

# HARDWARE HACKER

**Laser printer repairs, sync-separator circuit, GPS navigation update, video interface module, and hacking Super Nintendo!**

**DON LANCASTER**

**W**e will start out with our usual reminder that this is your column and you can get lots of technical help, off-the-wall networking, plus consultant referrals per the box below. Your best calling times are from 8–5 weekdays, mountain standard time.

But please, before you call, make sure that the answer isn't already in the text or in the *Names and Numbers* or in our occasional special resource sidebars. And please have a pencil or pen handy. I just cannot believe the number of calls I get from readers that either refuse to look at or can't find the sidebars.

I am also greatly expanding our informal PostScript *Hardware Hacking Consultants Network*. Send me a letter or give me a call if you wish to participate.

We also have special *Hardware Hacker* and *Midnight Engineering* topics up on *GENIE PSRT*. You could reach me via [SYNERGETICS] e-mail here to get the preprints, reprints, tutorials, and other great downloads in our ongoing experimenting in electronic on-demand publishing—and receive late breaking news (especially on PostScript, solar energy, and caller ID) literally as it happens.

We do have lots of information this month on the *Super Nintendo* interface. But first...

## A GPS update

We sure had strong reader interest in our GPS navigation story from two columns back, so here is a quickie update:

That GPS, or *Global Positioning Satellite* system includes a flock of roving satellites that broadcast spread spectrum codes on 1227.6 and 1575.2 megahertz. By receiving those signals and digitally processing them, you can obtain your exact

position and speed anywhere in the world to an absolute accuracy of a hundred feet or so, and a potential relative accuracy of an inch or less. Thus GPS can be used for long-distance navigation *and* for accurate surveying.

The horse's mouth key paper you need is known as the ICD-GPS-200 document and is obtainable at no charge to U.S. citizens through *Space Systems Division/MZEE*. You must send them a letter stating your name and purpose.

A great \$12 Dan Doberstein reprint titled *A GPS Data Receiver* is newly available through *DKD Instruments*. It includes an excellent tutorial on GPS, full construction details on his ham radio-style GPS receiver, and an extensive bibliography. The receiver is both data-only and an older analog design. While specifically designed with hardware hacking in mind, this receiver is definitely not a "shake the box" project. You'll need microwave, digital logic, RF design, and software skills to successfully complete it. Your costs are also likely to be very much higher than by using a modern digital chip set as well.

Good navigation technical papers often appear in the *Journal of the Institute of Navigation*. Those folks also have a new three-volume *GPS Resource File* available for \$50.

The prices of the commercial

GPS receivers are literally in free fall, and I'd expect a \$35 chip set and a \$79.95 system within five years. Today's best offer in a high-quality receiver useful for trucking companies and such appears to be the GPS-1 from *Loyola Enterprises*. The current list price is \$795 plus software.

Note that all the GPS signals are right on top of each other and deeply buried in background noise, so any old surplus microwave receiver tuned to the GPS frequencies will show you nothing useful at all. Special digital *despreading* circuits must get built into your receiver.

I'll try to work up a tutorial on GPS in a future column. But I think I'd better first do some background stuff on the very fundamentals of digital correlation and spread spectrum communications. Whenever.

## Video sync separation

Another popular helpline topic is video interface. And the number-one ongoing request is for a simple and effective sync separator. The *sync separation* process lets you take the normal composite video signal and extract those horizontal and vertical synchronizing pulses from it.

The most obvious use for a sync separation is to let you clearly view video signals on your oscilloscope. Without a field or frame reference, all you will see is a blur. Other uses for sync separation involve stripping closed captioning or other data off specific horizontal lines present during vertical retrace, grabbing stock quotes, inserting windows, pattern generators, title overlays, wiping and fades, color keying, and other special effects. Or simply adding a pair of crosshairs.

Figure 1 shows you a simple and low-cost circuit I've worked up that

## NEED HELP?

Phone or write your **Hardware Hacker** questions directly to:  
**Don Lancaster**  
**Synergetics**  
Box 809  
Thatcher, AZ 85552  
(602) 428-4073

can combine both an effective sync separator and a low-cost universal video interface card. The key chip is the *National* LM1881 sync separator mini-dip. You take your usual one to two-volt positive-going *sync = ground* video signal and capacitor couple it to pin 2. The chip extracts the composite video and produces the active-low TTL/CMOS-compatible composite sync output on pin 1.

