

## Getting computer and peripheral schematics, a first look at the Laserwriter, innermost secrets of power supply design, methods of video sync separation and combination.

By Don Lancaster

There's been a lot of reader feedback on the low-pressure pneumatics we looked at a few columns back. It seems that a lot of other hobbyists in wildly different fields also have dibs on air pressure as a substitute for electromechanical stuff. For instance, a player piano is nothing but a bunch of low-pressure pneumatics, and there are lots of enthusiasts around who rebuild or restore these instruments. There's an outfit called, of all things, the *Player Piano Company*. In its catalog, you will find all sorts of low-pressure pneumatic goodies and ideas.

Great stuff.

Seems the largest of the radio-controlled model planes are also going pneumatic for such things as landing-gear controls. *Bryon Originals* is one source. These systems tend to run at much higher pressures than you can handle with one of those 25 cent EGR valves. Since the EGR valve is really intended for vacuum use, when you reverse it for low-pressure robotics, the valve will "crack" around 11 psi or so. The model-plane people often run their equipment at 100 psi.

A very few model-railroad people also use medium-pressure air for such things as turnout switches and roundhouse doors that slowly and smoothly open. One company involved with these products is *Del-Aire Products*. This time, the pressure is up to around 50 psi, mostly because they insist on the tiniest cylinders possible. For instance, at 5 psi, you can get 5 pounds of force with a cylinder that is 1 inch square. Go to 50 psi, and you only need an area of 0.1 square inch. This can be done with a square cylinder only 0.33 inch on a side.

On to this month's goodies . . .

### Where do I get a schematic for a computer or printer?

The first and most obvious place to look is in the technical or repair manuals for

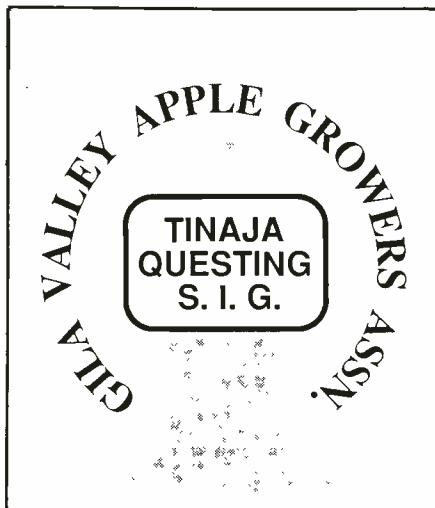


Fig. 1. A snappy Laserwriter image done with Applewriter on an Apple IIe. Print time was 17 seconds and materials cost was less than four cents. Though shown in black and white, the original was done in two colors.

the microcomputer or printer in which you are interested. Normally, the technical stuff is held back, and you get charged extra to access this information.

Some computer stores do not want you to know these manuals even exist because they cut dearly into their service profits. The trick is to call the manufacturer directly. Should they try to shuttle you off on a local dealer, tell them you are from Littlefield, Arizona, or some similar "non-urban" area. If that fails to get results, get on a modem line or a club SIG and holler for help.

As examples, Apple has its *IIe Technical Reference Manual* (#A2L2005) and separately available pair of *IIc Technical Reference Manuals* (#A2L4030). Getting hold of these has loosened up bunches, and they should now be available at most technical bookstores, newly reprinted by Addison Wesley.

One of the best-kept secrets around is the *Sams* series of *Computerfacts*. These are similar to the older *Photofacts* that are essential for radio and television re-

pair. A typical Computerfact packet contains a complete, large and well-organized schematic, disassembly instructions, parts lists, troubleshooting guides, the whole bit.

There are 43 of these packets available so far. As typical ferinstances, the *Apple IIe* version is #8920 and the original *Imagewriter* printer is #8941. The brand-new *Imagewriter II* packet is in the works and should be available by the time you read this. Cost is around \$20 each.

Sadly, there is not an *Apple III* packet available. I sure have gotten a lot of help line calls from orphaned III people, who are desperately clawing at anything at all they can get their hands on. The *Macintosh* packet is not yet ready.

