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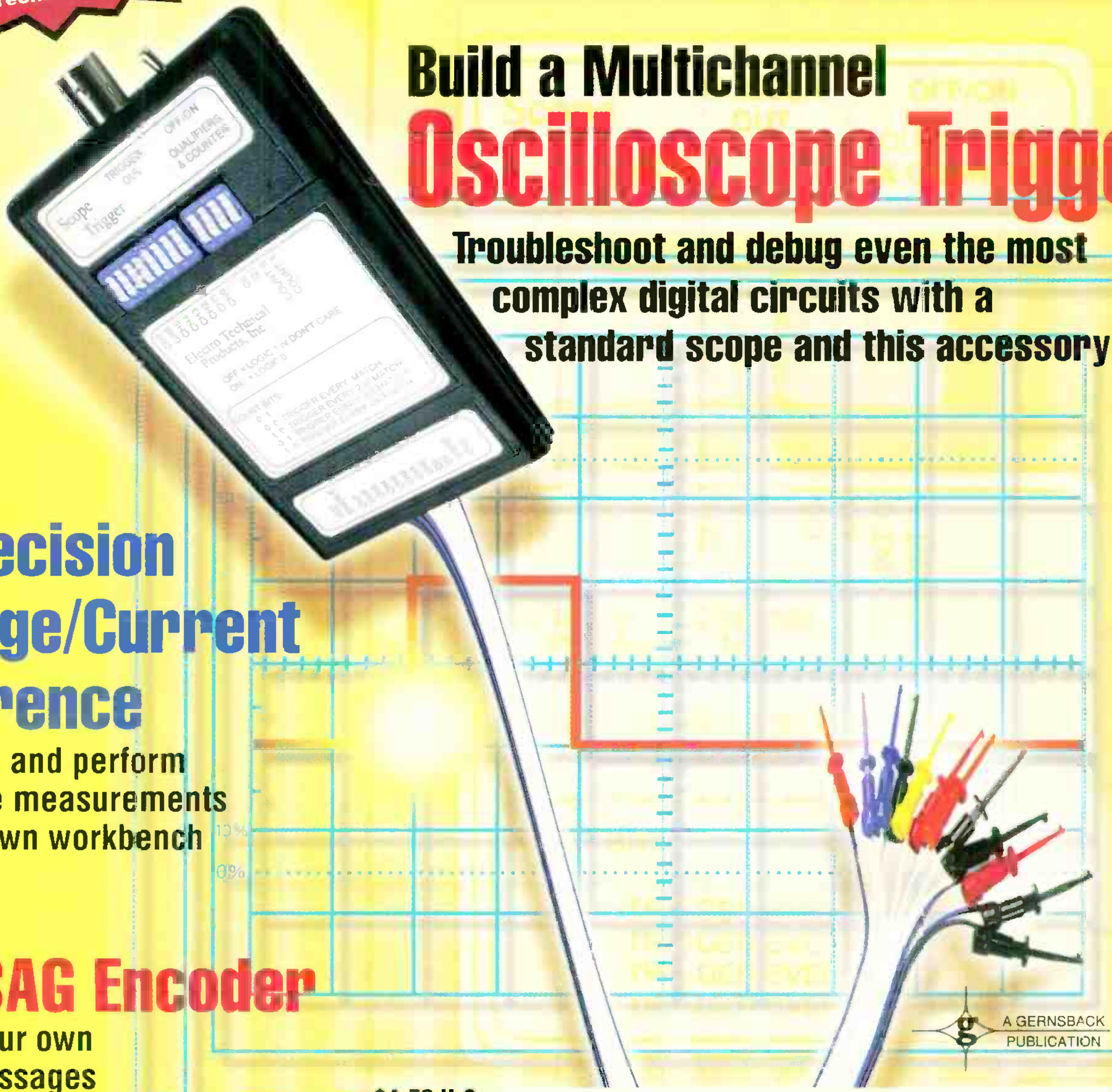

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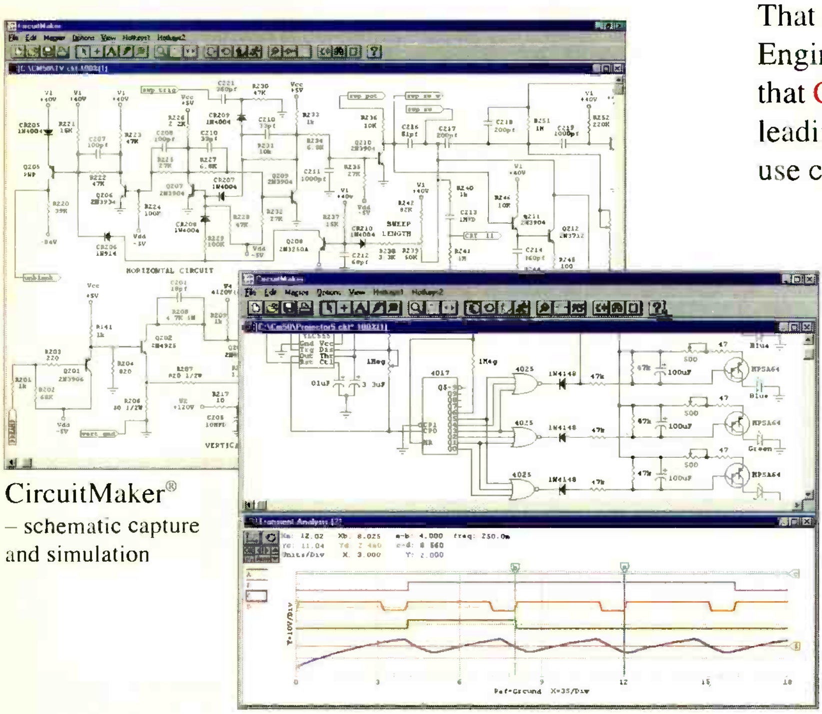

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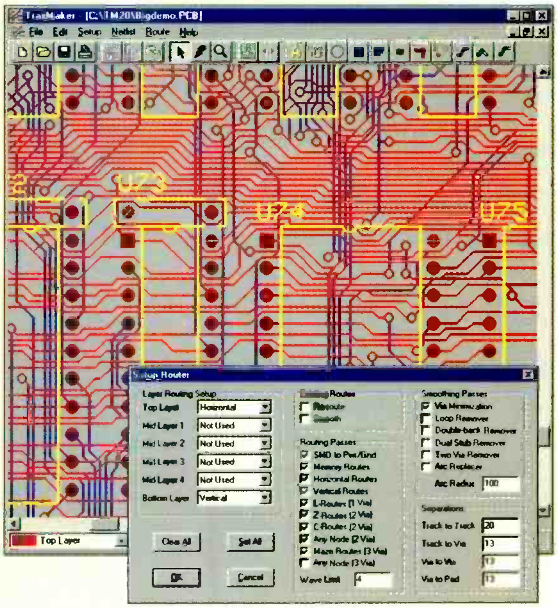

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Vol. 69 No. 2

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ON THE COVER

TECHNOLOGY

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EDITORIAL

Unanswerable FAQs

In the nearly 17 years I've been associated with Gernsback Publications, I've fielded hundreds, if not thousands, of reader questions. Most can be answered quickly and efficiently. Others simply can't be answered. Of course, as you might expect, it's the unanswerable ones that seem to come up time after time. Here are some examples of the frequently-asked questions (FAQs) we can't answer:

I need a circuit to . . . . We get a few of these a week, sometimes with detailed specifications and notes on the intended applications. If we answered them all, this page and all the ones that follow would be blank. The time demands of putting out **Electronics Now** just don't allow us to do the research and design work required. Even so, when we know of a circuit that will approach the reader's needs, we'll take the time to send it and often even add comments or hints to help things along. Further, the circuit requests we feel would benefit the greatest number of readers are printed and answered in our monthly "Q&A" department. One further suggestion here: Why not ask your fellow hobbyists for help? Posting a circuit request on the Forums at our www.gernsback.com Web site might just get you exactly what you are looking for.

How can I modify project XYZ? The projects that appear in these pages have undergone days, weeks, months, and sometimes years of development and testing by the author. Without duplicating that work, we have no way of knowing what the impact of any proposed modifications might be; in some cases, they could easily render a project dangerous to use. Therefore, any modifications are solely up to you. If you like, you could contact the author for help, but any response or help is solely up to him or her. Which brings us to . . . .

How can I contact the author? Actually, this is one we CAN answer. Almost always, our authors are independent contractors who do not work for the magazine. As such, our policy is to not give out mailing addresses or telephone numbers without their permission. In most cases, where authors are willing to be contacted directly, contact information is provided in the article. In all other cases, you must write the author in care of **Electronics Now**, and we will forward your letter. In a similar vein . . . .

What's the kit supplier's telephone number? Often there is none. That's because many of the companies doing kits for our authors are part-time "kitchen-table" operations that simply do not have the resources to handle telephone orders or other calls. In any case, all available contact information for any kit supplier is always provided in the article.

There you have it—our short list of unanswerable FAQs. We wish we could answer them all, but, alas, it's not a perfect world.

Carl Laron
Editor

Q & A

READERS' QUESTIONS, EDITORS' ANSWERS

BNC: The Answer?

Readers wrote from as far away as Australia to tell us what "BNC" stands for. The trouble is, they didn't agree! "Bayonet Navy Connector" was one of the most popular answers, sanctioned by a Hewlett-Packard catalog. Others include "British Navy Connector" and "Baby 'N' Connector."

The most authoritative source was an article in *Electronic Packaging and Production*, 1980, which cites a "legend" that BNC stands for "Bayonet Neill-Concelman." Paul Neill and Carl Concelman definitely did invent the earlier N connector and C connector respectively. It's certainly plausible that the B stands for bayonet, because a TNC connector is the same thing, with threads instead of a bayonet attachment.

We thank everyone who wrote.

Pulley Correction

Your answer to the question on slowing down a tape recorder ("Q&A," September 1997, page 11) is incorrect. A larger pulley on the motor shaft will cause the recorder to speed up. You need a smaller pulley on the motor shaft to slow it down. — Robert Blum, Huntington Station, NY

Oops! You are correct. We also thank Vincent Sullivan, for pointing out that the *torque*, not the *power*, is what changes when you change the pulley or gear ratio. He also points out that gears are not used in good tape recorders, though we've seen them in talking toys.

Power-On Sequence

Q *I need to turn on the components of my audio system in a particular sequence, about five seconds apart, to prevent loud transients in the speakers. Can you suggest a circuit that would automate the process, and would also turn off the equipment in the opposite order? — T. M., Pleasant Grove, UT*

A Power-on and power-off sequences are a classic problem in industrial electronics; old-fashioned solutions involve thermal-delay relays and other awkward circuits.

Figure 1 shows a thoroughly modern solution using an LED bargraph chip. In effect, the chip displays the gradual charging and discharging of a capacitor. But instead of turning on a set of LEDs, it drives a set of solid-state relays (up to ten) which can control AC loads. Adjust C1 until the timing suits you; you may need to make it as large as 220 µF. The power-down sequence will be slower than the power-up sequence.

Artificial Voice Box

Q *I am a laryngectomee; my larynx has been removed surgically. In order to speak, I use a vibrating device that I hold against my throat. Unfortunately, it makes me sound like an alien from outer space. I hate it!*

Is there a device I can build or buy that will smooth out the vibrations? I would use my vibrator to speak into the device which would remove some of the buzz, making the speech sound closer to normal. — E. C., Las Vegas, NV

A That's a very interesting idea. As you've found out the hard way, intonation (tone of voice) is the hardest part of speech synthesis. The human voice box varies in pitch and loudness, and even turns its vibrations on and off many times during the articulation of a single word. Your artificial larynx can't do anything but buzz continuously at a fixed frequency.

It would probably require digital signal processing, but it ought to be possible to filter your speech to remove some of the buzz and amplify the harmonics added by your vocal tract. Even then, your speech would be far from natural, but it ought to be easier to understand.

Thinking even more futuristically, why not pick up the nerve impulses that would have gone to your larynx if it were still there and use them to control the artificial larynx? Then you might be able to achieve much more natural speech.

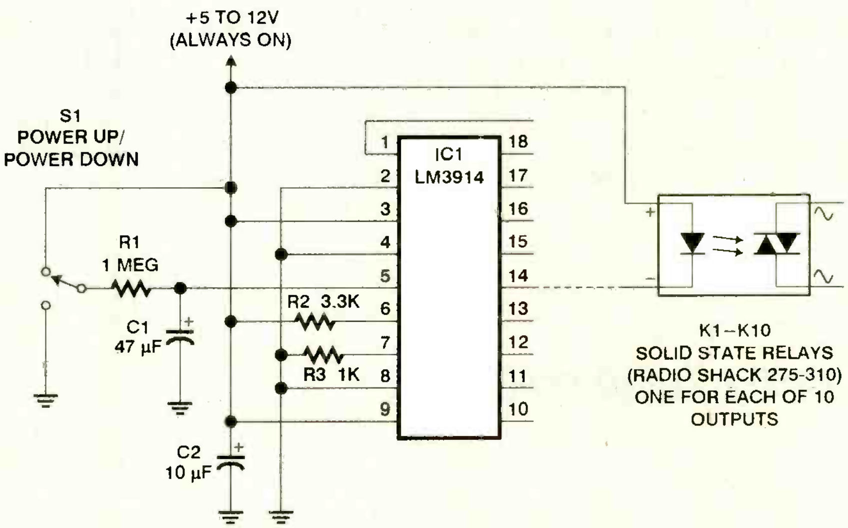

FIG. 1—A MODERN SOLUTION TO A CLASSIC PROBLEM—here an LED bargraph-driver IC is used as the heart of a circuit to turn equipment on and off in sequence.

HOW TO GET INFORMATION ABOUT ELECTRONICS

On the Internet: See our Web site at http://www.gernsback.com for information and files relating to our magazines (**Electronics Now** and **Popular Electronics**) and links to other useful sites.

To discuss electronics with your fellow enthusiasts, visit the newsgroups sci.electronics.repair, sci.electronics.components, sci.electronics.design, and rec.radio.amateur.homebrew. "For sale" messages are permitted only in rec.radio.swap and misc.industry.electronics.marketplace.

Many electronic component manufacturers have Web pages; see the directory at http://www.hitex.com/chipdir/, or try addresses such as http://www.ti.com and http://www.motorola.com (substituting any company's name or abbreviation as appropriate). Many IC data sheets can be viewed online.

Books: Several good introductory electronics books are available at RadioShack, including one on building power supplies.

An excellent general electronics textbook is *The Art of Electronics*, by Paul Horowitz and Winfield Hill, available from the publisher (Cambridge University Press, 1-800-872-7423) or on special order through any bookstore. Its 1125 pages are full of information on how to build working circuits, with a minimum of mathematics.

Also indispensable is *The ARRL Handbook for Radio Amateurs*, comprising 1000 pages of theory, radio circuits, and ready-to-build projects, available from the American Radio Relay League, Newington, CT 06111, and from ham-radio equipment dealers.

Copies of past articles: Copies of past articles in **Electronics Now** and **Popular Electronics** (post 1993 only) are available from our Claggk, Inc., Reprint Department, P.O Box 4099, Farmingdale, NY 11735; Tel: 516-293-3751.

Electronics Now and many other magazines are indexed in the *Reader's Guide to Periodical Literature*, available at your public library. Copies of articles in other magazines can be obtained through your public library's interlibrary loan service; expect to pay about 30 cents a page.

Service manuals: Manuals for radios, TVs, VCRs, audio equipment, and some computers are available from Howard W. Sams & Co., Indianapolis, IN 46214 (1-800-428-7267). The free Sams catalog also lists addresses of manufacturers and parts dealers. Even if an item isn't listed in the catalog, it pays to call Sams; they may have a schematic on file which they can copy for you.