Several other pins on the LM1881 provide other functions that you may find handy. Pin 3 gives you a vertical sync reference as one single pulse without the usual teeth or serrations. This is the one you will usually want to lock your scope to. Pin 5 is a burst gate that gives you a slightly delayed horizontal sync pulse that can be used to extract any NTSC chroma burst information from the signal.

An RC network found on pin 6 is intended to create a default vertical sync in the absence of a true NTSC video input. This is handy for the "almost" NTSC common to the computers and video games. The

time constant can be shortened for higher scan rates; see National's data sheet for details.

Finally, pin 7 lets you pick out the odd and even fields of an interlaced NTSC frame. The output is active

only when the input composite video has a full interlace. Advanced color editing is one possible use.

An external source of the usual five-volts DC is needed. Since the current is only seven milliamperes, just about any old supply will do. As usual, keep the power bypass capacitors real close to your chips.

Several other features on the circuit are handy for special video interface cables. The three large capacitors let you couple red, blue, or green video off emitter-follower outputs and then connect them to RGB monitors. A 75-ohm resistor is handy for terminating cables. And a logical high signal is useful for such things as enabling the sound on certain receiver/monitors.

By itself, the inverter is handy for converting active-low sync into active-high and vice versa. While most of the video systems use active-low sync, *Commodore* and one or two of the others might not.

The printed circuit layout is shown in Fig. 2. Empty boards, kits, tested circuits, and both stock and custom interface cables are available from *Redmond Cable*. You can call or write them for a current price list. I'll also post this layout on *GENie* PSRT so you can easily create your own accurate version without the need for any photographic work. See HACKFG51.PS.

You might want to keep some empty or partially populated boards on hand to solve special cabling and interface uses. The large runaround

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## SYNERGETICS

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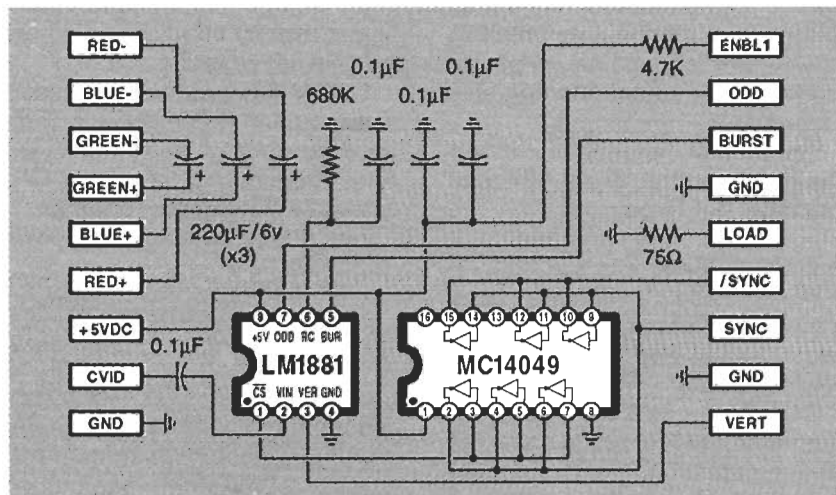


FIG. 1—THIS COMBINATION SYNC STRIPPER and universal video interface can solve a lot of problems for you, including Super-Nintendo-to-anything interfacing, video overlay, and scope TV frame locking. Kits, fully tested units, and custom cable assemblies are available through Redmond Cable.

ground on the outside of the board is especially handy for shielded-cable terminations.

For this month's contest, just tell me about an unusual or off-the-wall use for a sync-stripper circuit. There will be all of those usual *Incredible Secret Money Machine II* book prizes, along with an all expense paid (FOB Thatcher, AZ) *tinaja quest* for two going to the very best of all. As usual, send your written entries directly to me at *Synergetics*, rather than over to **Radio-Electronics** editorial.

Let's hear from you.

### Nintendo interface

As Fig. 3 shows us, there's a very interesting *Multi-Out* connector on the back of those *Super Nintendo* game machines. That gives you lots of alternate video and sound output formats that you might find handy.

For instance, you can go to a RGB monitor for sharper images and better colors. Or add total stereo sound or Super VHS improved resolution.

Or you may want to hang any old TV-compatible color monitor plus a pair of headphones on the machine to silence kids and keep them off your main prime-time television set.

Let us see exactly what is on the

connector and how to use it. By a special arrangement with *Redmond Cable*, all the connectors, that interface kit, and special and stock cable solutions for most *any* Super Nintendo interface are now available.