### What's the real word on the Laserwriter?

I've had mine for only a week or so. But, my, oh my, what a machine!

Kiddies, the price of typesetting with full graphics has just dropped below a dollar a page. Not one red cent more.

Where to even begin.

The *Laserwriter* sets any size type you like, mixed with any style of graphics in any size you can imagine in any configuration. You can easily do such things as homecoming posters and sidewalk-to-sidewalk centennial banners. Signs of any size and shape are trivial. There's even a neat *Postscript* procedure that will automatically chop up the sign or poster into as many 8½"×11" pieces required. Later, you tape the pages back together to get up to whatever size you need.

It is trivially easy to move, spin, repeat or stretch an image every which way. You can have any shade of gray you want, and even four colors with repeated passes are possible. Variable size and slant text along a circular or even an arbitrary path is easily done.

One thing not well known (guess why?) is that *Applewriter* on an *Apple IIe* does as good, if not better, a job than the *Mac-*

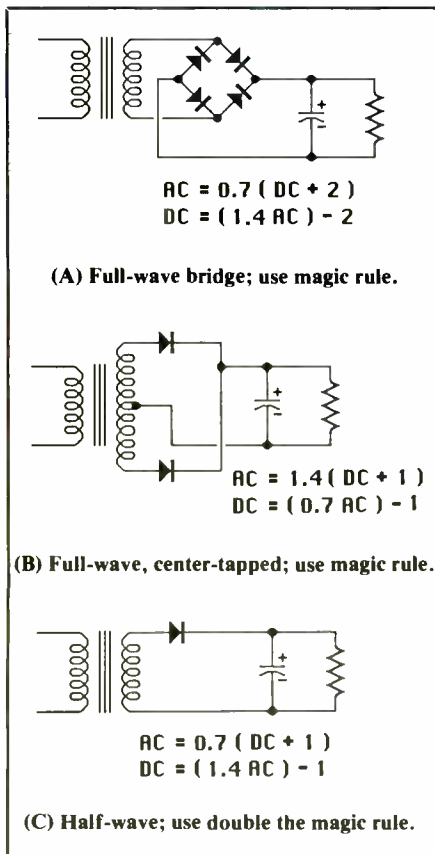


Fig. 2. Shown here are the three most popularly used power supply circuits.

Intosh does in driving the *Laserwriter*, including graphics so fancy that they are not available out of any of the common Mac programs.

We'll note in passing that *MacPaint* has no way to handle the high-resolution alphabets, *MacWrite* isn't good at larger or integrated graphics, and *MacDraw* is a cruel joke at best.

HIRES dumps or any other bit-mapped graphics are done by converting them to hex ASCII character pairs that are easily handled by *Applewriter* and its *WPL* supervisory language.

The *Appletalk* network stuff is also not needed. In fact, it can severely limit what you can do with the *Laserwriter*. Among

## A 10,000 Microfarad Capacitor will give one volt of ripple under a one ampere load.

Fig. 3. The magic "10k" rule for power supply filter capacitor design. Use this rule only when designing a 50- or 60-hertz full-wave power supply. When designing a half-wave power supply, double the capacitance.

other things, it excludes you from using the so-called *Diablo* emulation mode.

And yes, I'll put my money where my mouth is.

I have five *Laserwriter* images created with *Applewriter* on a *Ile*. I'll be glad to send you free copies of them. I'll also gladly give a free *Sams* book to anyone who can show me *any way at all to do these on a Mac* that is even remotely as cheap, as easy, as powerful, and as convenient as using *Applewriter* on a *Ile*.

Figure 1 shows a typical image. This was done on a *Ile* under *Applewriter*. Once you know exactly what you are doing and have built up a library of goodies, this complex an image should take you around 10 minutes to program and 17 seconds to print. Materials cost is under four cents for a single color, and under seven for two.

One neat thing that is not at all obvious is that it does not matter what order you put the image onto the *Laserwriter*'s bitmap. You are free to, say, do your backgrounds first, artwork second, your headlines third, and your fine print last. More importantly, you do a form letter by putting the letter in the *printer* and changing only the name and address for each repeated pass. A *Ile*, again with *Applewriter*, can process hundreds, or even thousands, of letters at a whack.