Manuals for older test equipment and ham radio gear are available from Hi Manuals, PO Box 802, Council Bluffs, IA 51502, and Manuals Plus, PO Box 549 Tooele, UT 84074.

Replacement semiconductors: Replacement transistors, ICs, and other semiconductors, marketed by Philips ECG, NTE, and Thomson (SK), are available through most parts dealers (including RadioShack on special order). The ECG, NTE, and SK lines contain a few hundred parts that substitute for many thousands of others; a directory (supplied as a large book and on diskette) tells you which one to use. NTE numbers usually match ECG; SK numbers are different.

Remember that the "2S" in a Japanese type number is usually omitted; a transistor marked D945 is actually a 2SD945.

Hamfests (swap meets) and local organizations: These can be located by writing to the American Radio Relay League (Newington, CT 06111; http://www.arrl.org). A hamfest is an excellent place to pick up used test equipment, older parts, and other items at bargain prices, as well as to meet your fellow electronics enthusiasts—both amateur and professional.

Maybe this will be the next research project at a major lab somewhere.

Detecting Voltage Increase

Q *I have an overhead garage door with a safety beam across the opening. I would like to sound an alarm in the house when someone breaks the beam. When the door is up or down, the control voltage is 11-volts DC, and when the beam is broken the voltage rises to 20 volts. I need a circuit to detect that voltage increase and operate an alarm whose power supply is independent of the garage door opener. — E. U., Northfield, OH*

A A circuit that should do the job is shown in Fig. 2. It uses a Zener diode to subtract 12 volts from the voltage going to the coil of a miniature relay. Thus, at 11 volts, no current flows, but at 20 volts, the relay gets 8 volts, which is more than sufficient to pull it in, even though it's nominally a 12-volt relay.

Be sure to use a relay with a high coil resistance (500 ohms or more) so the diode doesn't overheat.

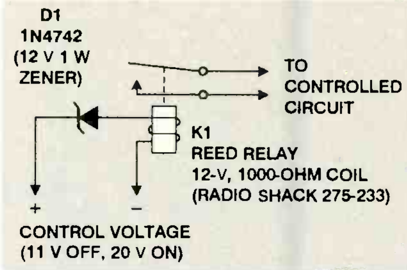

FIG. 2—HERE'S A CIRCUIT that can be used to detect an increase in voltage: The relay pulls in when the voltage exceeds about 17 volts.

Back-Up For Car Alarm

Q *My car, like most, has an alarm installed on it. Could you suggest a circuit for a 12-volt battery backup for the alarm that would also charge the back-up batteries as the car is being driven? — W. S., Phoenix, AZ*

A Without knowing the power requirements of your alarm, it's hard to be specific, but Fig. 3 shows a simple way to charge a 12-volt lead-acid gel cell from your car's power supply. Then the alarm will still work even if the main battery runs down.

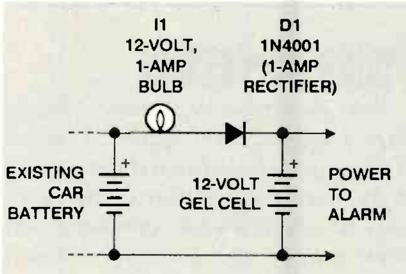

FIG. 3—THE CAR'S ELECTRICAL SYSTEM charges the 12-volt gel-cell back-up battery, but, thanks to diode D1, only the car's alarm is able to take power from it.

The diode acts as a one-way valve so that only the alarm can take power from the alarm battery. The light bulb limits charging current to 1 amp; under normal conditions it will never light up.

XT Memory In PC AT?

Q *I have an old 286 AT clone to which I would like to add more memory. Can I use an old memory card for an XT? — J. W. B., Warren, MI*

A Yes, possibly, but only up to a total of 640K (the memory limit of the XT). Addresses from 640K to 1Meg are reserved, and on the XT bus, higher addresses don't exist—the bus doesn't have address lines for them. There may also be timing problems. In any case, it won't hurt to try; you will not damage your computer.

Build A Multimeter?

Q *I am new at electronics and find it difficult to spend a lot of money on equipment I could probably build myself. I've been looking for plans for a good multimeter to no avail. Could you provide me with a design for a multimeter that measures ohms, capacitance, and AC/DC volts and amps? — G. G., Bradenton, FL*

A Believe it or not, it's generally cheaper to buy a multimeter than to build one. If you want a real bargain, find a partly defective multimeter that you can repair; many of the parts are replaceable. The main digital IC in a DMM, and the meter movement in an analog meter, are not easy to replace.

At the heart of any multimeter is a big multi-contact switch; that's the part that would be hardest to make for yourself. If you're building meters for yourself, it's easier to put fewer functions in each instrument, so you don't need complicated switching. See the *ARRL Handbook for Radio Amateurs* for some circuits and advice.

Avalanche!

Q *I'm having a difficult time finding out about skier avalanche communication. I wrote to you in July of 1996 requesting this information, have scanned every issue, but so far have found nothing. — R. G., Gig Harbor, WA*

A Unfortunately, space does not permit us to answer all the questions we receive, and this one has been particularly hard to research. Here's what we've found out so far.

Avalanche transmitters are carried by skiers so they can be located by radio direction finding even if they are buried in snow. Originally, they were very-low-frequency transmitters, operating at 2275 Hz, which is within the audio range. Newer ones operate on 475 kHz, just below the AM-broadcast band. Low frequencies are used so the signals won't reflect off objects or the atmosphere. Range is limited to a few hundred yards, but the higher frequency gives somewhat better range than the lower one.

We'd like to hear from readers with more information to share. Because it's a critical safety device, you probably wouldn't want to build your own avalanche transmitter, but homebuilt direction-finding receivers might make for some interesting experimentation. Also, some good multi-band radios cover 475 kHz, so all you'd need is a directional antenna.

Electronic Ignition

Q *My brother has a 1953 6-cylinder Chevy. He lives in a country where gasoline is expensive and of bad quality. Since I am an electrical engineer he has asked me for electronic help. Would a capacitive-discharge ignition help? Can you suggest a*

(Continued on page 18)

LETTERS

SEND YOUR COMMENTS TO THE EDITORS OF ELECTRONICS NOW MAGAZINE

Telephone Number Updated

Thanks for reviewing the TriField Natural EM Meter in "New Products" (**Electronics Now**, November 1997). However, our telephone number has since changed. Our current number is (808) 874-9126 (Phone/Fax). We can also be reached via e-mail at emfmeter@webtv.net or at our Web site: http://www.maui.net/~emf.

DAVID FAGGIOLI
ALPHALAB, Inc.

Code Readers Revisited

The article by Thomas Fox, "Reading Automobile Computer-Service Codes" (**Electronics Now**, December 1997), is a good one. I, too, have found *Sure You Can Work on Electronic Ignition*, Wells Mfg. Corp., to be quite useful. Mr. Fox did not mention that this book can be purchased, at a low price, at many auto parts stores and in the auto department of some discount stores.

As he did say, a service manual for the car is also needed, such as *Chilton*, *Haynes*, or *Motor's* manuals—available at the same stores. Another option is a manual from the car's manufacturer, which is the best source of service codes. However, a few manuals don't have codes. In that case, the general codes in the Wells' book can be used.

However, I have found that not all "code readers" are as useless as Mr. Fox's description. Since neither my 1993 edition of the Wells' book nor the manual of the Ford I was repairing had complete information about entering the diagnostic mode in a Ford product, I purchased a Sunpro CP9015 Ford Code Scanner for about $30. I found it to be much more than a simple code reader.

Besides reading the codes stored in memory, it also activates diagnostic routines in the car's computer. The "Key On-Engine Off" tests evaluate most of the sensors, relays, and solenoids; and there's also a "wiggle" test for finding loose connections (with a buzzer indicator). The "Key On-Engine Running" tests indicate current problems, which may not be stored in memory, and change various settings to see if the car responds properly.

On cars with separate fuel injectors for each cylinder (as opposed to "throttle-body" injectors), it will test for "weak," "very weak," or "dead" cylinders. This testing is done by turning off the injector for that cylinder and measuring the change in engine rpm. Codes are read out by a flashing LED, since many Ford products do not have a "Check Engine" light.

BILL STILES
Hillsboro, MO

"Does Not Compute!"

I am a free-lance journalist, who has written for **Electronics Now** and other technical magazines. I'm also a dinosaur—I balance my checkbook in my head, use a wall switch to turn on the lights, and use a four-legged security system to guard my house.

I still don't own a personal computer. From the look of things, I never will. My friends have given me all of the arguments. However, I still do all of my work on a word processor that costs only about 10% of the PC system I would need to replace it. Although I'd love to own a PC, I've never been able to justify the cost.

I draw my schematics by hand, knowing that a CAD software package can do it easier and faster. However, it would probably take me even longer to enter the unusual circuit elements I use into the program library. A PC-board design package might be handy, but most of my designs are too complex for a single-sided board—long traces are NOT the best solution.

Surfing the Net looks like fun, but after reading Michael A. Covington's nicely-done article "Ethics and the Internet" (**Electronics Now**, September 1997), I *definitely* would *never* send any personal information over the Net.

For years, I've used a RadioShack pocket-scientific computer (16K of RAM), running my own BASIC programs to handle all of the heavy math in my designs. Scoff if you like, but doing the most difficult problems still left me memory to spare!

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Screen Savers or Pretty Pictures?

From your article "All About Monitors" (**Electronics Now**, July 1997), I learned that their technology differs little from the TV sets that I repaired in the mid-1970s on board the USS Forrestal. A common fault on the scores of picture tubes I replaced was that their cathodes were no longer capable of emitting enough electrons to yield a good picture.

Usually, the green cathode wore out first, resulting in a purple image. All those sets had high voltage between 25 and 30 kV. Even though many of them displayed color bars for hours, I never saw one with an image burned into its phosphors. But as long as electrons flow through the cathodes, those cathodes are wearing out. Screen savers do nothing to inhibit that flow.

Anyone who really wants to watch tropical fish swimming back and forth could install a fish bowl near his computer. And, when he goes to lunch, he could switch the monitor off.

RONALD D. LINDOW
Pittsburgh, PA

EN

EQUIPMENT REPORT

NOMAI 750.C PORTABLE SCSI HARD DRIVE

This portable SCSI hard drive can move more than a CD-ROM's worth of data between computers.

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If you regularly deal with large computer files, some type of removable media is a must. After all, floppy disks are useful for transferring a few kilobytes or even a few megabytes, and Zip and similar drives become necessary for moving 100 megabytes or so. But even that's not much, not with people dabbling in CD-R, making movies, and so on with their PC. And hard drives inevitably fill up no matter how large they are; so being able to add storage is a plus.

A Solution

One practical solution is the Nomai 750.c portable SCSI hard drive. That unit packs 750 megabytes of data on to removable cartridges that cost about $69 each—that's only 9 cents per megabyte. The Nomai 750.c is available in internal and external PC and Mac versions, and there are parallel-port and docking-bay options for the external models. The external PC version we tested costs about $359, which includes one 750-megabyte data cartridge pre-formatted for a PC, an AC power supply, a SCSI card, and all necessary cables.

The Nomai 750.c removable hard-disk drive is fully compatible with SyQuest cartridges. It can read and write Nomai 750- and 540-megabyte cartridges, or any SyQuest-compatible disks. The drive uses Winchester technology and achieves an average seek time of 10.5 milliseconds and sustains a data transfer rate of 3.46 megabytes per second.

SCSI is a popular option on many PCs these days, and a PC that doesn't have SCSI is just a few dollars away from having it. SCSI is inexpensive and fast, so it makes sense to use it for a 750-megabyte portable drive. An entire CD-R's worth of data can be gathered from different PCs and brought to the CD-R system for recording. Or 750 megabytes of storage space can be added to a PC with each new $69 cartridge.

The Nomai 750.c is small and extremely rugged. It measures 7-inches deep by 4¼-inches wide by 1⅞-inches high and weighs less than two pounds. It's small enough to be easy to carry around with you. The drive has a thick steel enclosure that could easily support a person, so it's not likely to get damaged simply by being bumped around. The enclosure has a modern looking matte-black finish. An AC power adapter supplies the +5 and +12 volts DC required by the drive. An eject button and power/activity indicator are located on the front panel.

Installing the Nomai 750.c

Installing and using the Nomai 750.c is very easy. The external model we tested comes with a SCSI card, and installing it is the most difficult step, though even that is a piece of cake. That's because it's a plug-and-play PCI card—Windows 95 instantly recognizes it and installs the drivers for it automatically. (What's more, if your PC already has a SCSI card in it, you don't even have to install the one included with the drive.) After that, one simply plugs the Nomai's power supply into an AC outlet and pops in a PC-formatted cartridge—when the system boots, the removable drive becomes part of the operating system.

Having 750 megabytes of free disk space to play with is a good thing, especially if your original hard drive is getting clogged. And the speed of the Nomai 750.c is equal to most conventional hard drives, so there's no penalty in performance whether you are archiving data or running applications off it. In benchmark tests, the Nomai drive had a cached speed of 716 MB/s and an uncached speed of 0.77 MB/s. We tested the real-world speed of the drive by copying a 427 MB file; the job took exactly 4 minutes—a transfer rate of 1.78 MB/s when writing data to disk, which is always slower than reading data from disk into RAM.

The Nomai 750.c package includes Adaptec EZ SCSI 4.0 software on CD-ROM and SCSISelect on diskette. Those utilities let you prepare cartridges, format for PC or Mac, change a configuration, update firmware, change the SCSI ID via software, manage read/write cache options, test and re-format disks, verify the disk surface and reallocate bad blocks, low-level format disks, control the cartridge lock on the drive, and eject cartridges by software.

Some Final Thoughts

The Nomai 750.c is very handy and very fast compared to MO and PD drives. It's also very affordable. If you've been waiting for the right removable media drive to come along before buying one, then the wait is over. Now is the time to get a Nomai 750.c. For more information contact the manufacturer directly (Nomai; 592 Weddell Street, Suite 5/6; Sunnyvale, CA 94089; Tel: 408-542-5900; Sales Hotline: 888-99NOMAI; Web: http://www.nomai.com), or circle 15 on the Free Information Card. EN

BY JEFF HOLTZMAN

Pilot Port I/O

ONCE UPON A TIME THE VALLEY BEGAT A LITTLE COMPANY CALLED PALM COMPUTING, AND THAT WAS GOOD. SO GOOD, IN FACT, THAT MEDIUM-SIZE U.S. ROBOTICS SWALLOWED IT WHOLE, AND THAT WAS FINE. SO FINE, IN FACT, THAT big ole 3Com Corp. gobbled it, and that was COOL. SO COOL, in fact, that when a USR/Palm manager presented 3Com president Eric Benhamou with a Pilot, he said, "Thanks, but I already have one. We all do." In fact, 3Com is said to be the largest installed corporate site for Pilots.

Anyway, it's a cool and useful thing. Not only can it help you get and stay organized, but you can also have fun with it. You can buy and download games for the Pilot, of course, but I'm talking about a different kind of fun. Like making it do things that are both interesting and unusual. Like making it talk to the outside world.

This month we'll examine a little data-logging application I wrote that allows the Pilot to track the minimum, maximum, and running average of a series of byte-size inputs. The program is called HiLo. HiLo is illustrated in Fig. 1. When you click the Go button, the program opens the serial port at 9600n81 and waits for input. Each time something arrives, the program recalculates and displays the values shown at the top of the screen. That process continues until you click the Exit button, at which time the program closes the serial port and exits.

CoPilot

The illustration was created using a freeware program called CoPilot. CoPilot runs on Win95/NT, and I believe ports are in progress to other platforms. CoPilot provides a fairly accurate and complete emulation of the Pilot. You can load, execute, and even debug Pilot programs using CoPilot. To run CoPilot, you need a copy of a Pilot ROM. The CoPilot package comes with a utility that allows you to upload your Pilot's ROM to your PC. The ROM is needed because there is actually a 68000 CPU emulator running beneath the hood. The bad news is that you can't use CoPilot to develop and debug serial I/O programs. Programs run, but serial I/O just doesn't occur.