The Multi-out connector is really six-over-six edge traces on a double sided circuit board. Looking at the rear, the traces are odd numbered 1,3,5,7,9,11 on the top, going right to left. And the similar pins are even numbered 2,4,6,8,10,12 on the bottom, again going from right to left.

Both pins 7 and 8 are grounds. The pair make terminating several shielded wires much easier.

A +5-volt DC output is provided on pin 10. It appears to be capable of driving at least 50 milliamperes. But you shouldn't suck the poor machine dry, and you should very carefully bypass and filter any use of the supply.

There are a pair of sound outputs. Pin 11 is your choice of monophonic sound or L+R matrixed stereo. Note that "left" plus "right" equals "both." Pin 12 is L-R matrixed stereo. These signals are capacitor-coupled and are the proper size for your usual audio inputs on a hi-fi receiver or computer monitor.

Note that some computer monitors have a sound capability

and some do not. The easiest way to tell is to find an obvious *volume* control located somewhere on the set. No volume control, no sound. Other monitors may need a special pin activated to turn the sound on or off. We'll see an example of this shortly.

All your sound cables should, of course, be shielded.

Sadly, the power levels are far too low to usefully drive a speaker or a pair of headphones. But *Radio Shack* has an interesting beastie that no Hardware Hacker should be without. It is their #227-1008C mini-amplifier and speaker. The L+R output easily drives the mini-amp via a miniature phone plug.

The mini-amp solves the problem of a monitor that has no sound. You can also plug headphones into your mini-amp for any silent running. The mini-amp is powered by your choice of an internal alkaline 9-volt battery or by a plug-in 9-volt DC supply.

Because of the matrix used, you cannot get stereo directly off pins 11 and 12. Instead, you have to *add* the two signals together to get the left channel, and *subtract* the two signals from each other to pick up the right channel. Like so...

$$(L + R) + (L - R) = 2L$$

and

$$(L + R) - (L - R) = 2R$$

A stereo dematrix can be done with a quad op-amp or a transformer and four resistors. In theory, you could make use of a CMOS-biased inverter amplifier, but your common-mode supply noise rejection might suffer on the right channel. More details on biased inverter amplifiers appear in my *CMOS Cookbook*.

Let me know if you need any more information on stereo matrix extraction.

There are three different types of video outputs found on the multi-out connector. Plain old grounded sync composite video appears on pin 9. That can be routed to any standard NTSC video input on a monitor, VCR, or television set. Note that a direct video input will often have sharper images and better colors than does entry by way of some channel 3 or 4 modulator. That's because less electronics get in the way and an RF modulation and demodulation can be eliminated.

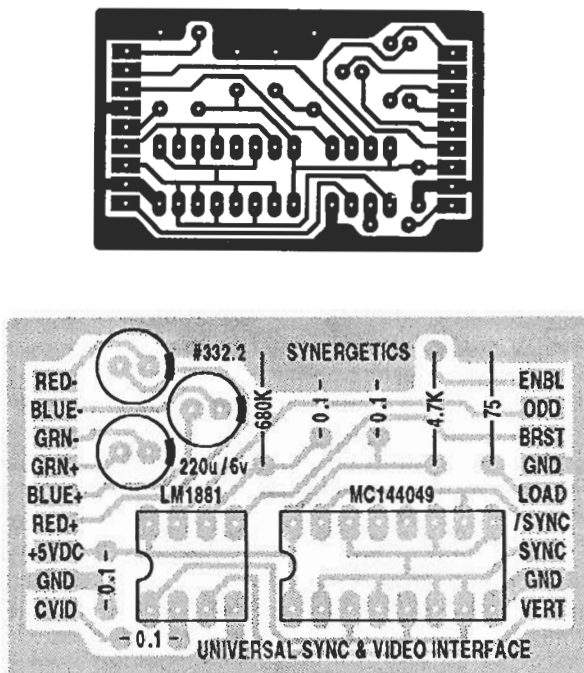


FIG. 2—PRINTED CIRCUIT BOARD LAYOUT and overlay for the universal video interface. Accurate and camera-ready art is also available via GENIE PSRT as file HACKFG51.PS. PostScript downloads can eliminate all darkroom work.

Super VHS, or Y-C video appears on pins 7 and 8 with that luminance "Y" output on pin 7 and the chrominance or "C" output on pin 8. They can be routed to any system which accepts Y-C video. Because of the separation of the color information and the higher bandwidths, these outputs should look far better than regular composite video.