Watching customized form letters quietly pour out of a machine at an eight-

copy-per-minute rate is a joy to behold. Yes, I have automatic software for both form letters and envelopes—call or write.

There are some problems though. The quality is not quite what a print house would call "typeset," since the resolution is "only" 300 dots per inch. A printer might call this "tabloid" quality. One way to beat this is to work double or triple size and then photo-reduce the result.

Another way is to find one of the many "real" typesetting machines that speak the same *Postscript* language the *Laserwriter* does. Once you have exactly what you want, the *same* software on the *same* machine can give you good typeset quality, say to 2400 dpi and beyond.

A second obvious problem is that there is no way to tractor feed anything, so things like envelopes, labels, or business cards have to be hand fed. And hand feeding requires custom programming.

Turning to nit picking, the laser engine itself shows some truly bizarre human engineering. You need continuous access to all four sides and the top of the printer, including the ability to simultaneously observe status lights at *both* the front and the back of the machine. An unreachable and often-used selector switch requires that you add a shaft extender before you can even put a knob on it, let alone use it.

The paper tray is far too shallow to the point of being a joke. An unnecessary "U" turn in the paper path adds to the

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jam potential and limits paper weight, but accomplishes nothing else useful. And while ridiculously quieter than most other printers, a laminar fan redesign could make the silence totally eerie.

That eight-pages-per-minute rating is the absolute maximum speed on repeat copies, and then only after you custom flip a magic "prefeed" software switch that ups the wear and tear on the laser engine. It is very easy for a complex image to take several minutes or more to finally get any output. Nonetheless, the print speed is impressive—awesome, even.

Print quality is surprisingly good on a very wide range of different papers. Gray images tend to blotch a little on high-rag papers. Giant black areas aren't quite solid either, but they are certainly usable.

You aren't supposed to use thermal "raised print" letterheads, but I suspect you can get away with it by always changing back to an older cleaning pad while you use them.

Yet another problem is that the *Diablo* emulation mode, like everyone else's, just flat out does not emulate a *Diablo* printer. I found out how to fix this so that you can easily do a true wall-to-wall microjustification and proportionally space in this mode. Pick up details by calling the Synergetics telephone number in the box and asking about the patches and utility package I have available.

And one thing that is absolutely infuriating. The toner cartridges are *not* the same as the stock *Canon* photocopier cartridges. In fact, through the use of special

*Torx* "tamperproof" screws, missing notches, brackets that are slightly different, etc., they went to an awful lot of trouble to make darn sure you would not casually interchange the two. Thus, printer cartridges will cost you more and will be harder to get, particularly in colors. The toner cartridges also look like they will be more than a little tricky to refill on your own.

## How do you design a power supply filter capacitor?

It never ceases to amaze me how many people do not know how to design a filter capacitor for a power supply. Thanks to an obscure and little known magic rule, the process takes all of five seconds and can easily be done in your head without pencil or paper.

Let's review.

Figure 2 shows the three most common power supply arrangements used today. These are the half wave, the full-wave center tapped, and the full wave bridge circuits. Also shown is how to spec the secondary voltage you need for a given dc output voltage, and vice-versa.

Practically all power supplies today use capacitor input filters and allow fairly high values of ripple voltage. The ripple is then taken out and the output voltage is dropped by an integrated-circuit voltage regulator that follows the "brute force" supply.

Now for the rule. Check out Fig. 3. A 10,000 microfarad capacitor gives you 1 volt of ripple for 1 ampere of current. Just scale from there. A 1000-microfarad capacitor will give you 1 volt of ripple for 100 mils of current; 2500 microfarads should be a safe value for 1 volt ripple at 250 mils; and so on.

All you have to remember, then, is the "10k rule." There are two minor gotaches, however: The rule works only at 60 Hertz, but you can scale from there; and you have to double the rule for half-wave supplies.