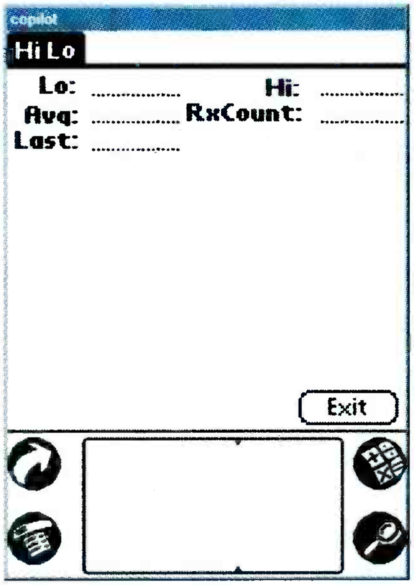


FIG.1—COPILOT IS A FAIRLY COMPLETE EMULATOR for the Win95/NT environment. An independent DLL implements a complete, virtual 68000 CPU, which can run the actual code uploaded from a Pilot ROM. CoPilot doesn't do serial I/O.

Setup and Use

Using HiLo is easy. First download the program to your Pilot using the Pilot Install Tool. Then close the HotSync manager, so it will relinquish the (PC's) serial port. Run a telecommunications program, such as HyperTerminal on the PC, with a setting of 9600 bps, 8 data bits, no parity, and 1 stop bit. Next, with the Pilot in the cradle, run HiLo, and click the Go button; any characters typed on your PC's keyboard will end up in HiLo's queue. Remember that you're sending ASCII characters so for a Ctrl-A, you'll see a value of 1; for 'A' (uppercase) you'll see 65; and for 'a' (lowercase), you'll see 97.

The complete program is over 300 lines of C code, not to mention the resource and header files, so we can't print the whole thing here. What I will do is discuss overall program flow, and present details of key routines. You can pick up the complete source, along with the executable, at the new Ingineering web site, www.ingininc.com. Look for HiLo.Zip, and unzip with the -d option if you want to recreate the build directory structure. I created the program in MetroWerks CodeWarrior DR3 running on NT4, but it should be easy to port to GCC.

PilotMain and The Event Loop

Analogous to the 'main' routine in a normal C program, the entry point for a Pilot program is called PilotMain, shown in Listing 1. When the user launches an application, the operating system calls the corresponding PilotMain, passing it a command code and a set of launch flags. The command code and flags provide a clever way to implement system-wide behavior. For example, the Pilot's built-in Find procedure doesn't search the Address Book, the Memo Pads, and everything else. Instead, it calls each

(Continued on page 17)

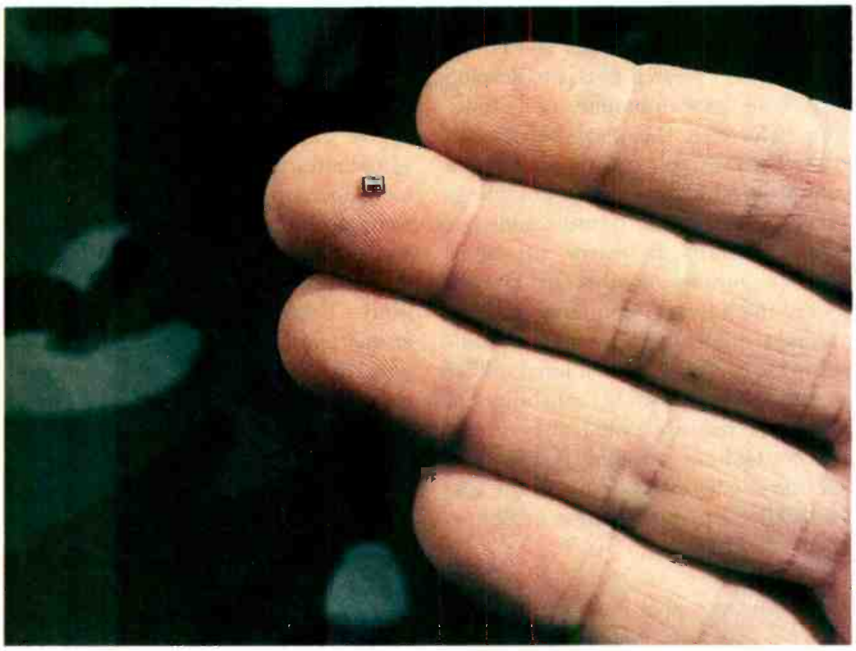
Prototype

The Docter Will Sense You Now

BY DOUGLAS PAGE

Using a tiny, wireless electronic device that can be attached like a band-aid or imbedded in a fingertip or earlobe, tomorrow's doctors and paramedics will be able to remotely monitor the vital signs of high-risk patients or permit neo-natal babies to be liberated from sensor wires so they can be held and stroked.

These medical telesensors—miniature integrated circuits that can measure blood pressure, blood oxygen, pulse, and temperature, and then transmit data to remote receivers—are being developed for the military by government researchers at Oak Ridge National Laboratory (ORNL), which is located at Oak Ridge, TN.



THIS MEDICAL TELESENSOR CHIP can measure and transmit data on body temperature. It is the first of several remote sensors under development at the Oak Ridge National Laboratory. (Photo by Tom Cerniglio, ORNL)

Civilian and Military Applications

While the work at ORNL is for the military, there are also countless civilian applications for these tiny marvels. For example, doctors can use them to monitor vital signs from miles away, paramedics can be more prepared for emergencies that await their arrival, and fire-battalion chiefs can track the respiratory and safety status of firefighters and "hazmat" crews working in smoke or toxic clouds. In that last application, built-in alarms will notify firefighters, for instance, when blood oxygen levels indicate danger. The sensor chips can also automatically telephone emergency services when triggered by a patient's deteriorating vital signs.

The military's interest in the sensors is for remote battlefield triage. "Military leaders need a way to find out quickly which soldiers have been wounded and what their conditions are," said ORNL's Thomas L. Ferrell, lead researcher on the project. "Then, medics will be able to decide whom to treat first and whom to remove from the battlefields for treatment." Of course, the same would also apply in civilian emergency or disaster situations. Also, if the soldier (or firefighter) were a fatality, that information would be transmitted, preventing the unnecessary endangerment of rescue personnel.

While there are many situations where these sensors could prove invaluable, civilian firefighters will especially benefit in several ways. "Our pulse-oximeter telesensor finger-ring or earlobe device will monitor the oxygen in the blood," said Ferrell. "If there's too much smoke or fume inhalation, an alarm will sound and an alert will be transmitted via a belt-worn radio device." Blood oxygen level is a reliable indicator of a wide variety of respiration problems. It is expected that later versions of the system will incorporate pulse-sensor and blood-pressure technology, in addition to an instrument that measures electrical conductivity in the skin, which is often used as an indicator of stress.

The pulse-oximetry sensor will measure the pulse on the wrist or neck using a pressure sensor. Blood oxygen changes are measured by detecting changes in hemoglobin, the iron-containing pigment in red blood cells. Hemoglobin's color changes when there is an alteration in oxygen level. "The sensor chip will have an infrared light source and detector that can measure changes in the light absorption of the hemoglobin when it is exited by light of specific frequencies," said Ferrell.

"Measurements of pulse rate are important to the military," he continued "because this information helps medics determine quickly which wounded soldiers are alive and which are not. Also, blood pressure can be determined by measuring and comparing times of pulse arrival at various points on the body. Measurement of a drop in blood pressure is important because that may indicate a soldier is bleeding." In a civilian setting, measurement of erratic pulse rate can warn that a patient has cardiac arrhythmia.

Eventually the system will be capable of providing diagnostic information on such conditions as shock and injury. The ultimate research goal is to develop an array of chips to monitor body functions collectively. They will be attached to the body, using methods similar to a waterproof bandage, sending physiological data via wireless transmission to a remote monitor. In rescue situations, whether military combat or civilian search-and-rescue, the data will be transmitted directly to paramedics, indicating the condition of an injured soldier or firefighter. Homing capability, in which the monitor could also receive global-satellite-positioning (GPS) data, will one day be incorporated in the system, allowing precise location of all firefighters, soldiers, etc. at all times. The value of commanders or rescuers having access to that information can not be overstated.

Progress To Date

So far the research group has produced a temperature sensor 2.3 millimeters square—about one-eighth the size of standard postage stamp. The chip can be attached to a fingertip or earlobe where it can measure body temperature and transmit a reading when queried by a remote receiver. Ferrell said the chip contains a temperature sensor that measures absolute temperature to within one-tenth degree Celsius using bipolar transistors whose electronic properties are sensitive to temperature. The chips also contain some analog signal-processing circuitry and a short-range (about 1.5 meters) digital transmitter designed to transmit to a nearby helmet- or belt-worn transceiver/microprocessor unit. That unit analyzes the trauma situation, compresses the data, and if indicated, sends an alert to the appropriate medical professional via a longer-range transmitter

"Each chip," said Ferrell, "will have a unique identifier—a characteristic radio-signal pattern . . . in which the frequency spectrum changes every few microseconds. Such spread-spectrum transmission allows the monitor to know which individual soldier, firefighter, etc. needs immediate medical care."

The pulse-oximeter chip is expected to be near production status as soon as early this year (1998), Ferrell said. "At present, only the body temperature telesensor chip has been constructed, and it will require two further iterations at a chip foundry before its final form. Each cycle of fabrication takes several months. The master-control unit is only partially designed, and a full range of telesensor chips will not be ready for several years—unless a large increase in the funding of this project is obtained. We have, however, put in place all of the basics needed to show that this technology is within our grasp without further requirement of extraordinary scientific breakthroughs."

Clinical trials will be done in association with cardiac surgeons as they cool patients during surgery and need to monitor brain temperature, Ferrell said. Also, patients undergoing chemotherapy, and those who lose their ability to regulate their body temperature, must sometimes be packed in ice if a fever sets in. With early intervention, in which the onset of a fever may be reported by one of the telesensors, simple aspirin often is sufficient.

"We will soon begin work on the skin-conductivity telesensor chip for measuring pulse, respiration, and ion-level on the skin (a measure of stress)," Ferrell said. "Blood pressure we hope can be done accurately by passive monitoring of pulse velocity."

The Oak Ridge National Laboratory research, funded by the Defense Sciences Office of the Defense Advanced Research Projects Agency (DARPA), is expected to become so important in civilian settings ORNL is seeking additional funding from the private sector to speed up the research.

"Wireless monitors attached to the skin," said Ferrell, "could provide valuable information on the physiological conditions of intensive-care patients in hospitals, high-risk outpatients (aiding paramedics responding to the scene), or infants at risk of suffering sudden infant-death syndrome (SIDS)." EN

➤ Interoperable Cable Set-Top Boxes

Cable Television Laboratories, Inc. and its members have established *OpenCable*, a project aimed at developing a new generation of set-top boxes that are interoperable. These devices will enable a range of interactive services to be provided to cable customers. The OpenCable effort will include an intellectual property (IP) pool and a certification process for testing vendor compliance.

The first task of OpenCable is to evaluate responses to a request for information (RFI) that was sent to leading computer and consumer-electronics companies. The RFI seeks their input into the creation of a draft specification for advanced set-top boxes. CableLabs executives and board members have held meetings with CEOs of companies in these industries. This research was overseen by MediaOne President and COO William T. Schleyer, who is a member of the CableLabs Board of Directors.

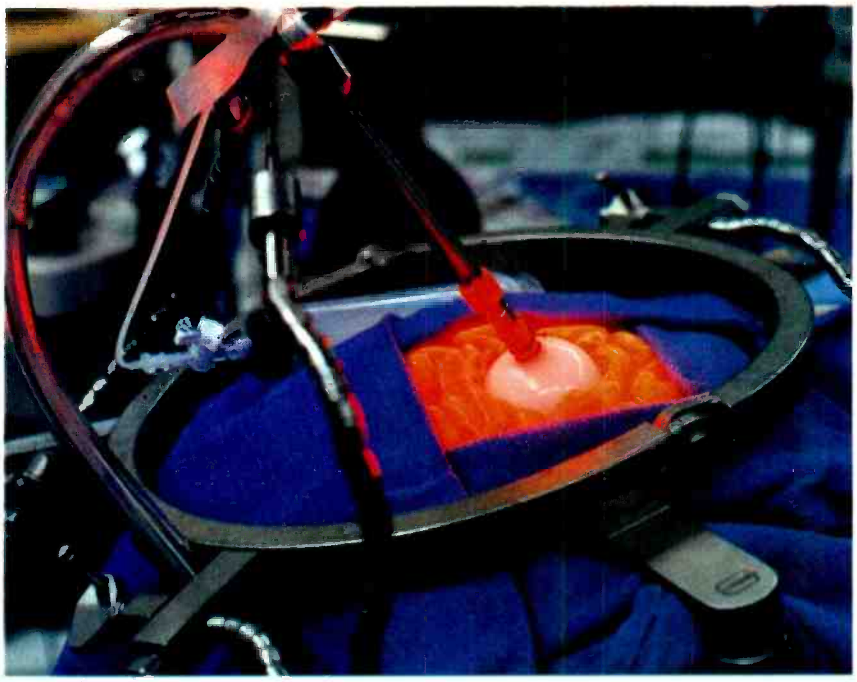
"Our meetings with other industries have shown us that microprocessor and semiconductor technology are advanced to the point where a set-top box can become a digital set-top computer very soon," according to President and CEO of CableLabs, Dr. Richard R. Green.

CableLabs is a research and development consortium of cable television system operators representing more than 85% of the cable subscribers in the US, 75% of subscribers in Canada, and 12% of subscribers in Mexico. For more information, check their Web sites at http://www.cablelabs.com, http://www.cablemodem.com, and http://www.cablenet.org. EN

Space Research Spotlights Tumors

Special lighting technology—developed for NASA Space-Shuttle plant-growth experiments—may soon help treat cancer and save lives on Earth. A treatment technique called Photodynamic Theory uses tiny pinhead-size LEDs to activate light-sensitive, tumor-treating drugs.

Experiments indicate that when special tumor-fighting drugs are illuminated with LEDs, the tumors are more effectively destroyed than with conventional surgery. The light source, consisting of 144 tiny diodes, is compact (about ½-inch in diameter), and mechanically more reliable than lasers and other light sources used to treat cancer. The entire light source and cooling system is only the size of a medium suitcase.



THIS SIMULATION shows how LED probe would be used, in conjunction with special drugs, to destroy brain-cancer tumors.

Through the Small Business Innovation Research Program, NASA funded contracts to demonstrate the feasibility of using LEDs in cancer treatment. The program is managed by the Technology Transfer Office at Marshall Space Flight Center, Huntsville, AL. In this application, the LED forms the tip of a new nine-inch neural probe. The LED probe can be used for hours at a time, remains cool to the touch, and is a fraction of the price of a laser.

"This new probe illuminates through all nearby tissue," said Dr. Harry Whelan, pediatric neurologist at the Medical College of Milwaukee, WI. "We've used lasers too," he added, "but they are often unreliable and limited in color spectrum. Lasers are also very expensive and lose power in their fiberoptic cables."

The technique used by Dr. Whelan involves injecting the patient's bloodstream with a drug called Photofrin II. The drug attaches itself to the unwanted tissues and permeates them, leaving the surrounding tissues unaffected. The doctor then places the solid-state LED probe near the affected tissue to illuminate the tumor and activate the Photofrin II drug. Once activated by the light, the drug destroys the tumor's cells, leaving the tender brain stems virtually untouched.

The FDA has approved using the LED probe on a trial basis in the removal of children's brain tumors. After the clinical trials are concluded, Dr. Whelan anticipates full approval of what could be the operating technique of the future. Further research combining LEDs and promising new drugs is yielding the possibility of deeper tumor penetration with the probe, faster reaction times, and shortened patient sensitivities to sunlight.