The best video of all, though, is available as a separate red (on pin 1), green (pin 2), and blue (pin 4) video. The red, blue, and green outputs come from emitter followers and have a strong DC bias. They *must* be capacitor coupled to your ultimate destination using a 220-microfarad or higher series capacitor on each line. Be certain to put the (+) side of the capacitor on the Nintendo end.

The needed RGB sync appears on a fourth active-low line on pin 3. The active-low sync is correct for Apple IIGS, Sony, and most "standard" RGB uses. It is the complement of what is needed for *Commodore* and certain others. The line swings rail-to-rail or ground to +5 and thus is both CMOS and TTL-compatible.

Note that some connector plugs do not have all of their pins available, especially for the RGB sync and VHS chroma. The Redmond plugs include all of the pins.

Several interface circuits appear in Fig. 4. In each case, a partially populated Fig. 1 circuit can be used to greatly simplify your cables and interface.

In Fig. 4-a, you can connect RGB video to any Apple IIGS monitor by using the three serial video capacitors and the right connector on each end of your cable. Since the IIGS monitor has no speaker, you have to use a hi-fi or the *Radio Shack* mini-amp.

Figure 4-b shows an interface to the older *Sony* KV1311-CR receiver/monitor. Again, we have those three serial video capacitors. This time we use an enabling resistor to turn on the internal sound and eliminate any need for a companion amplifier.

The interface to the *Commodore* 1084 color monitor is shown in Fig. 4-c. As usual, the red, blue, and green video have to be capacitor

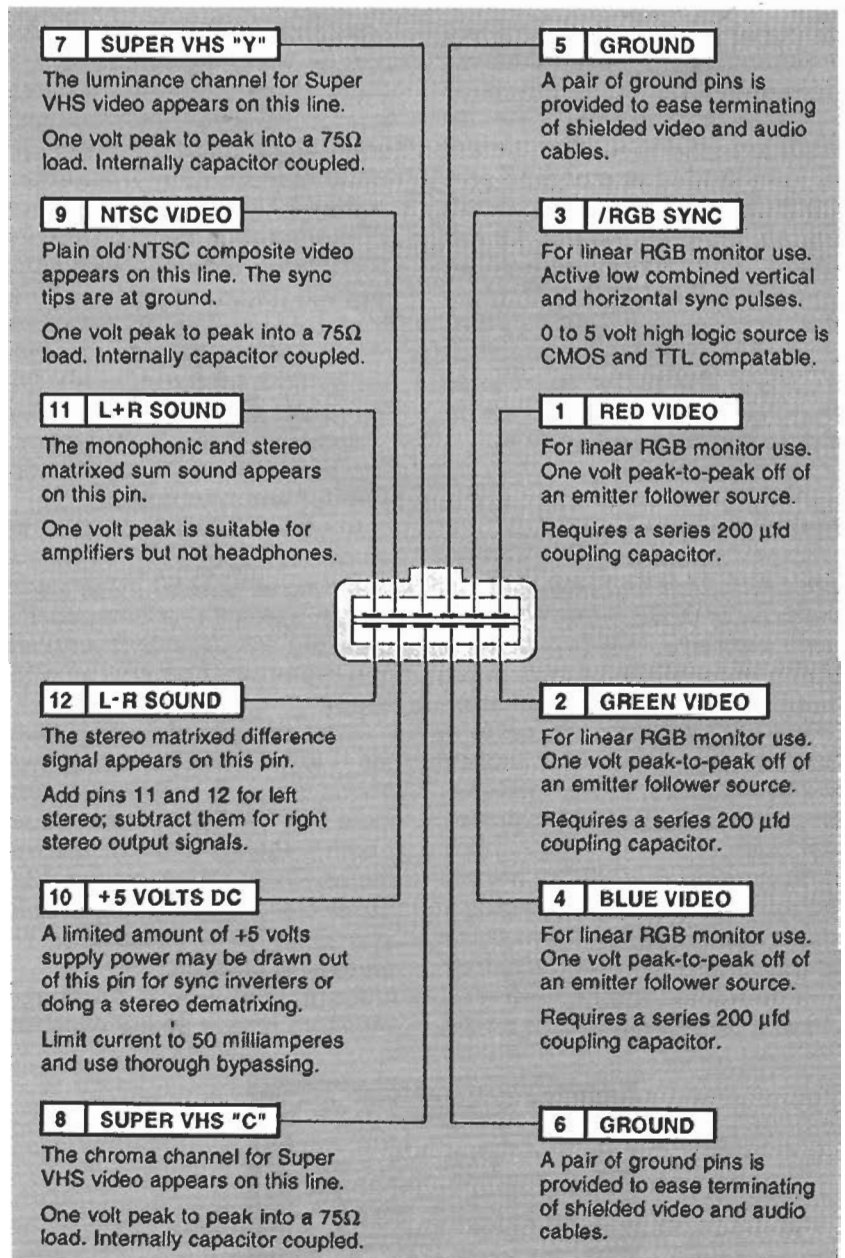


FIG. 3—THE SUPER NINTENDO MULTI-OUT REAR CONNECTOR has all sorts of useful video and audio options available. Here are the key details.

