap, they are sanely priced.

Motorola elected to go the true genlock route with their MC1378 video synchronizer. The pinouts of this chip appear in Fig. 1; more details can be found in the MC1378 data sheet, applications note, and in graphics chip set data pack.

This chip is basically a group of phase lock loops (PLLs) that first lock the vertical sync pulses to each other and then lock the individual horizontal scan lines. Special provisions are made to handle VCR jitter. For this chip to work, interlace and true NTSC timing would seem to be essential, and the MC1378 must take over and substitute for the main system clock on whatever is doing the computing. Thus, while it looks great on paper, I don't yet see any obvious way to drop this dude into an Apple or a Mac.

The second chip is the *Texas Instruments* TMS 4161 Multiport video RAM, which is also available as 4-bit and 5-bit SIMM modules (TMS 4161 EP4 and EP5). Figure 2 shows the pinouts, and more tech details are found in TI's *MOS Memory Data Book.* These versatile multiport RAM chips are easily used for frame grabbing.

From the computer side, this chip looks and acts like a plain old 64K × 1 dynamic RAM. From the television side, the chip looks and acts like a high-speed video shift register that holds an entire line of pixels. Lines can be any multiple of 64 pixels, with 256 lines of 256 pixels being a good hacker starting point.

Once during each horizontal blanking interval, a transfer command is given that moves the stored computer bytes into the line shift register. This is the only time that any synchronization or arbitration is needed between the computer and the television source. At all other times, the computer is free to write to RAM in any order it likes, while the TV is free to clock out the pixels at its chosen rate.

One way to eliminate virtually all arbitration is to grab two frames and write to the first one while you are reading the second. But a wait state generator can do the same arbitration faster and simpler. A plain old blanking interrupt can sometimes be used instead.

The number of chips you need depends on how fancy you get. For a simple black-and-white titler, one of these chips will do the job, giving you one bit per fairly large overlay pixel. If you want to get fancy and add finer resolution, gray levels or color, you set up multiple "pixel planes" as needed. For instance, 5 planes would get you one of 32 gray levels, while 12 planes would let you pick any of 4096 colors from an Apple IIGS or similar pallette.

The usual way to get from noninterlace to interlace is to write the same pixels to both the even and odd interlaced fields.

Denser and cheaper multiport video RAM chips and modules are just around the corner, and a $50 frame grabbing genlock is not all that far away. Naturally, *Modern Electronics* is most interested in any construction project on a reasonable-cost genlock that would drop into a mainstream-type computer.

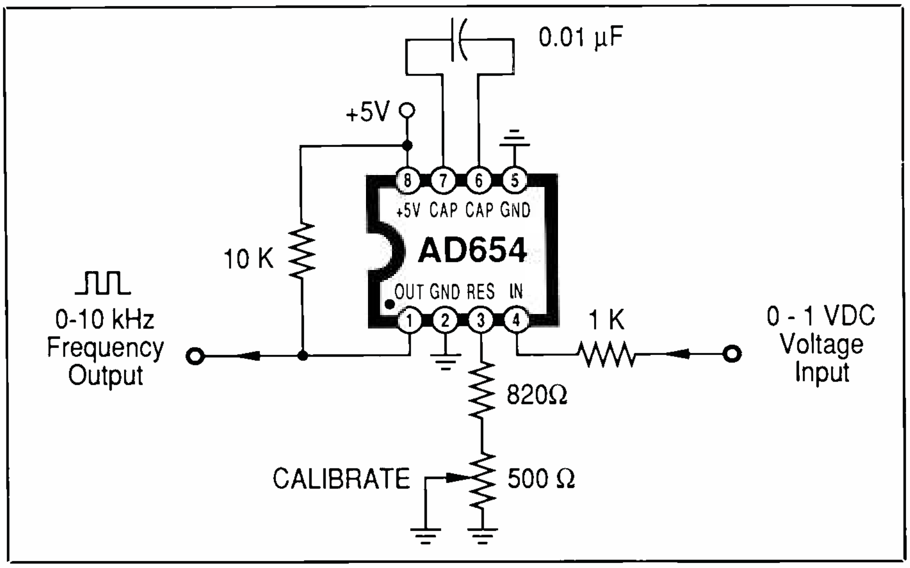

Fig. 3. A simple voltage-to-frequency (v/f) converter circuit.

What is Postscript?

Postscript is the exciting new page-description language from *Adobe Systems* that is fast becoming the *de facto* desktop publishing standard for laser printing and typesetting.

There are some outstanding advantages to Postscript. First and foremost, it is fun to use. In fact, the language is downright addictive. Postscript generally lets you build much higher quality images much more flexibly and with incredibly more power.

Another major advantage is its device independence. This means that the very same textfile that is sent to a laser printer can later be sent to a typesetting machine for much higher print resolution.