"We're very happy to be a part of this innovative procedure," said Rose Allen, manager of the Space Product Development Office at the Marshall Center. "It is exciting to see how NASA's commercial space research results in benefits on Earth. Who would have thought that experiments searching for ways to improve agricultural products would lead to a medical procedure that saves children's lives?"

The LEDs, developed for Marshall Center by Quantum Devices, Inc., (Barneveld, WI), were first intended for use in food-growth experiments in outer space. They were used as low-energy light sources on NASA's second US Microgravity Laboratory Spacelab mission in October 1995, as part of the Astroculture Plant Growth Facility. The experiment was led by Dr. Raymond J. Bula of the Wisconsin Center for Space Automation and Robotics (Madison, WI), a NASA Commercial Space Center.

"The LED technology developed by NASA offers new hope to children with cancer," stated Dr. Whelan. "Every one of our cases will be a critical case with no hopeful alternatives. We think this new probe will help give children with tumors a chance to live healthy, happy lives."

Low-Altitude Vertical Flights in Urban Areas

A research and development project conducted in Atlanta during last year's Olympic games could have a long-term impact on improving transportation in crowded cities. Supported by the FAA, Operation Heli-STAR (Helicopter Short-Haul Transportation and Aviation Research) showed that communications, navigation, and surveillance (CNS) equipment based on the Global Positioning System (GPS) could reliably track helicopters operating in large metropolitan areas.

Air-traffic-control radar now provides the primary means of monitoring aircraft in flight. However, ground clutter caused by obstructions such as tall buildings prevents tracking low-altitude flights in urban areas. This problem restricts helicopter transportation in cities where clogged highways would otherwise make vertical flight an attractive alternative to ground transportation.

A SPECIALLY-EQUIPPED Operation Heli-STAR helicopter is shown here landing at GIT's research facility.

"Operation Heli-STAR showed that the technology is here now to do low-altitude traffic control in urban areas," according to Charles M. Stancil, manager of the Georgia Tech Research Institute (GTRI). "Everything that we planned and designed for the system worked. We could track the aircraft, communicate with them, send weather information, and even change the mission just by using digitized messages."

Some 88 aircraft equipped with this technology participated in Heli-STAR during the Games in Atlanta. The aircraft used on-board GPS systems to determine their own positions, then reported that information every few seconds to a central ground station through a very high-frequency (VHF) data link. Heli-STAR also sent data about all project aircraft operating in the area to multi-function displays that were installed aboard many of the helicopters. On the ground, sophisticated equipment used bar-coding and an extensive computer network to track cargo as it moved to its final destination.

On the busiest day, the project processed 83,000 aircraft position reports between 6 AM and 10 PM, tracking more than 60 aircraft engaged in a wide range of cargo delivery and public safety missions—including critical security requirements. Heli-STAR used 12 heliports strategically located around Atlanta. Routes were established to minimize noise and avoid the restricted airspace set up around Olympic venues.

Development of Heli-STAR began in 1994. The Heli-STAR program was the result of cooperation among numerous government and industry groups who shared the $10 million cost. Among the government agencies involved were the FAA, NASA, Department of Defense, and GEMA (Georgia Emergency Management Agency). Businesses and organizations, among others, were ARNAV Systems, the Harris Corporation, Helicopter Association International (HAI), and the Atlanta Vertical Flight Association (AVFA). The Project Operations Center was established at Georgia Institute of Technology's (GIT's) Cobb County Research Facility, near Dobbins Air Force Base.

The project was intended both to demonstrate the feasibility of the GPS-based equipment and to gather information for development of future large-scale helicopter and low-altitude operations. EN

Speaking of the Olympics . . . .

The NEC Corporation announced that it will sell, beginning in Japan, the world's first high-definition 50-inch plasma television, the *Hi-Vision Plasma X*. Sales will begin in February to coincide with the start of the Winter Olympic Games in Nagano, Japan. The 50-inch Hi-Vision Plasma X (PX-50V2) offers 1.4 times the screen size of its 42-inch predecessor.

The use of a panel production process specifically for manufacturing large-sized high-resolution screens permits pixel pitch to be reduced to 0.81mm from 1.08mm. This process produces a 1365×768 pixel screen (or PDP—plasma display panel) capable of displaying over one million pixels. Integrated circuits that endure high pressure allowed NEC to achieve a very slim television at 97mm.

New versions of NEC's 42-inch PlasmaX television and the 33-inch plasma display unit (PX-33M2) share in the design concepts of the 50-inch model. These new models, which have been on sale since December, are slimmer than the previous ones: 89mm instead of 99mm. The PX-33M2 is compatible with NTSC, PAL, and SECAM broadcast signal standards. Worldwide sale of these TVs is expected to start in Spring 1998.

Both the 50- and 42-inch plasma TVs use NEC's capsulated color-filter (CCF) technology. This technology applies a black stripe to non-discharging plasma cells for more vivid contrast in bright-light conditions at a ratio of 40:1. CCF offers colors purer than those of any Braun tube TV. Both models feature display, tuner/selector, and speaker units in a component-style set, and use only one cable to connect the display and the tuner.

NEC sees the new PDPs as meeting the demands for thinner, larger, and clearer TVs. They anticipate that the combined demand from consumer and business users will result in the shipment of 30,000 NEC sets in 1998. That figure is expected to rise to 300,000 per year by the year 2000. The price in US dollars is about $22,500 for the 50-inch display and $12,083 for the 42-inch set. EN

COMPUTER CONNECTIONS

continued from page 12

application with a special launch code. The app in turn knows that it should search its database and return results to the calling app. We don't need that functionality, so the only launch code HiLo responds to is the one for normal program launch.

When it receives that code, it calls a startup routine, which draws the main form and obtains a reference to the serial port. It then goes into an event loop, in which various processes in turn get a chance to handle events. The Palm OS is not multitasking, so the term processes must be taken loosely, in the sense of a block of code that belongs to a separate logical entity.

Events include things like detecting pen motion on the screen, hardware button presses, serial I/O, alarms, and so forth. Applications can add their own events to the event queue. For example, in HiLo, when the user clicks the Exit button, the program enqueues an "appStopEvent." When the event loop terminates, control returns to PilotMain, where the StopApplication routine performs any required clean-up. In our case, that primarily means closing the serial port.

Within the event loop, the system gets first crack at handling events. That allows it to do things like, for example, translating raw pen strokes into ASCII characters, which in turn get enqueued as keyDown events. Typically, if a process handles an event, it returns a value of True, so that subsequent (higher-level) processes skip over it.

After the system, the menu handler gets next crack at events. For simplicity, HiLo has no menu, so I commented out the corresponding code. I didn't simply remove it, because I want to show the default event-processing hierarchy. Next, the application's main form gets a try, and finally, the active form. Again, for simplicity, this application has only one form, so the latter call is redundant. And again, I didn't remove it, for the same reason.

So after the user starts an application, the Palm OS settles into the event loop. The event loop itself is nothing but a large, possible nested switch statement, with cases for different types of events, and subcases for instances of each type. Typically there are cases for system events, form events, control events, and so on. Then, where it makes sense, nested switch statements perform code (or launch subroutines) that depend on the subtype. For example, the event dispatcher for control events would have a case for each control for which an application needed to respond to an event, and a sub-sub handler for each event type it needed to respond to. An application does not have to respond to every possible event for every control.

The Palm OS is not object-oriented,

LISTING 1—SERIAL I/O ROUTINE

```
static void SerIOReceive(void) {
        ULong               RcvCount = 0;
        Err                 error;
        Byte                BufIn[17];

        if (!SerIORef || !SerIOConnected)
        return;

        error = SerReceiveCheck(SerIORef. &RcvCount);
        if (error) {
        SerClearErr(SerIORef);
        FrmCustomAlert (AlertGenericAlert, strErrRcvChk, StrBlank, StrBlank);
        return;
        }

        if ((RcvCount <= 0))
        return;

        if (RcvCount > 1)
        RcvCount = 1;

        // Palm OS1, OS2 compatible
        error = SerReceive10(SerIORef, BufIn, 1, 10);

        // Palrm OS2 compatible only
        //error = 0;
        //RcvCount = SerReceive(SerIORef, BufIn, 1, 0, &error);

        if (error) {
        SerClearErr(SerIORef);
        FrmCustomAlert (AlertGenericAlert, strErrRcvErr, StrBlank, StrBlank);
        return;
        }

        SerIOCnt++;
        SerIOCur = BufIn[0];
        SerIOSum += SerIOCur;
        if (SerIOCnt > 0)
        SerIOAvg = SerIOSum / SerIOCnt;
        if (SerIOCur < SerIOMin)
        SerIOMin = SerIOCur;
        if (SerIOCur > SerIOMax)
        SerIOMax = SerIOCur;

        // display results
        ShowNumResultFld (HiLoMainFldAvgField, SerIOAvg);
        ShowNumResultFld (HiLoMainFldRxCountField, SerIOCnt);
        ShowNumResultFld (HiLoMainFldLoField, SerIOMin);
        ShowNumResultFld (HiLoMainFldHiField, SerIOMax);
        ShowNumResultFld (HiLoMainFldLastField, SerIOCur);

}
```

PILOT DEVELOPER RESOURCES

www.wademan.com/Pilot/Program/FAQ.htm
www.massena.com/darrin/pilot/index.html
www.sls.lcs.mit.edu/raylau/pilot/
www.usr.com/palm/pilotlinks.html
www.roadcoders.com/pilot/index.html
www.shoppersmart.com/jlehett/gccwin32.html
www.usr.com/palm/dresources.html
www.metrowerks.com (general info)
www.metrowerks.com/db/updates.qry?function=list&sw=CWPP3 (patches)

Newsgroups:
alt.comp.sys.palmtops.pilot
comp.sys.palmtops.pilot
news.massena.com/pilot.programmer
news.massena.com/pilot.programmer.codewarrior
news.massena.com/pilot.programmer.gcc
news.massena.com/pilot.programmer.jump
news.massena.com/pilot.programmer.pila

nor is the development language. Thus, the API presents parallel clusters of functions with similar names that perform similar duties on similar types of controls. For example, there are separate functions to set controls (buttons) and fields (entry fields) usable (visible and "clickable"). Conversely, some functions do not have parallels across controls and fields. In the absence of overridable methods with identical names and behaviors across different classes of objects, I wish the API were more consistent. On the other hand, the overall API is small enough that such inconsistencies are not intolerable.

Something Happened

The Palm OS user-interface philosophy gives high priority to UI (user interface) events, so those are handled first. (In a performance-critical application, that probably wouldn't be the case.) HiLo's event loop lets all other events get processed first, and then only for nil events does it attempt to read serial I/O. (A nil event is just the OS's way of keeping the system active when there is a lack of other stimuli. After so much time consisting only of nil events, the system powers itself down.)

Whenever a nil event occurs, HiLo calls the routine SerIOReceive, shown in Listing 1. SerIOReceive simply returns if the port hasn't been opened, if no characters have been received, or if an error has occurred. Otherwise, it reads a single character, updates the internal statistics (count, min, max, avg), and displays the results.

The routine that actually reads bytes from the UART is called SerReceive10. The routine was originally called SerReceive. The latter is now the OS rev. 2 version, and the former the original. By using SerReceive10, you can write code that will run on both versions. The new routine provides more and better status information, which we don't need for our application.

For Next Time

There are several ways we can proceed. Right now all we can do is read data; it might be nice to be able to write it as well. Another limitation is the user interface, which is pretty boring. It might be nice to see a histogram or a chart-recorder type of display. Peripheral to the Pilot itself, but nonetheless important, is the data input. Connecting the Pilot to an (emulated) ASCII terminal is OK, but there are an awful lot of interesting analog quantities out there.

Stay in touch; you can reach me via e-mail at jkh@acm.org. EN

Q & A

continued from page 7

source or publish a circuit? — R. F., Rochelle Park, NJ

A There are two things you can do: route the primary current through a transistor rather than directly through the points, and generate a primary voltage higher than 12 volts (perhaps more like 250). Almost all modern cars have transistor ignition, which does the first of the two. The second one is what you're asking about, and it ensures a really high spark voltage at all times.

Because you need high reliability and special parts, and because it's not going into your own car, it's probably best to use a commercial unit. Write to J. C. Whitney and Company, P.O. Box 8410, Chicago, IL 60680, and ask for a catalog. They have add-on electronic ignitions for American cars made since 1947.

Darts and Transistors

Q *I'm looking to build an electronic dart board out of an old computer. Are there any plans available for this project?*

Also, I have an old receiver for which I need two transistors, a 2SA765 and a 2SC1445. What can I use as replacements? — J. Z., Waukesha, WI

A We don't recall an electronic dart board project, but we'd like to hear from any reader who has designed and built one. Constructing the board itself, with digital sensors embedded, is the hard part.

The transistors are easier. Any parts jobber should have ECG, NTE, and SK reference books in which you can look up transistor substitutes. Those you ask about are silicon audio power output transistors, equivalent to ECG197 and ECG196 respective

Writing to Q&A

As always, we welcome your questions; please write to Q&A, **Electronics Now** Magazine, 500 Bi-County, Blvd., Farmingdale, NY 11735. The most interesting ones are answered in print. Due to the volume of mail we receive, we regret that we cannot give personal replies. EN

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Since 1934, CIE has been on the forefront of an ever expanding technological revolution. CIE's curriculum is unique from other independent-study schools in the respect that we not only provide hands-on training utilizing today's technology we also instill the knowledge and understanding of why technology works the way it does. This is the foundation upon which every CIE graduate can trace their success back to and in which CIE's reputation as a quality learning facility is based on.

Project Engineer

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Telecommunications

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BY DON LANCASTER

Investigating Brown's Gas, A Tiny TV Generator, and More

THIS MONTH, WE AGAIN HAVE A FASCINATING MIXTURE OF PSEUDOSCIENCE AND REAL SCIENCE TOPICS. INTERESTINGLY, HOWEVER, THIS TIME "THEY" ALMOST (BUT NOT QUITE) GOT THE PSEUDOSCIENCE RIGHT. BEFORE WE GET TO THAT, LET'S see if we can kick things off with a little dose of reality.

The PIC Calibar

Tim Jenison of NewTek just sent me one of his new *Calibar* television test generators. That $349 pen-sized instrument, shown in Fig. 1, can replace an entire studio full of professional NTSC TV test gear. The device generates the 24 precision test patterns shown, and it can also double as a station master sync generator. It can be used in the field, drawing power from a two-hour internal battery, or on the bench, using a standard wall-transformer AC supply.

The ergonomics here provide new meaning to my search for elegant simplicity. The user interface consists of a pushbutton! You briefly hit the button twice to turn it on. If you don't like the current pattern, keep hitting the button until the one you want comes around. Hold the button down to turn power off. A single red LED lights if the Calibar is active.

Internal 10-bit digital accuracy is used for highest waveform precision. Baseband video is output from a male BNC connector. Phono plug, phono jack, and female BNC adaptors are also included. There's also a "magic" set of blue glasses you wear for chroma balance.

Before we get too much further, let's review some NTSC TV basics. The crucial frequency is called a chroma reference or color subcarrier, and it is always a precise 3.579545 MHz, though it is usually quoted as 3.58 MHz. When that signal's phase is zero, it corresponds to a color very slightly on the purple side of blue. As you shift the phase of the signal, the color produced varies as shown in the "color wheel" or "vectorscope display" of Fig. 2. Thus, the phase of the 3.58-MHz signal sets the color, while its amplitude sets the saturation. Actually, a color-difference amplitude scheme is used so that very little subcarrier is needed with whites or pastels. Chroma shift adjustments are also made to favor facial and skin tones.

The chroma reference is divided by 227.5 to produce a horizontal-scan frequency of 15,735 Hz, providing 63.55 microseconds for each horizontal scan line. They are further divided by 262.5 to produce a vertical field frequency of 59.94 Hz. Two fields are combined into a single, interlaced scan, giving you a frame rate of a tad under thirty frames per second.