Just why does the 10k rule work? Nor-

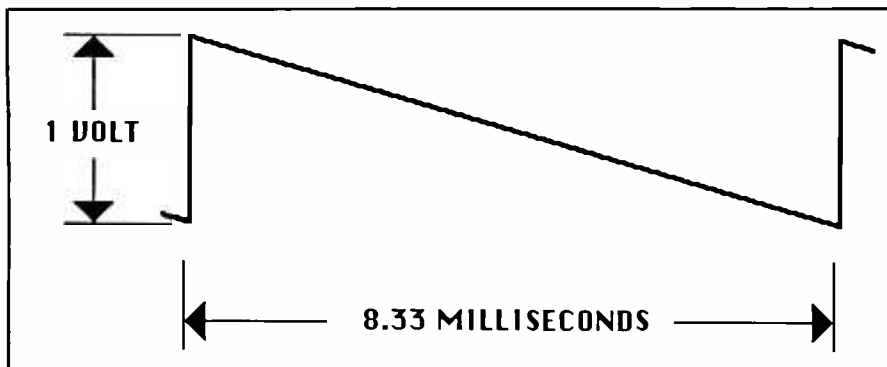
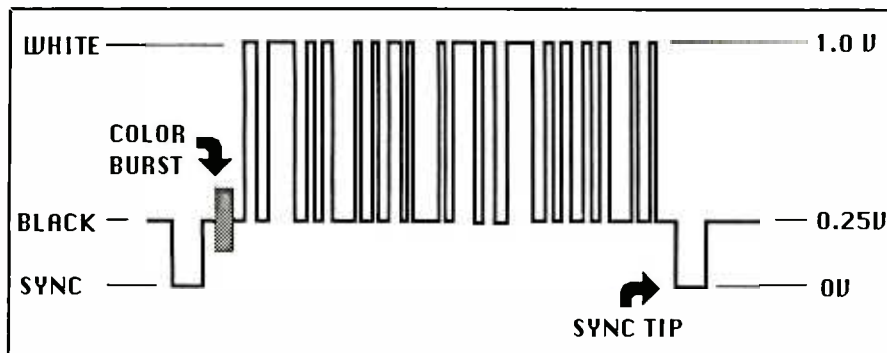


Fig. 4. This is the approximate waveform across an 8300-microfarad filter capacitor in a full-wave 60-Hz, 1-ampere supply. To simplify scaling, figure an even 10,000 microfarads.

Fig. 5. A typical data monitor composite-video signal.