Text and graphics can be mixed in any manner anywhere on the sheet to the full available resolution of the printer. You can easily translate (move), scale (magnify or reduce), or rotate (twist) any image any way you want. You can even arbitrarily map any text and graphics image onto virtually any surface.

As many of you already know, all of the Hardware Hacker graphics (and original text) is done using Postscript, working from Applewriter on the IIGS and driving a Laserwriter Plus.

Many hundreds of Postscript fonts are now available, and any individual font can be shown any size from 3 point to 65,000 point. (72 points = 1 inch) Thus, you can letter anything from a tiny model railroad sign to the name on your town's water tower, all with a single procedural font. Fonts can easily be stretched in any direction, leaned, outlined, clipped, or modified for other special effects. You can even create your own very-high-quality custom fonts.

Postscript has a very strong cubic spline drawing and curve-tracing ability that can let you draw smooth and continuous curves six ways from Sunday. Photographs and grays are easily included, although the final halftone quality depends on the printer you have in use.

In fact, it is Postscript that has made Apple's Laserwriter Plus the best-selling printer in the world today. That is in dollar volume; the best selling printer in units sold is the Imagewriter. And yes, that's for *all* printers used on *all* personal computers!

There are several good ways to get started with Postscript. Two are the *Postscript Cookbook* and the *Postscript Reference Manual.* If you can't find these locally, I have a few extra copies on hand here. No, I didn't write them, but I sure wish I had. My own Postscript books are still in the works. You'll also want to subscribe to *Colophon*, which is Adobe's free Postscript newsletter.

I have lots of free printed Postscript demos and routines that you can run if you call or write. I've also got a fancy "Postscript Show and Tell" that now runs under just about any word processor, editor, or telecomm program, on just about any personal computer. You can also use the Hardware Hacker phone number for free Postscript help.

If you want to tackle a really advanced hacker project, just write and then debug your own Postscript interpreter for the Imagewriter or another dot matrix printer. I must get around 30 helpline calls a day requesting this. The language itself is in the public domain, so there's nothing stopping you except for some personal time and effort.

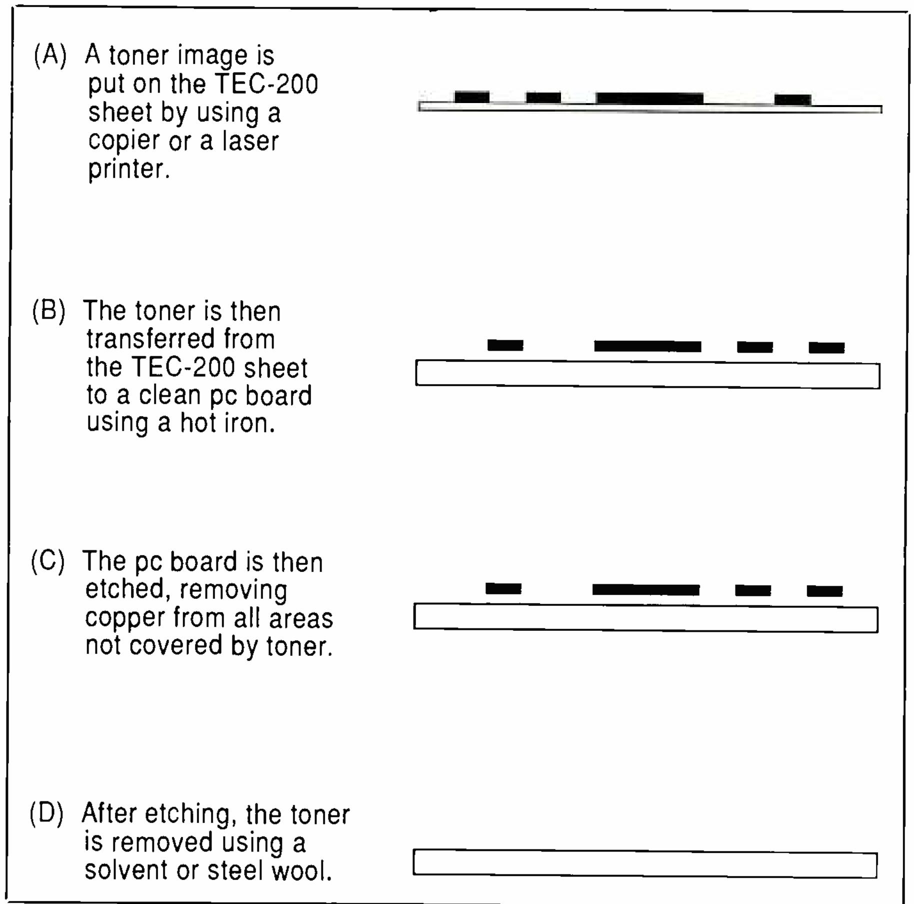

Fig. 4. How TEC-200 sheets simplify hacker fabrication of pc boards.

How can I measure voltage with my personal computer?