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US e-mail: don@tinaja.com
Web page: http://www.tinaja.com

Back to our horizontal scan line: The line is separated into a live scan time of around 55 microseconds and a blanking time, called the horizontal-blanking interval, of slightly over 8 microseconds. Blanking gives a classic CRT "picture-tube" electron beam enough time to reset from the right side of the screen back to the left.

Baseband video is normally set so that one volt is white, a tad over a quarter volt is black, and zero volts are the "blacker than black" sync tips. The horizontal-blanking interval includes a five-microsecond wide horizontal-sync pulse and an eight-cycle long chroma reference burst on its "back porch". Those are used to synchronize or lock the transmitter to the receiver.

The vertical-blanking interval is more complex. Vertical blanking is needed to give the electron beam time to get back to the top of the screen. Various "hidden" services are also provided in that interval, including closed captioning, test signals, and timing standards. The vertical blanking also provides a vertical sync pulse as the third locking signal. Some fancy equalizing "teeth" are also placed in the vertical-sync pulse to preserve horizontal-sync extraction and to take care of the half line offset between even and odd fields.

Inner Details

Figure 3 shows a rough block diagram of the Calibar. The PIC 16C57 microprocessor used is not quite fast enough to directly generate the highest speed video timing, but it does all of the slower tasks such as a partial pattern timing, horizontal scan-line generation, pattern picking, pushbutton housekeeping, sync, and the frame-rate timing. The usual 4× chroma frequency of 14.318

MHz is used as a master system clock.

The heart of the circuit is a high-speed, low-power, 10-bit Harris D/A converter, followed by a fast video op-amp driver with a carefully controlled bandwidth. The D/A is driven from a large EPROM pattern generator. Low address bits of that pattern generator are continuously and sequentially accessed when you scan across each horizontal line. Upper address bits pick the pattern for the particular lines being output.

A resettable 4-bit CMOS binary counter does the fastest of the pattern addressing. The PIC does everything else! Their PIC apparently executes one instruction cycle every chroma cycle of 3.58 MHz. My best guess as to how the "half cycle" at the end of each horizontal line is handled is by using horizontal-line-pattern pairs. Again guessing, I suspect that the need for any half or odd horizontal lines is eliminated by generating a full two frames of four fields. Special line-pair sync patterns would be needed for each case of even or odd field and even or odd frame.

Clearly, there is some innovative programming going on here. There's 910 samples of 4X chroma per line, so 10 address bits (2^{10} = 1024) should handle the sequential addressing for one horizontal line, or 11 address bits for horizontal-line pairs.

With a 64K word EEPROM, that leaves you with five address lines to access up to 32 possible line patterns. Many of those will be needed for the exotic synchronization; some others can be reused in several modes.

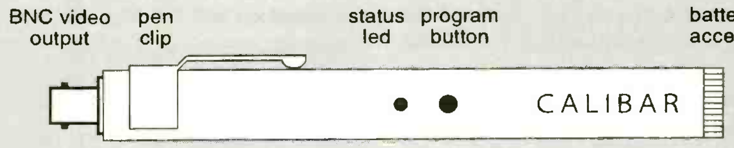
The nice thing about this scheme is its content independence. You don't have to try and logically define all of the patterns; all you do is stash their values in a lookup table. Not all that many live patterns should be required, because any selected screen-display mode does not change much in the vertical direction. And certain screen modes are simply combinations of earlier ones. All patterns are exact, and as precise as 10-bit samples allow.

I was sort of joking to Tim that he should also offer the classic "indian head" pattern. Done as lookup, that would require a somewhat oversize EPROM; with some folding, around eight megs might do it.

Note that the Calibar is NTSC only. It is not intended for VGA or other computer-monitor uses, due to differences in scan rates and how colors are generated and distributed. However, I'd guess that similar computer monitor testers are in the works.

As an aside, NewTek is not in Kansas anymore (took the dog, but left Aunt Em). Note their new Texas address in the Names and Numbers box elsewhere in this article. Their Website remains www.newtek.com.

I will try to work up some PIC video



CALIBAR PATTERNS

1 - SMPTE multipurpose bars
2 - Multiburst FCC frequency check
3 - Modulated gain/phase ramp
4 - Blackburst 7.5 IRE plus sync
5 - White 100 IRE screen
6 - Luminescence ramp 0-100 IRE
7 - 5 MHz sweep plus markers
8 - B/W Crosshatch generator
9 - Red pure color screen
10 - Luminance IRE 10 step
11 - Luminance 5 step IRE 20
12 - SMPTE plus FCC multiburst
13 - EIA bars plus PLUGE
14 - Green pure color screen
15 - Blue pure color screen
16 - Blackburst 0 IRE
17 - Magenta pure color screen
18 - Cyan pure color screen
19 - Chroma bars plus red
20 - B/W convergence dots
21 - Chroma 5 step IRE 20
22 - Full field color bars
23 - Chroma 10 step IRE 10
24 - NTC7 composite sin-square

FIG. 1—PEN-SIZED AND PIC-BASED CALIBAR from NewTek replaces a whole studio full of television test instruments. The 24 standard precision test patterns listed can be generated.

demos in a future column. Meanwhile, much more on PIC apps appears on the PIC Library Shelf and the pair of PIC Web Link pages on www.tinaja.com; also look there for ELESIMP.PDF, which contains more on elegant simplicity. Good sources for video in general are the older *Television Engineering Handbook* from McGraw-Hill, and the newer *Video Demystified* from Harris Semiconductor. More TV and video information appears as this month's resource sidebar.

Meta Studies

How can you honestly evaluate a controversial technical concept? One older scientific tool that's seeing new life is called the meta study, in which you simply "study the studies." You objectively and without bias gather together everything you can find on the subject. Both pro and con. Only after everything is gathered do you try to judge both sides for relevance, scientific rigor, timeliness, hidden agendas, vested interests, and overall credibility. From there, you go on to decide whether you want to spend the time and effort to further involve yourself. The argument "But you haven't done the experiment" cuts no ice here. The chances are "the experiment" (or its interpretation) will be dead wrong anyhow.

A meta study usually will clearly tell you whether there is any point in getting further involved. It all comes down to a simple matter of probabilities. A meta study is similar to a civil jury trial, where "preponderance of evidence" is carefully sought, along with the suitable "motive, means, and opportunity." After you have run a few meta studies, obvious "looks like a duck—quacks like a duck" patterns emerge. The big picture patterns that easily let you separate science from pseudoscience, or the scams, "not even wrong" bad labwork, and "thuzzy finking" from the real opportunities and genuine breakthroughs.

The web sure makes doing meta-study searches simple and easy. I've got lots of brand-new search tools at www.tinaja.com/webwb01.html. But my favorite search tool remains good old Hotbot.

Meta studies work in nearly any field. As one practice non-electronic example, punch L-Carnitine into Medline and you'll probably reach the same conclusions that I did: This nutritional supplement does seem highly useful and effective for certain cardiovascular problems, but does not normally provide stamina or energy benefits for fitness jocks. More on this can be found on my site in DONTSICK.PDF. Free Medline links are at www.tinaja.com/beewb01.html. A custom meta-study service is at www.tinaja.com/info01.html.

It's a Gas

I decided to apply a meta study to Brown's Gas, one currently popular web pseudoscience topic. I found a fascinating mixture of legit science, highly unexpected though apparently valid "gee whiz" results, along with outrageously unsupported claims. The bottom line is that I spotted nothing here to get personally excited about, although a PostScript and PIC-controlled flutterwumping precision torch just might make for a rather interesting project.

First off, note that any decent torch

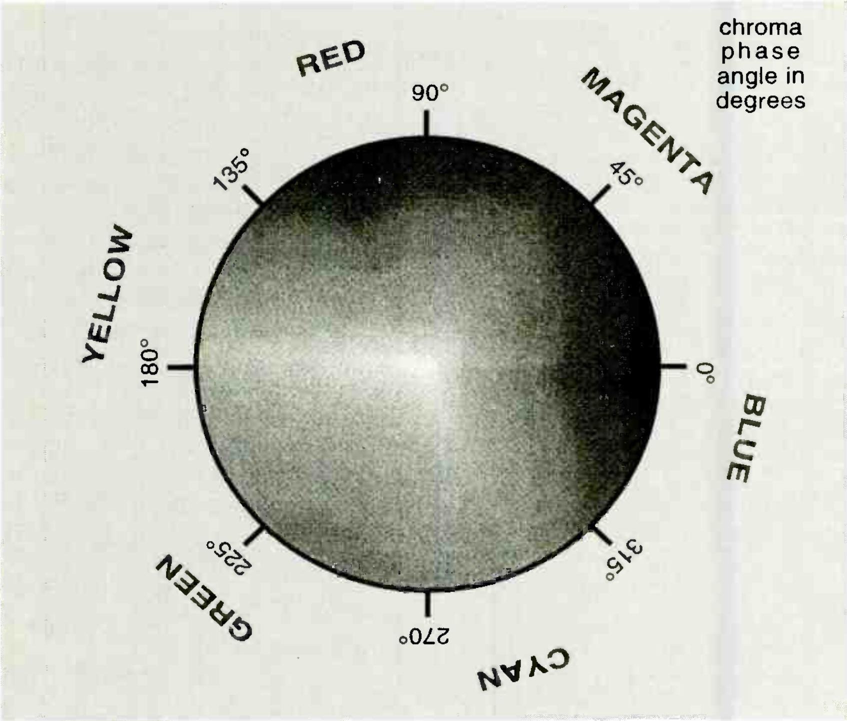


FIG. 2—THE NTSC CHROMA SUBCARRIER PHASE determines the hue, while its relative amplitude sets the color saturation.

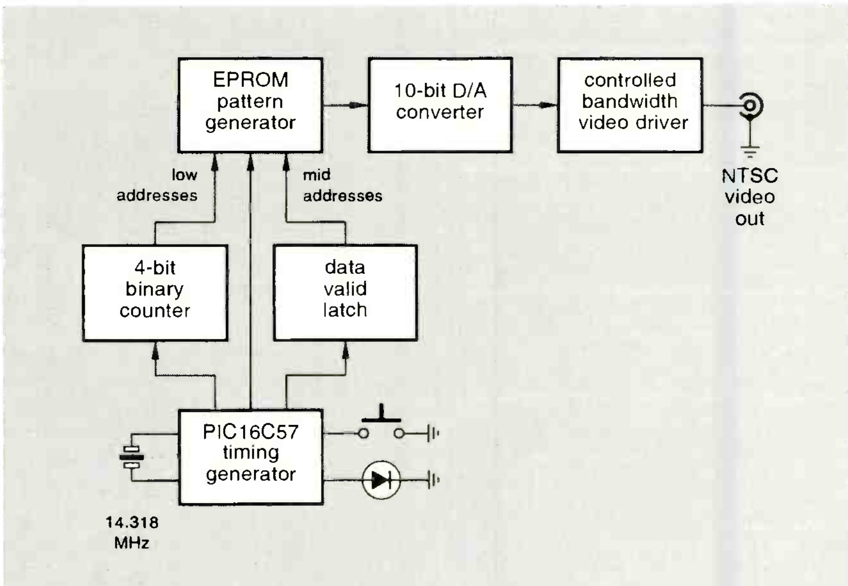


FIG. 3—A SIMPLIFIED BLOCK DIAGRAM of the Calibar. Table lookup of 43 chroma samples is provided to 10-bit accuracy. The PIC controls most table access and does all the synchronization and low-frequency timing.

SOME TELEVISION BROADCASTING RESOURCES

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Broadcast Engineering
9800 Metcalf Ave.
Overland Park, KS 66212
(913) 967-1737

Broadcasting & Cable
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New York, NY 10011
(212) 337-6942

Cable Vision
825 7th Ave.
New York, NY 10019
(212) 887-8400

College Broadcaster
71 George St.
Providence, RI 02912
(401) 863-2225

Electronic Media
740 N Rush St.
Chicago, IL 60611
(312) 649-5293

HDTV Report
1201 Seven Locks #300
Rockville, MD 20854
(800) 777-5006

IEEE Communications Journal
445 Hoes Lane
Piscataway, NJ 08855
(908) 981-0060

Multichannel News
825 7th Ave.
New York, NY 10019
(212) 887-8400

National Association of Broadcasters
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(202) 429-3931

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Santa Ana, CA 92707
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Vienna, VA 22182
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SMPTE Journal
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White Plains, NY 10607
(914) 761-1100

Television Broadcast
460 Park Ave. S 9th Flr.
New York, NY 10016
(212) 378-0400

Television Quarterly
111 W 57th St.
New York, NY 10019
(212) 586-8424

TV Technology
5827 Columbia Pike #310
Falls Church, VA 22041
(703) 998-7600

person can pull off all sorts of magic tricks. At Thatcher Fire Department, we have a Broco oxy-iron torch we use as the "master key" to vaporize anything between where we are and where we want to go. I've personally used a Broco to cut through cement blocks and to burn the bottom out of a bucket full of water—from the inside.

Let's start with the re-mixed gas a chemist would get from the classic electrolysis of water. That will be a stoichiometric mixture of very nearly two parts of hydrogen and one part of oxygen by volume. For semantics, let's call this one stokegas on the off chance that Brown's Gas might really be something else. Stokegas is one of the most highly combustible substances known to man. For that reason, stokegas gets normally generated and used only as it is needed. Storage is a big time no-no. Specialized torches seem to be a good on-demand match here.

Stokegas burns with an extremely hot, but remarkably low-energy flame; the degrees are there but the BTUs are not. For instance, gasoline offers 9000 watt hours of energy per liter. Stokegas at normal temperature and pressure delivers only 2.4 watt hours per liter. Stokegas theoretically burns at 5120 degrees F, or 3100 degrees C. Hydrogen in air theoretically burns at 3860 degrees F, or 2400 degrees C. By contrast, acetylene in air burns at a hotter 4770 F, or 2670 C.

Claims that you can briefly place your hand near a stokegas flame do appear true. But do not try it! The reason is that despite the extreme temperature, there is not enough heat energy present to briefly do you any significant harm.

A claim that stokegas "adjusts" its temperature to suit the task at hand is apparently rotten labwork. Infrared thermometers are based on emissivity, and there is darn little to emiss. The correct method to make an accurate reading is to place an object in the flame and heat it. Then measure the object's emitted radiation. Even then, interpretation can get rather tricky.

Is a hydrogen flame invisible? Hazmat folks think so—especially during that hot summer afternoon tanker rollover in the Phoenix desert when they had to "joust" with a rag on a pike pole to find the flame front. However, in the lab you can in fact see the flame, albeit it a rather weak one. Reasons for the near invisibility include an emission primarily in the ultraviolet, the lack of carbon particles, and the low total energy involved.

Valid hydrogen proponents are taking steps to make their flames more visible. Their efforts are similar to placing methyl mercapan odorant in natural gas, which otherwise has no smell whatsoever. Interestingly, it seems that when they first tried natural gas odorants, they used a chemical that smelled good, rather than bad, which made people purposely leave their gas jets open to act as room air fresheners!

Does stokegas implode rather than explode? Not really. However, if the container walls are cool enough, the generated steam will condense and will provide you with an amazingly reduced final pressure, perhaps down around 1 PSI or so, giving you an explosion rapidly followed by condensation.

There are two rather distinct, but overlapping processes here. After demonstrating that effect several times in a row, the container walls and the accumulated water usually seem to heat up enough that positive pressures result. The claims that an "implosion" can lead to any "sub-vacuum" pressures or pressures below the vapor pressure of liquid water have no apparent basis in fact. "T'ain't likely McGee."