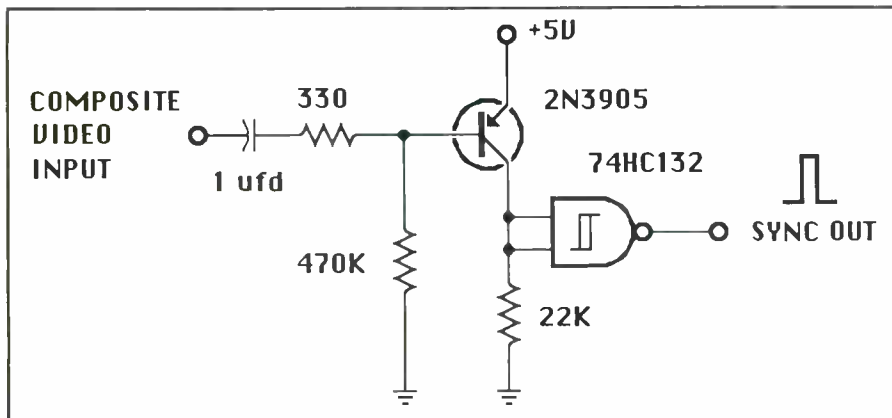
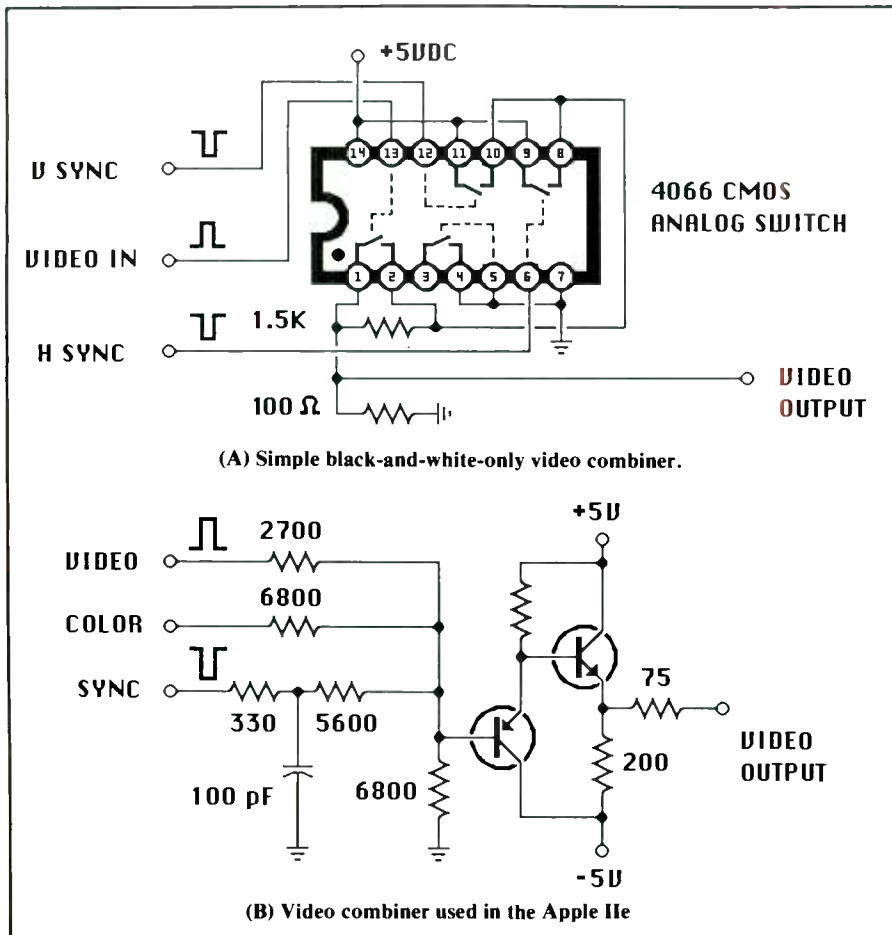


Fig. 6. This simple sync stripper extracts sync pulses from composite video.

Fig. 7. Either of these two simple circuits can be used to combine sync, video and color burst signals into a single composite-video signal.



mally, ripple is only a tiny fraction of the total output voltage; so the waveform at the capacitor looks almost like a sawtooth. The waveform briefly charges the capacitor only during the very peak of the input ac cycle. Then the capacitor discharges into the load for the rest of the cycle. (Note that the diodes conduct very briefly for only a very small portion of each line cycle.)

Now, the capacitor waveform isn't quite a sawtooth, since the diode conducts for a while and the decay is really exponential. Let's make the conservative and useful assumption that there's a true sawtooth waveform at the capacitor, as shown in Fig. 4. The operating rule of a sawtooth applied to a capacitor states that the current equals the capacitance times the voltage change divided by the time interval [ $I = (C\Delta V/t)$ ]. To normalize things, let  $I$  be 1 ampere and  $\Delta V$  be 1 volt. A full-wave rectifier generates a 120-Hz sawtooth, which has an 8300-microsecond ( $1/120$ ) time interval.

In solving the equation, you see it takes 8300 microfarads to allow only a 1-volt drop for a 1-amp current in 8.33 milliseconds. Since 8300 isn't a stock value, we conservatively round things out to an even 10,000 microfarads.

And there's our magic rule.

### How do I strip video sync signals?

Thanks to all the bargain video monitors and orphaned microcomputers on sale these days, there's been an awful lot of help line requests for either combining sync and video signals or else taking them back apart again.

If the video dots and the synchronizing signals are together on one wire, this is called "composite video." If the video dots are on one wire and the synchronizing signals are on one or more separate wires, this is called "split sync."

Needless to say, you need a sync stripper to get from composite video to split sync and a sync combiner to get from split sync to composite video. Which you need

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depends on which bargain parts you happen to be using.