coupled to the appropriate pins on the *LinRGB* connector. This time, an active-high sync is needed rather than active-low, so the inverter must get added as shown. While the sound is internal, it has to be routed via a separate audio cable and phono plug that goes into the *Audio* input. The size and position adjustments on the back might also need a slight readjustment.

Yes, we are working on VGA and multi-sync solutions. Stay tuned or check *GENie* PSRT for availability.

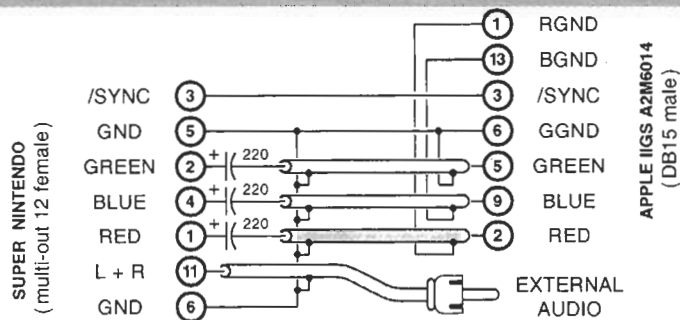
Once again, some mix-and-match kits, all-pin connectors, parts, and cables are available from

*Redmond Cable*. Do let me know which other interface circuits you would like to see worked out.

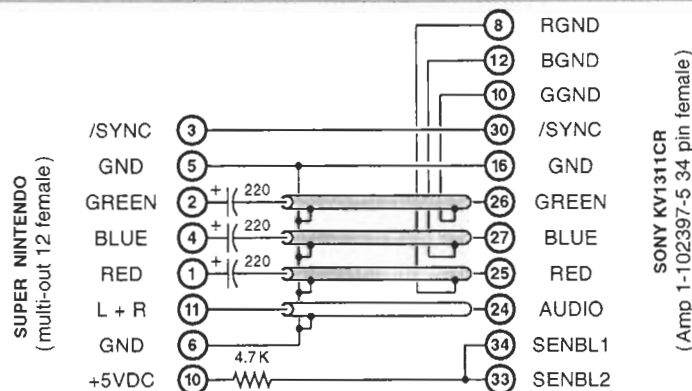
### Laser printer repair

Where can you go to get training, parts, and information on today's laser printers? Many of the printer manufacturers are super secretive and go far out of their way to prevent you from getting the parts and materials you need to make best use your printer and to keep it alive cheaply. So, for this month's resource sidebar, I thought we'd gather together some of the best of the laser repair resources.

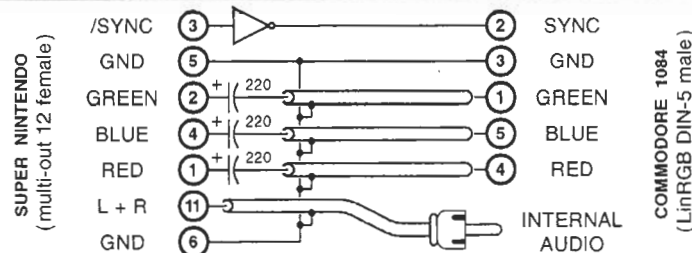




(A) APPLE IIGS A2M6014 MONITOR



(B) SONY KV1311CR RECEIVER/MONITOR



(C) COMMODORE 1084 MONITOR

FIG. 4—TYPICAL SUPER NINTENDO TO LINEAR RGB video monitor interface connections can give you sharper resolution and better colors.

The overwhelming majority of all laser printers use *Canon* engines, so that is usually where you'll want to start. *Hewlett Packard* has by far the best and the most available *Canon* manuals in the industry. And since an SX engine is an SX engine, those HP manuals are most useful on similar *Apple*, *QMS*, and lesser machines.

Figure 5 summarizes the key HP service manuals, along with some of the competing machines they cover. HP recently has sharply raised all of their service manual

prices. Many of these HP service manuals are in the \$100 range. Even at that price, they pay for themselves on their first use. They are essential gottahaves.