Could a reduced-pressure engine be developed? Possibly. Would it be useful or efficient? Almost certainly not. Why? Because of inherent and fundamental thermodynamic-cycle limitations. More

NAMES AND NUMBERS

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(201) 292-5100

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New York, NY 10158
(212) 850-6088

on thermodynamic cycles can be found in HACK64.PDF.

Certain Brown's gas proponents claim they are generating something that's different than stokegas. Yet the schematics I looked at seemed to be sending more-or-less plain old current through more-or-less plain old water.

Brown's gas proponents claim to melt tungsten. That is believed to be impossible with stokegas. However, reversible tungsten side reactions that can involve oxidation, ablation, or a sublimination appear to be credible mainstream explanations for the observed effects.

Proponents also claim significant generation and long-term storage of monoatomic oxygen and hydrogen, which I find highly unlikely, and a chemist finds so hilarious he won't even talk about it. As far as anyone knows, monoatomic hydrogen and oxygen very rapidly recombine into their diatomic forms, or quickly enter into other reactions at most realistic temperatures and pressures.

Certain Brown's gas proponents also claim over-unity generation and the ability to neutralize radioactivity. The strongest evidence for these last three extraordinary claims so far is a GIF image of a large orange box, which clearly is radiating at 590 nanometers. Uh, nice try.

As to doing over-unity hydrogen generation, it does turn out that up to one sixth of electrolysis energy can sometimes in fact come from waste heat rather than input electricity. But this modest "gain" happens only at low production rates and is usually swamped by other cell losses.

There is also classic EE student lab blunder #01-A, where you'll fail to accurately measure rms power when dealing with any unusual waveforms. More on this in MUSE112.PDF.

Claims that any electrolysis cell "stays cool" are easily explained by staying in the endothermic generation region between 1.23 and 1.47 volts. More details in Peavey's ineptly misnamed *Fuel From Water*, stocked by Lindsay Publications.

In short, I've found nothing whatsoever to convince me that Brown's gas is in any way, shape, or form any different from stokegas. But the simple mass spectrographic proof apparently has never been done. Other Web proponents claim to be able to somehow "resonate" a water molecule, aiding its dissociation in some vaguely over-unity manner. The problem is that the frequencies they are using seem ten million times too low. And even if resonance worked, I personally see absolutely no way that any energy gain could possibly result in the process.

Claims that a hydrogen-powered car can be run with "a few watts of electricity" are usually demonstrated by running the few watts for a long time, dangerously accumulating the gas, and then idling the car for a brief instant—otherwise known as using a piggy bank effect. Unless such extraordinary claims can be solidly backed up by lots of independent tests and extraordinary evidence, those on-board "miracle" hydrogen-electrolysis generators will remain totally useless for cars. Why? Because you'd be ridiculously better off sending the electricity directly to wheel motors in the first place.

Lots more about Brown's Gas is on the Net. Be sure to remember that Net clearly stands for Not Entirely True. There is no Brown's Gas torch or information supplier that I can honestly recommend. First, because of highly questionable claims and endemic bad labwork. And second, because I strongly feel the Broco is a vastly better choice for any

Gasoline	9000 Wh/l	13,500 Wh/Kg
Lithium	350 Wh/l	150 Wh/Kg
Flywheel	210 Wh/l	120 Wh/Kg
Lead Acid	40 Wh/l	25 Wh/Kg
Hydrogen	3.5 Wh/l	39,000 Wh/Kg

FIG. 4—COMPARE THE ENERGY DENSITIES shown here and draw your own conclusions as to the worth of each as a fuel or a means.

hazmat, rescue, underwater, or maintenance. More on hydrogen can be found in MUSE115.PDF.

An Energy-Density Summary

It never ceases to amaze me how figures that people do not want you to see sometimes are extremely hard to pin down. One example is a simple and direct comparison of energy density. Another is the fact that the currently highly touted electric car has a theoretical maximum energy-storage equivalent of less than six pints of gasoline (less than your lawn mower).

As a review, a fuel is something (such as gasoline) that is capable of delivering net BTU's worth of "on the books" energy. The fact that the sun and some swamp labored eons to pre-concentrate the energy does not seem to count. What does count by today's economics is just how much energy you get back for the energy and "energy equivalents" you put in, using today's dollars.

By contrast, any energy transport means (such as hydrogen or lead acid) does not deliver any net "on the books" BTUs or watt hours. Those are simply ways of moving already existing energy to a more convenient time or place, but always at an efficiency and energy loss.

At any rate, two very important measures of "how good" either a fuel or an energy transport means are: How heavy is it? How much room does it take up? A useful measure of "how heavy" is in watt hours per kilogram (Wh/Kg). The "how much room" can be measured in watt hours per liter (Wh/l). Figure 4 gives you the direct comparisons for conventional and alternate energy densities. Form your own conclusions.

New Tech Lit

What just might be the long-sought inside secret to photosynthesis may have appeared in the September 26, 1997 issue of *Science*. Check out "A Metalloradical Mechanism for the Generation of Oxygen from Water in Photosynthesis" by Hoganson and Babcock, on pages 1953-1956. Their key process may involve a manganese compound that goes through five reaction states. The first state accepts water and solar energy and kicks off both an electron and a hydrogen ion. The second, third, and fourth stage also kick off an electron and a hydrogen ion. The fifth state burps out a new diatomic oxygen molecule as a "waste product," and reverts itself back to state one.

From SenSym comes an update on their fine *Solid State Pressure Sensors Handbook*. Dallas Semiconductor has their latest *Short Form Catalog* on clock, temperature, digital pot, and other unique chips.

Our two featured trade journals this month are *Biocard International* on hand print and related security, and *Weighing Technology* on scales.

The Secrets of Building a Plastic Injection Molding Machine forms the latest title from Lindsay Publications. It shows you how to recycle ordinary plastics into custom items. Vince and Dave Gingery are the authors. It lists for $15.95. Lindsay's Website is www. keynet.net/~lindsay.

One Internet marketing book I am rather impressed with is *Increasing Hits and Selling More from your Web Site*. It is authored by Greg Helmstetter and published by Wiley. Amazon Books sells it at $19.96. While largely non-technical, it seems to nicely complement some of the ideas and concepts you'll find in the Webmaster Library Shelf files of my www.tinaja.com.

Free and detailed specs on new PostScript Level III are now available from www.adobe.com. Level III is more about "formalizing" high-end publishing and networking options, rather than about adding new low level features, although there is a unique curve tracing feature (spline interpolation of sampled data), that I will be looking at closely. Sadly, the transparency options you'll need for video apps still seem to be either lacking or well hidden.

Brand new opportunities in PIC PostScript robotics can be found in POSTFLUT.PDF My ongoing Blatant Opportunist columns are now in e-zine format at www/tinaja.com/blat01.html The latest two include BANNYEAR. PDF on profiting from Internet advertising banners; and TRIMODE.PDF about tri-mode paper, electrons, and plastic publishing options. For details on starting up your own tech venture, take a gander at my *Incredible Secret Money Machine II* as per my nearby Synergetics ad or at www.tinaja.com/ismm01.html.

As usual, most of the mentioned items should appear in the Names & Numbers or the Television Resources sidebars. Always check there before you phone our U.S. technical help line shown in the Need Help? box you'll find nearby. Let's hear from you. EN

NEW PRODUCTS

USE THE FREE INFORMATION CARD FOR FAST RESPONSE

Digital Multimeters

FLUKE CORPORATION'S 70/20 Series III Digital Multimeters (DMMs) is ergonomically designed. Its tapered shape provides stable results in harsh, industrial environments. The Series III DMMs can be used in a variety of electronic and electrical applications by technicians in field service, facilities maintenance, and/or production equipment maintenance and installation; in bench service and repair, and in manufacturing environments.

The DMMs feature a large, high-contrast screen and segmented bargraph for easy reading. With the meter's Touch Hold function that automatically freezes the reading and beeps when the measurement is captured, technicians are able to focus their attention on the test probes without having to touch any button. The user-interface has been improved to provide easier access to the Range and Hold buttons. In addition, the battery and fuses can be replaced without breaking the calibration seal, thus eliminating unnecessary calibration.

The top-of-the-line models, the 79 and 26 Series III DMMs, offer true rms, capacitance, frequency, and low-ohms capabilities. These meters measure volts, millivolts, DC, AC/DC volts, ohms, and amps. All the models in the Series III family perform diode and continuity tests.

Complying with the International Electrochemical Commission (IEC) 1010-1 safety category ratings, based upon the ability of meters to withstand power surges and high voltage transients, the Series III has protection up to 6 kV. Input ranges and functions are protected up to the meter's rated voltage. They have dual IEC 1010 ratings for Overvoltage Category III 600 V and Overvoltage Category II 1000 V. These DMMs will not blow a fuse or be destroyed if accidentally connected to a live circuit while in the resistance mode.

The Series III meters are rugged and durable; their integrated, overmolded cases are meant to withstand falling, being dropped, or being tossed into a tool box. List prices for the 70 Series Model III DMMs are $199 (Model 79 III), $179 (Model 77 III), $159 (Model 75 III), $129 (Model 73 III), and $99 (Model 70 III). For the 20 Series Model III DMMs, the list prices are $219 (Model 26 III), $199 (Model 23 III), and $179 (Model 21 III).

CIRCLE 20 ON FREE INFORMATION CARD

Fluke Corporation
P.O. Box 9090
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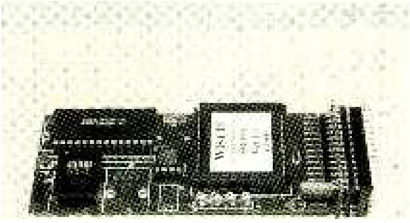
Fax: 800-FLUKE-FAX or 206-356-5116
E-mail: fluke-info@tc.fluke.com
Web: www.fluke.com

Low-Cost EPROM Emulator

The SR256, Socket Rocket, from Wisch Communications is a low-cost EPROM emulator with the ability to emulate 8K × 8, 16K × 8, or 32K × 8 EPROMs. Designed as a productivity tool, the SR256 features a sophisticated command-line loader utility, jumperless operation, and single-device bus loading. It has 90-120nS access times, dual-polarity reset outputs, and an LED status indicator. Its small outline accommodates dense component areas.



CIRCLE 21 ON FREE INFORMATION CARD

The command-line loader utility allows users to load Hex, S-Record, or Binary files into the emulator. It also enables them to set the EPROM size of the emulator, to fill unused locations in the emulator with a data byte, to locate code anywhere using offsets, to verify that the data loaded is correct, and to run a self-test diagnostic on the emulator.

Cables and software, as well as a shareware table-driven assembler, are included with the SR256, as is the manual and step-by-step instruction for installation and use. The SR256 is priced at $99, plus shipping and handling.

Wisch Communications
2550 Trinity Mills Road, Suite 132B
Carrollton, TX 75006
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Fax: 972-417-3821
E-mail: wischcom@cyberramp.net

Schematic Capture Tool

CircuitMaker Version 5 has recently been released by MicroCode Engineering. The Windows-based schematic capture and simulation tool now features fast, accurate, mixed-signal simulation previously only available on higher-cost EDA software. Aimed at engineers, this software can simulate any combination of analog and digital components—without manually inserting A/D or D/A translators. Version 5 makes mixed-signal simulation as easy as analog-only simulation.

Along with the expanded simulation capability, the new release features a larger device library of over 4000 devices, easier SPICE model import, and no limit on the number of pins for an individual device. Version 5 offers a proven, accurate, 32-bit SPICE-based simulator for analog and mixed-signal circuits. It also provides fully interactive digital logic mode when only logic simulation is needed.

CircuitMaker is an EDA software tool that seamlessly integrates schematic capture and simulation in one complete program. Professional schematic capabilities include a built-in symbol editor, a macro feature for hierarchical devices, and SmartWires automatic wire routing. These features allow users to quickly create high-quality schematics. Designers can also export CircuitMaker schematics as PCB netlists for use in MicroCode's TraxMaker or other printed-circuit-board layout products.

A wealth of analyses in the software allows designers to test and troubleshoot circuits in a virtual lab environment, without worrying about bad parts or faulty connections that often plague traditional prototyping. With a click of the free-floating Probe tool, users can instantly see waveforms and measurements on virtual instruments, like the digital oscilloscope, curve tracer, bode

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plotter, or digital multimeter. Simulation tools like CircuitMaker give engineers the freedom to try all scenarios, changing parts or component values to see how changes affect the circuit's operation and performance.

The software operates on the Windows 3.1x, 95, and NT platforms. Single-use copies are priced at $299. Special upgrade offers are available for current registered users.

MicroCode Engineering Inc.
927 West Center Street
Orem, UT 84057
Tel: 800-419-4242 or 801-226-4470
Fax: 801-226-6532
E-mail: sales@microcode.com
Web: www.microcode.com.

Serial Data Acquisition Module

B&B Electronics has introduced an RS-232 serial-port data-acquisition module. It amplifies and conditions the very low-voltage signals coming from sensors, so that they can be monitored and recorded on a PC. Two digital I/O lines and six A/D channels are provided.

An optical fiber link in each line provides a minimum of 2500V DC isolation against electrical ground loops, surges,

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and spikes. The 2320PSDA is port-powered on the RS-232 side of the device. An external isolated power supply is needed to power the I/O side of the device, which has terminal blocks. The host RS-232 serial port is a DB-25 (female) connector.

Demonstration software and a data-logging utility on a 3.5-inch disk are included. The 2320PSDA is priced at $109.95. The optional power supply is $14.95.

B&B Electronics Manufacturing Co.
707 Dayton Road
Ottawa, IL 61350
Tel: 815-433-5100
Fax: 815-434-7094
Web: www.bb-elec.com

Coax LAN Test Accessory Kits

Two Coaxial LAN Test Accessory Kits from ITT Pomona provide the network technician with everything needed for

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coax-cable LAN troubleshooting, installation, and repair. The Model 6201, a general-use LAN test kit, includes a flexible assortment of cables, breakouts, termination plugs, and adapters. The Model 6202 LAN test kit is designed specifically

(Continued on page 62)

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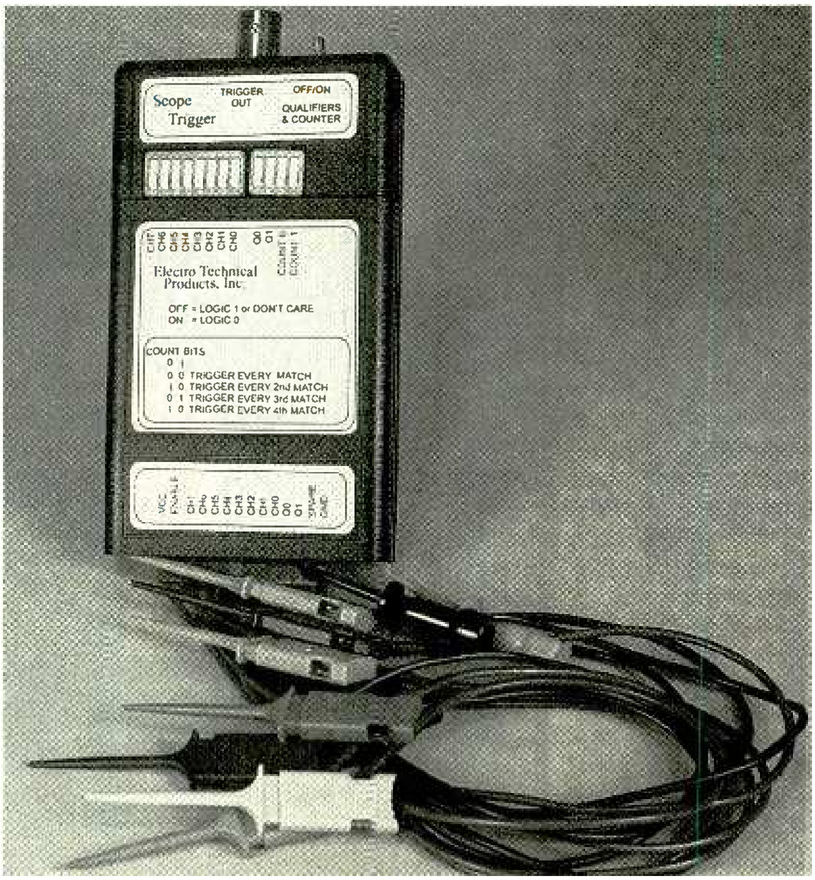
Build a Multichannel Oscilloscope Trigger



Trigger an oscilloscope sweep on a combination of input signals!