If you are interested in only black-and-white video directly cabled to a monitor, sync stripping or combination is no big deal. It's only when you need noise-free over-the-air transmission, color or gray-scale that things get messy.

Figure 5 shows a "typical" combined video signal. Normally, the signal is 1 volt high. Sync pulses are at 0 volt, with the horizontal sync pulses being around five microseconds wide, and the vertical sync pulses being a fancy waveform that lasts around 200 microseconds. Video black is around 0.25 volt, and full white is at 1 volt. Gray is between white and black.

The time between horizontal sync pulses is usually around 63 microseconds (15.735 kHz) for standard video, but can

NAMES AND NUMBERS		
<b>Addison Wesley</b> General Books Div. Reading, MA 01867 (617) 894-3700	<b>Inside Laserwriter</b> 467 Saratoga Road S621 San Jose, CA 951129 (408) 966-1010	<b>Player Piano Company</b> 704 East Douglas Wichita, KS 67202 (316) 263-3241
<b>Byron Originals</b> Hiways 59 and 75 Ida Grove, IA 51445 (712) 364-3164	<b>Motorola Semiconductor</b> Box 20912 Phoenix, AZ 85018 (602) 244-6900	<b>Howard W. Sams</b> 4300 West 62nd Street Indianapolis, IN 46206 (800) 428-SAMS
<b>Del Aire Products</b> 407 North 7th Street Allentown, PA 18102 (215) 432-9975	<b>Postscript (Adobe)</b> 1870 Embarcadero Road S120 Palo Alto, CA 94303 (415) 852-0271	<b>Synergetics</b> Box 809 Thatcher, AZ 85552 (602) 428-4073

be much less for high-resolution monitors that run at higher sweep frequencies. The vertical sync pulse rate is usually 16.7 milliseconds (59.95 or 60 Hz). The time between vertical pulses is called a field.

Sometimes, two fields are interlaced into a single frame. Interlace does not work well with dot-matrix characters; so most micro uses of video do *not* involve the interlace technique.

Should color be used, there is a color burst tacked onto the back porch of the horizontal sync pulse. This is an 8-cycle burst of 3.579545 MHz that is used to synchronize the color circuits of the display or monitor if it is using NTSC (never the same color) stock video.

NTSC video is limited in bandwidth and color resolution, so you cannot normally get more than 40 dot-matrix characters across a color TV screen. To beat this limit, fancy monitors use RGB video in which individual signals are sent directly to the red, green, and blue guns. Each gun then behaves as if it is really receiving high-bandwidth B&W video. Only at the screen is the color sorted out.

Figure 6 shows a simple sync stripper that will split the sync pulse from a composite-video signal. The transistor and input coupling capacitor act as a "leaky dc restorer" and only the very sync tips get highly amplified. The output Schmitt trigger then further cleans up the signal and inverts it to positive-going sync.

Note that the value of the bias resistor

on the transistor is much higher than normal. You want the transistor to amplify *only* the negative-most sync tips. This resistor's value can be adjusted for the best operation.

Note also that you can use the other Schmitt triggers in the quad package to separate the vertical from the horizontal sync. Just how you do this depends on what polarity signals you want, but the key is to stall half a horizontal time and then check for a high level. If high, you have vertical sync.

Much more information on simple video interface appears in my *TV Typewriter Cookbook (Sams #21313)*.

Combining sync is just about as easy as stripping sync. Usually, you will have a video signal, a horizontal sync signal, a vertical sync signal, and an optional color burst on separate lines, and you want to merge them into a single output line.

Figure 7 shows two circuits for doing this. The first uses a single CMOS analog switch to combine everything. This one may be slightly low in bandwidth and is black-and-white only, but is sure is simple. The second is the sync combiner used in later versions of the Apple IIe.

If you have to get fancier, Motorola is now second sourcing some very interesting and very complicated integrated circuits that do all sorts of neat video things "by the rules." Be sure to check out their MC1374, MC1377, TDA3301, TDA3303, TDA3330, and TDA3333 in particular.

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