The secret to measuring voltage with a personal computer is to hang a beastie called a "voltage-to-frequency converter" onto an input port line and then use a machine-language software routine to count the frequency for a tenth of a second. Even a cassette input port can often be used, and the technique works on just about any personal computer.

Simple, cheap, and reliable V/F converters in the past have been hard to find. The obvious 555 timer route is difficult to use accurately, especially with a ground-referenced input. And game paddle inputs are often hard to use, limited in range, and inaccurate.

Instead, Fig. 3 shows a brand new *Analog Devices* chip called the AD654. This chip sells for around $4, gives you a 0-to-10-kHz square wave output, and needs only a single +5-volt supply. Resolution can be 0.1 percent or better.

Frequency is calibrated by changing

the 500-ohm trimpot. You can run at 100 kHz by using a 1,000 pF capacitor instead, but most personal computer software might not be able to keep up with this higher rate.

Two gotchas: For maximum accuracy, you should have a 1,000-ohm source impedance; so you may want to drive this from an input buffer of some type. And, don't forget that pullup resistor on the open collector, or you won't be able to see the output square wave.

Your software routine should count changes on the port line for a tenth of a second or so. Note that all possible routes through the software routine must take *exactly* the same amount of time.

Let us know what other uses you can come up with for this extremely simple measurement circuit.

Is there a simple process for making printed-circuit boards?

There sure is. There's an exciting new product out called a TEC-200 transfer sheet available from *Meadowlake*. These are nothing but 8½ × 11 sheets of clear Mylar or whatever that may or may not have some special coating on them. Cost is between 40 cents and a dollar per sheet, depending on quantity.

Figure 3 shows how these TEC-200 sheets work. The process is alike but different somehow from the Omnicrom or Kroy Kolor stuff.

The sheets possess the magic property that toner from a copy machine or a laser printer will *loosely* stick to them. What you do is first copy the *positive* printed circuit image you want onto the Mylar sheet. Then you place the imaged sheet, toner side down, onto an extremely clean printed circuit board. You then apply a hot iron to melt the toner. The toner will now stick to the copper much better than it does to the Mylar, so when you peel the Mylar off, a toner image stays on the copper cladding on the pc blank.

You next use the toner as an etch resist! No photography, no silk screening, and no resist pens are needed at all.

Sometimes you will have to reverse the image. To do this, just image onto Mylar once, and then recopy from the Mylar, toner up and backed by a white sheet of paper. Note that the final toner pattern on the copper pc material should have black toner where you want copper to remain and clear where you want copper to be etched away.

Your copper pc material must be scrupulously clean. Scour it *twice* for five minutes each time, using a chlorine bleaching cleanser from the grocery store, and drying the board on a fresh inside turn of a roll of paper towels. Note that totally clean copper is wettable by water, and you'll get a smooth and unbroken flow only when clean enough.

A reducing copy machine can be used for oversize artwork. Since fingerprints are a no-no, always handle the sheets and the pc material by the edges only.

A brand new process? Hardly. Back in the old days when *Xerox* machines were far too cumbersome and much too expensive for plain old paper copies, they offered a similar process that directly transferred toner onto an unetched pc board, but as part of a room sized, ridiculously expensive and extremely hard-to-use machine.

You can probably think of all sorts of other uses for this new material, since you are now able to put a toner image on virtually anything that will sit still and can stand brief application of a hot iron. Callouts for the other side of the printed-circuit board are one big possibility, while instant dialplates are another.

Laser printers work beautifully with this stuff. You can even put Omnichrom or Kroy Kolor over the final toner!

Apparently, the material can stretch or deform slightly. This should not hurt use for most homebrew printed-circuit projects, particularly if you are careful and practice a time or two on less-critical work. You should trim the sheet to within ½" of the image before actually fusing the toner to the printed-circuit board. If any retouching is needed, the usual resist pen can do the job.

The *Meadowlake* people have a special Hardware Hacker offer of five sheets for

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What's new in tech literature?

Analog Devices has an expanded and revised *Analog-Digital Conversion Handbook* out. This well written hardbound textbook is a cut above your typical in-house "official company line" publications. It is worth the $32 price. You can also get a free subscription to their *Analog Dialog* house organ by contacting Cammy O'Brian per the Names and Numbers box.

There's also a *Linear and Conversion Applications Handbook* available from the *Precision Monolithics* people. While the ap notes are aimed primarily at premium op amps, there's a lot of good info here that can be applied to most any old bargain op amp.

For the latest in power-supply design, check into the *Power Supply Circuits Handbook* by *Maxim,* the *Lambda Semiconductor Applications Handbook*, and *Powerconversion* magazine.

For a new product of my own, check out the newly bound reprints from my *Ask the Guru* column.

As our usual reminder, this is your column and you can get technical help per the Need Help? box below. If you haven't done so already, be sure to write or call for your copy of the brand new free stuff list. **ME**

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