THOMAS PETERICK

If you have ever experimented with your PC's hardware, you have probably figured out that a two-channel oscilloscope isn't exactly the best tool for debugging or troubleshooting computers. Generally, when digging around in any computer-based circuit, you want to look at the resulting output of several input signals. A two-channel scope doesn't provide that capability. With the Multichannel Oscilloscope Trigger presented here, you can examine one or two signals with a triggering circuit based upon as many as ten other inputs. Such a capability can be very handy when you want to be sure that data is written to the correct I/O address or the correct bit is set when a memory operation takes place.

The Multichannel Oscilloscope Trigger can assist in providing faithful and reliable information when probing digital circuits. The scope trigger is a ten-bit comparator with a built-in counter feature. It generates an output pulse when the inputs match the value set into the selector switches or on some multiple of matches. The counter feature allows the scope trigger to provide an output pulse on every second, third or fourth count. The output pulse can be fed into the trigger of a standard oscilloscope causing the scope to trigger only when the digital signals present at the monitored inputs match the switch settings on the trigger unit.

Circuit Description. The schematic for the scope trigger is shown in Fig. 1. It consists of two integrated circuits, three resistor packs, and some support circuitry. The monitoring portion of the circuit is built around IC1, a 74AC520 eight-bit comparator. It compares the inputs that are connected to pins 5–12 of J1 to the switch settings on S2. Pin 13 of J1 is an enable control that must be at a low logic level (or grounded) for IC1 to operate.

When the inputs match the switch settings, a negative-going pulse appears on pin 19 of IC1 and is passed on to IC2, a GAL16V8 Programmable Logic Array (PLA). The programming for IC2 is set so that it acts as both a 2-bit comparator and a counter. Inside IC2, the inputs from pins 3 and 4 of J1 are compared to S1-c and S1-d. If the inputs match the switches and there is a negative pulse from IC1, the logic inside IC2 decodes a data match and outputs that condition on pin 17. In other words, S1-c and S1-d act like a ninth and tenth comparator bit, extending the range of IC1.

The count process is also controlled by IC2. If both S1-a and S1-b are on, every match is passed out of IC2 on pin 19. If S1-b is turned off and S1-a is turned on, every other match is passed out of pin 19 of IC2. The full set of combinations for S1-a and S1-b is shown in Table 1. The counter feature gives the Multichannel Oscilloscope Trigger greater flexibility for whatever type of triggering is needed.

Resistor packs R1, R2, and diode D1 provide some isolation from the circuit under test as well as protection for the scope trigger, in case the Multichannel Oscilloscope Trigger is not hooked up properly to a circuit. Resistor pack R3 acts as a set of pull-up resistors for S1 as well as for the inputs on J1. That is done in order to have a valid signal on the inputs in case not all of the inputs are needed. Capacitors C1 and C2 are for power decoupling.

The final output to the oscilloscope trigger is selected by S3. If the output from IC1 is to be used directly by the oscilloscope, the final trigger can have up to eight trigger

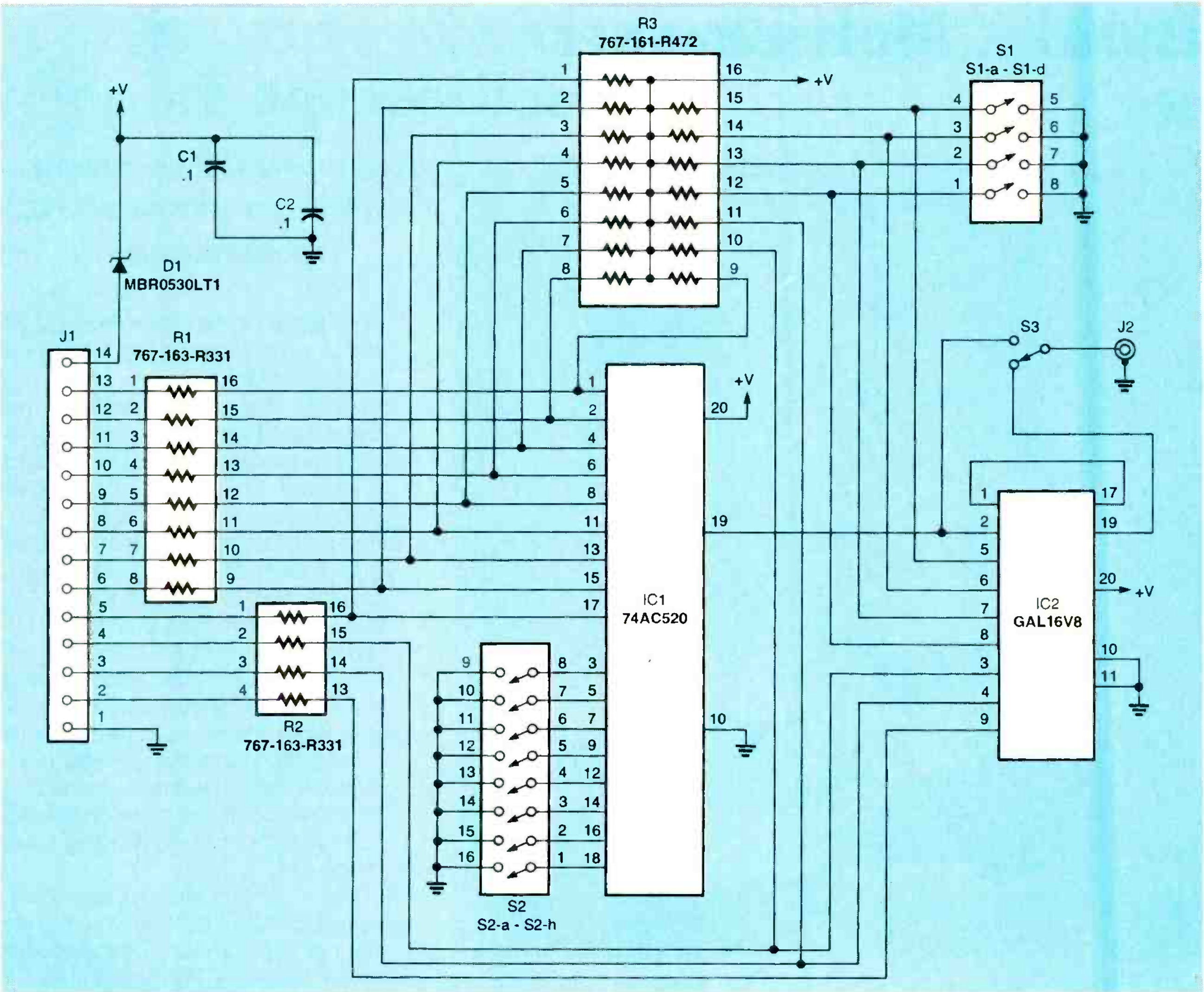


Fig. 1. The Multichannel Oscilloscope Trigger is a simple device that lets you use your oscilloscope to examine complex circuits. You can trigger your oscilloscope on a combination of either eight or ten logic inputs. You can also set the output to trigger on every trigger occurrence up to every fourth trigger occurrence.

inputs at a speed up to 100 MHz. By using the output from IC2, the trigger output can be more sophisticated in operation. However, the speed of the trigger will drop to about 50 MHz.

Building the Multichannel Oscilloscope Trigger. The Multichannel Oscilloscope Trigger uses several surface-mount (SMT) components. Anyone with knowledge of soldering should be able to build the unit without difficulty. If you do not have any experience with surface-mount technology, this project is a good first exposure to the methods used in working with SMTs. The sidebar on soldering SMT components should be reviewed before starting construction.

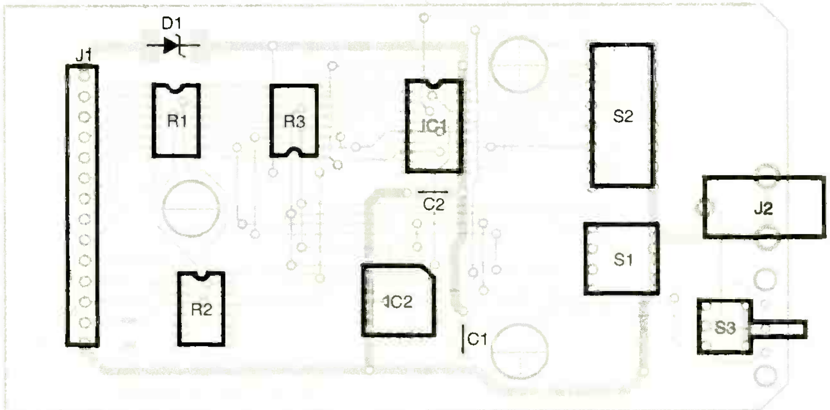
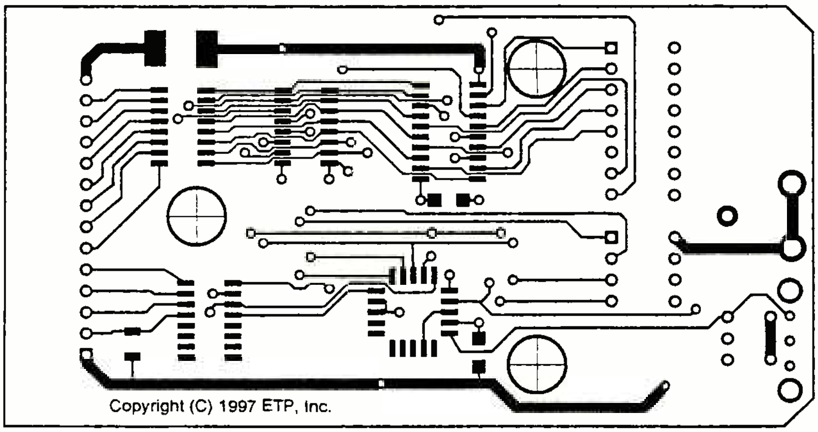
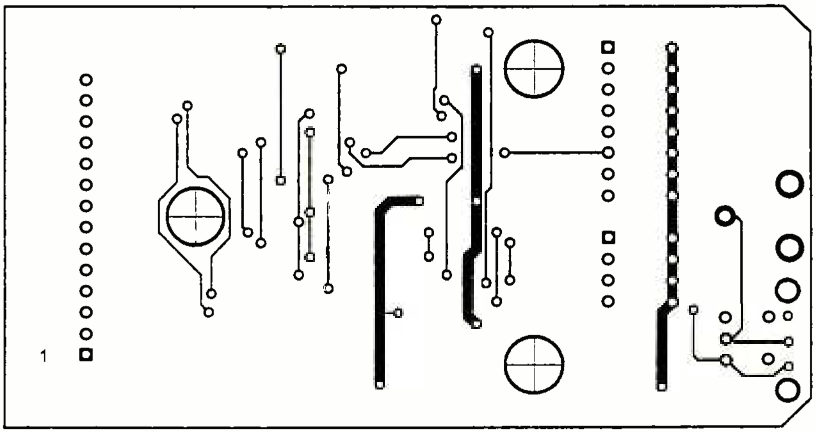


Fig. 2. The Multichannel Oscilloscope Trigger is based on surface-mount components. This project is a good introduction if you've never worked with SMT components before.

The programmable logic array, IC2, must be programmed before it is installed in the board. If you wish to program your own part, the programming data can be downloaded from the Gernsback FTP site (ftp://ftp.gernsback.com). The



Here's the foil pattern for the component side of the Multichannel Oscilloscope Trigger.



The solder side of the Multichannel Oscilloscope Trigger completes all of the connections needed to the other side of the board. If you're making your own board, don't forget to make the connections between the two sides of the board or the Multichannel Oscilloscope trigger won't work.

name of the file that contains the data is otrigger.dat.

If you are using the PC board from the kit given in the Parts List or you have etched your own board using the foil patterns included here, follow the parts-placement diagram in Fig. 2 for component location. Start by soldering the surface-mount components to the PC board. That approach will make it easy to position the soldering iron and solder the components to the PC board without some of the larger components getting in the way. After C1, C2, D1, R1–R3, IC1, and IC2 are in place, install the through-hole components. If you wish, you could add a jumper wire between pin 13 and pin 1 of J1. That will disable the pin 13 input on J1 and permanently enable IC1. A disadvantage to that modification is that it will not be possible to cascade several Multichannel Oscilloscope Trigger units together. However, it is not necessary to remember to ground the enable line when using a single unit. The enable input can also be used as an active-low qualifier input for the Trigger—the choice is entirely up to you.

Install sockets for S1 and S2. That will lift the switches off the PC board and project them through the top of the case. The trigger output jack, J2, has a large thermal mass, making it more difficult to solder to the PC board with a small iron. When soldering J2 onto the board, heat the two large pins more than the pads on the PC board. The joint will

AN SMT PRIMER

Soldering surface-mount components is no different from any other soldering task. The limited contact area that SMT components have just makes the same job more critical. Dirt or contamination that could be ignored on through-hole components cannot be tolerated on SMT components. Therefore, the first rule of SMT soldering is cleanliness. The least bit of contamination on the PC board or component can drastically change the amount of solderable surface area in a connection.

Use fresh components and PC boards to reduce the chances of contamination. The soldering iron should be tinned and shiny. If there is any flux crust or dark spots on the iron tip, wipe it off with a damp sponge and re-tin the tip. Always use fresh solder.

The second rule is that the equipment should match the job. You don't crack walnuts with a sledgehammer, nor should you solder SMT components with an oversized soldering iron. To do the job right, the soldering-iron tip should match the physical size of the SMT connections. A suggested tip size should be no bigger than 1/16 inch. It is also a good idea to purchase solder that is appropriate for soldering SMT components. A solder diameter between 0.015 and 0.031 inch is suitable for most SMT tasks.

The third rule is to watch the temperature of the soldering iron. All common electrical solders begin to melt at about 361° F. Applying an iron with a tip temperature over 800° F to the joint could damage the component or the board. If the tip is properly sized to the job, there is no need to heat a component lead and PC board contact to more than 600° F to solder components.

Now that we have the right tools for the job, let's examine how to hand-solder an SMT component to the board. For multileaded components, pick a corner lead on the PC board for the component to be soldered. Melt some solder onto that pad. Position the component on the board. Heat the component and wetted pad with the soldering iron. The solder will reflow and the component leg will sink into the solder. Inspect the component's alignment with its footprint. If the alignment is good, solder the diagonally opposite corner from the first connection so that the component cannot move. If the alignment is not correct, reheat the joint and move the component until the alignment is good. With two diagonal corners soldered in place, the other pins can be soldered. Those connections are done the same way you would solder any other connection—heat the component and pad with the soldering iron and apply solder to the component leg. The corner-tack method holds the component in good mechanical alignment.