HP also sells parts to anybody overnight via VISA and an 800 order line. Again, sadly, individual parts are hard to get. They prefer to sell you an entire \$50 fan instead of the 50-cent grommet which is the only thing that ever goes wrong with the fan.

The best place to go if you want to buy individual laser-printer parts is

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33459-90906 (SX Engine)	LaserJet IID LaserJet IIID	-----	-----
33471-90904 (LX Engine)	LaserJet IIP	Personal LW NT	PS410
33491-90929 (SI Engine)	LaserJet IIIsi	-----	-----

**FIG. 5—THESE HEWLETT-PACKARD LASER SERVICE MANUALS** can be used for mechanical repairs on most of the printers shown here. While expensive, they are the best information sources available, and far easier to get than the others. Many different laser printers use Canon engines, so these HP manuals are very useful on similar machines. HP also sells parts to anybody overnight via VISA and an 800 order line, although individual parts are hard to get.

Don Thompson, who also novfers by far the finest multi-level t ing and repair seminars in the e industry.

My two favorite places for t u refilling supplies and materials, Arlin Shepard of *Lazer Produc* and Walt Jeffries and his crew a *Black Lightning*. The latter are also into special toners for fabric printing and printed circuits as well, should you have such a need.

Black Lightning also publishes *The Flash*, a free and friendly news-letter crammed full of useful desk-top information.

There are several laser-printing and toner-recharging trade journals, but the only one of any consequence is *Recharger*. They are already up to several hundred pages per issue, and list dozens of suppliers for just about any laser-printing repair need.

I try to carry a lot of toner and laser printer repair stuff on our *continued on page 75*

## HARDWARE HACKER

continued from page 68

GENIE PSRT. We also have on-line real-time conferences with the leaders in this field; lists of upcoming conferences and downloadable transcripts of past conference are available. These files usually will start off with an "RTC" prefix.

### New tech lit

From SGS/Thomson a new *Modem Databook and Applications* manual. From *Benchmark*, a 1991 *Databook* on their energy management (power switching) chips for laptops, real-time clocks, and non-volatile memories.

A new and very thorough *Heatsink Application Handbook* is available from *Aham Tor*. TV satellite products and information are offered by *AIS Satellite* and *Skyvision*. Both provide free catalogs. *Skyvision* has a very good satellite book selection.

Our two new trade journals for this month include *Electronic Product Review* that covers all kinds of new component parts and *CADalyst* for those users of Auto-Cad CAD/CAM systems.

The company *Small Parts* has always been a great place to go for all the robotic and mechanical stuff your hardware store never heard of. As well as any pre-cut plastic and metal shapes. They have recently moved to larger quarters, so you might want to note their new address and pick up a free catalog.

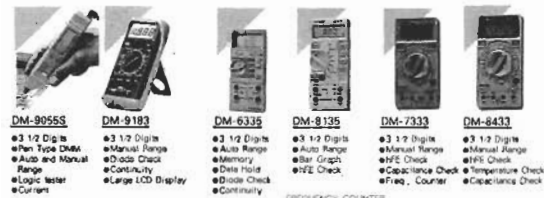
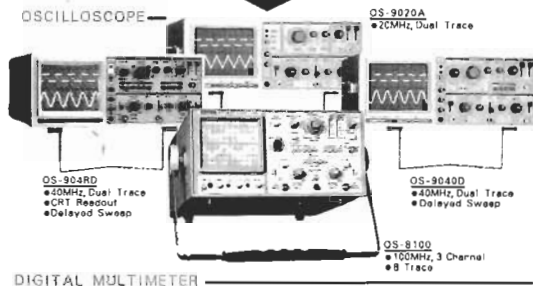
A free *School Shop* catalog from *Rutland* offers all the usual machine-shop tools and supplies.

A no-charge sample of backlit fiber-optic displays is available from *Serigraph*, while *Caplugs* offers a free sample *idea kit* of their plastic plugs, caps, and enclosures.

A reminder that I now stock my *Active Filter Cookbook* for all of the fundamentals of quickly building up your own analog low-pass, band-pass, and high-pass filter circuits. I've got autographed copies of the book on hand for you here at *Synergetics* when you call or write. You can get this book by itself or as one portion of my *Lancaster Classics Library*.

R-E

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"You're planning a vacation in the Pacific Northwest, and you want to line up things for the kids to do. So you need to find the amusement parks and zoos in Oregon and Washington."

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