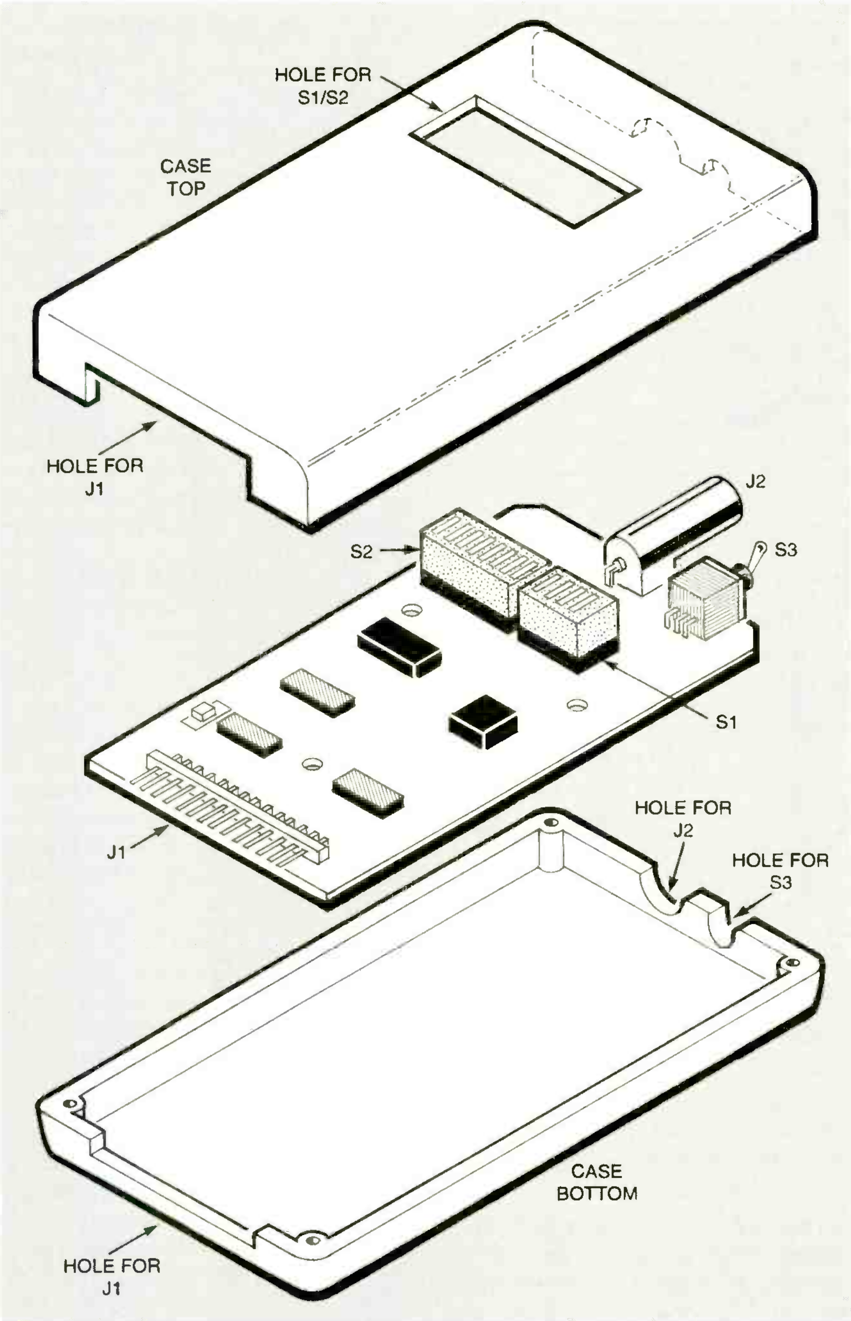


Fig. 3. The Multichannel Oscilloscope Trigger fits nicely into a small hand-held case. Several holes will need to be cut at specific locations in order for the controls to be accessible.

PARTS LIST FOR THE MULTICHANNEL OSCILLOSCOPE TRIGGER

SEMICONDUCTORS

IC1—74AC520SC 8-bit comparator, integrated circuit, surface-mount
IC2—GAL16V8 programmable logic array, integrated circuit, surface-mount
D1—MBR0530LT1 Schottky diode, surface-mount

RESISTORS

R1, R2—767-163-R330G resistor network, surface-mount
R3—767-161-R472G resistor network, surface-mount

ADDITIONAL PARTS AND MATERIALS

C1, C2—0.1-µF capacitor, ceramic surface-mount
J1—14-pin right-angle header (Digi-key A5308 or similar)
J2—BNC connector, right-angle PC-board-mount (AMP 414373-1 or similar)
S1—4-position DIP switch
S2—8-position DIP switch
S3—Single-pole double-throw switch, right-angle PC-board-mount (Digi-key EG1905 or similar)
IC sockets, case (Digi-key SRM6-B or similar), wire, test probe clips, hardware, etc.

Note: The following items are available from Electro Technical Products, Inc., PO Box 16658, West Palm Beach, FL 33416-6658, E-mail: etpinc@pb.seflin.org: Complete kit of parts including pre-programmed IC2, case, PC board, and case labels, $64.95; Assembled and tested unit, $84.95; 13-piece test clip set for use with J1, $29.95. Please add $3.00 for shipping and handling charges. FL residents add appropriate sales tax.

eventually get hot enough for the solder to flow. When installing J1, you could cut off pin 2. That pin is not used, and can be utilized as an orientation key. Filling the hole on the corresponding plug will reduce the risk of installing the input cable backwards.

Once all of the components have been soldered to the board, inspect each solder connection thoroughly. Use a magnifying glass or jewelers loupe, if possible. Look for all the indications of a good solder joint. They should be shiny and even, without either too much solder or too little solder. Joints that have peaks or points have too much solder. If there is too little solder, it will be difficult to tell if the connection is soldered. Solder bridges and excessive solder can be cleaned up by using solder wick to draw the excess solder away from the components.

Drill and cut appropriate holes in a suitable enclosure. Square holes will have to be cut for J1, S1, and S2. Round holes are needed for J2 and S3. Measure the locations of those components on the PC board to find the locations that need to be cut on the case. Additional holes will be needed in the back of the case for mounting the PC board. Screws, nuts, and spacers can be used. As an alternative, plastic tubes can be glued to the inside of the case and the PC board held in place with self-tapping screws. The general

(Continued on page 56)

THE GREAT COMPRESSION

BY YASUDA HIROSHI*

MPEG is the key behind many of today's high-capacity multimedia technologies. Here's an overview of what it is and how it works.

Most readers of this magazine have likely heard the term "MPEG," and are aware that it is the key technology that has made digital direct-to-home satellite TV, DVD video, DTV (digital TV), and other advances possible. In this article, we will explore what MPEG is, what it does, and some of the history behind it.

Why MPEG? MPEG, which stands for *M*oving *P*icture Coding *E*xperts *G*roup, is a technology for compressing the amount of data contained in moving images such as in film and video. It is also the name of the organization that has worked to create international standards for this technology.

But why is compression needed at all? Take a look at Fig. 1, which is a comparison of the volume of data required for a person to spend an hour enjoying various media forms. As you can see from that figure, an hour of music requires 1,000 times as much data space as an hour's worth of text, and an hour of video takes up 1 million times as much data as an hour of text. While high-capacity CDs (compact discs), MO (magnet optical) discs, or DVD (digital video discs) can hold more than previously available technologies, there is still a limit on how much data can be placed on a single disc.

In the broadcasting realm, digital technology coupled with compression would allow a high-definition TV (HDTV) signal to be broadcast using no more spectrum than a standard, analog signal. It would also allow the transmission of multiple channels of standard-definition digital TV in the same spectrum space as a single channel of analog Television.

How Compression Works. Technology for the perfect reproduction of moving images has yet to be developed. Television broadcasts and film footage use a series of still photographs to reproduce motion. For television, 30-frames-per-second are used, while 24-frames-per-second are used for film. (Japan and the United States use the same number of shots per second for television, while European countries use only 25 shots per second. Consequently, video tapes recorded in Europe cannot be viewed in Japan or the U.S. without special equipment. No such regional differences exist in relation to movies.)

When many photographs are continually transmitted like this, often there are only minute differences between one still image and the next. If there is absolutely no movement on the screen during the 1/30th or 1/24th of a second between images, there is no need to send the next photograph as long as the previous image has been stored and can be re-shown in the place of the next photo. In this way, the number of photographs sent (the volume of data) can be reduced.

Figure 2 shows two images of a moving airplane. The entire image other than the moving plane does not change from one image to the next. Thus, that part of the image that has not changed need not be retransmitted. Assuming the moving

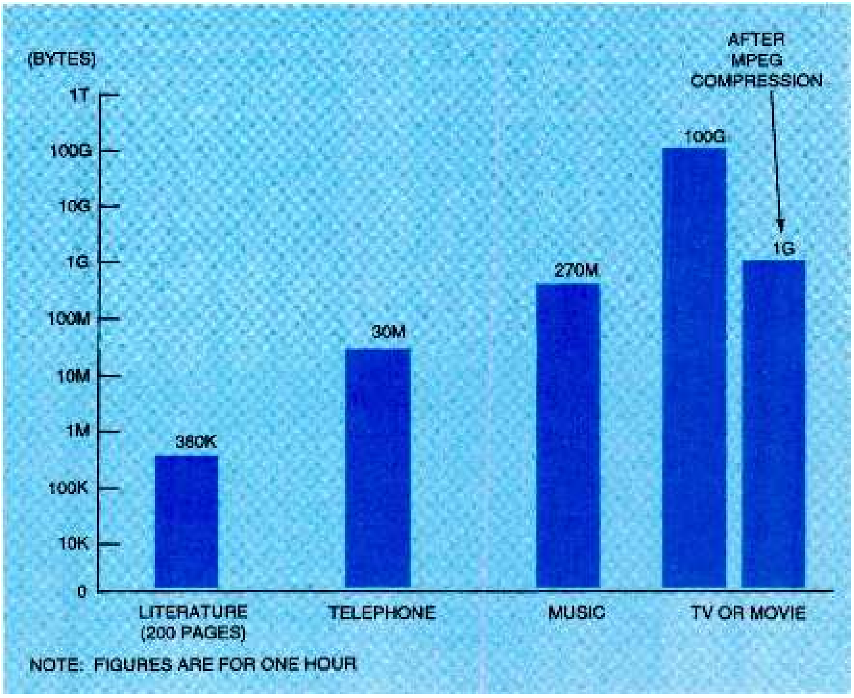


Fig. 1. While moving images (either video or film) require much more storage space than other types of media, MPEG compression can greatly reduce those requirements.

*Courtesy LOOK JAPAN, August 1997

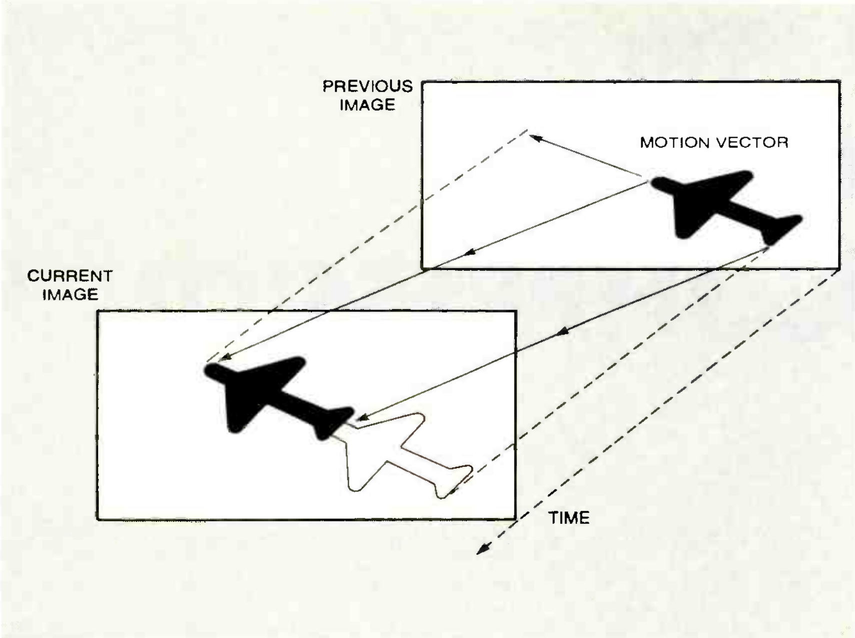


Fig. 2. For an object in motion, such as an airplane, and assuming that all other elements in the image are identical, the only additional information needed to produce the next frame is the object's motion vector and data for the area occupied by the object in the first frame.

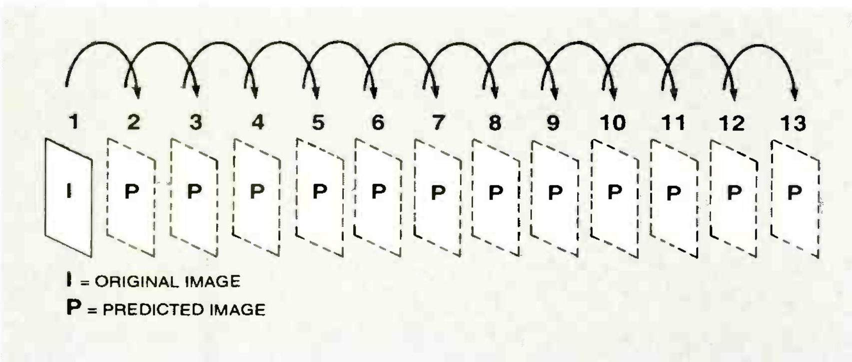


Fig. 3. In motion-compensated interframe coding, all images after the original (I) frame are predicted by combining the initial image and any motion information.

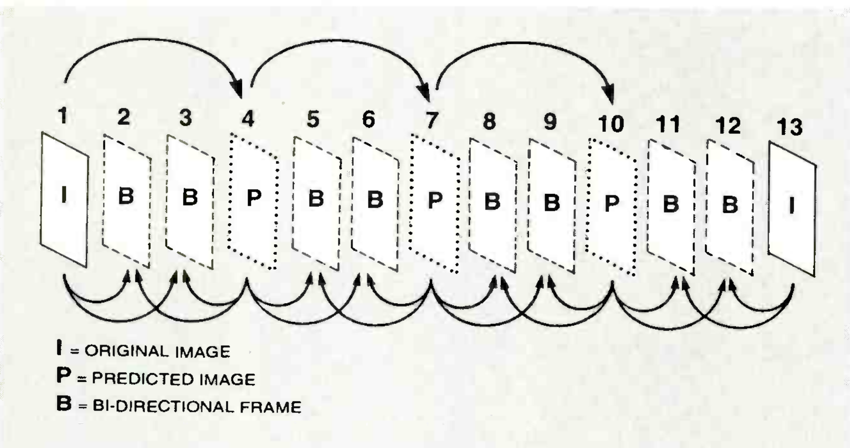


Fig. 4. In MPEG encoding, the frame stream is broken up into GOPs (group of pictures) and motion compensation from past and future images is used. For example, in this GOP the fifth frame is created using information from the fourth and seventh frames.

plane accounts for 1/20th of the total area of the image, for example, only 1/20th of the total volume of data need be transmitted to reproduce the next image. Furthermore, if the shape of the airplane is known, the only additional information needed is how far and in what direction (known as the vector of movement) the plane moved during the 1/30th of a second between the two still images.

In this way, the volume of data can be cut even more by simply moving the known image of the plane along the known vector of movement. (Of course, since it is not known what image will appear in the area occupied by the plane in the first image, the data for that area must be sent as well.) This method of reducing data volume combined with mathematical processing technology is called "motion-compensated interframe coding."

The initial research in that technology was initiated to find a way of making video telephone technology less expensive. MPEG took the motion-compensated-interframe-coding principle and corrected its faults, made it applicable to a wide range of fields, and standardized the technology so it could be used worldwide.

Establishing The Compression Standard. The history of MPEG standardization began in 1987 with the JPEG (Joint Photographic coding Experts Group). The difference between JPEG and MPEG is that JPEG encodes and compresses still images rather than moving images. By the fall of 1987, specifications for the JPEG international standards had already been settled and all that was left to do was to put them in writing and put them to a final international vote. Once those tasks were achieved, the organization formed to create the international standards would have completed their function. To dissolve the organization after going to all the trouble to create it, however, seemed a pity. In fact, there were calls for setting up a new task for the organization to take on. Then, at a meeting in the United States of JPEG members in November 1987, a discussion developed over the desire to place movies on CD and the possibility of creating compression-coding standards for film and television. Based

(Continued on page 56)

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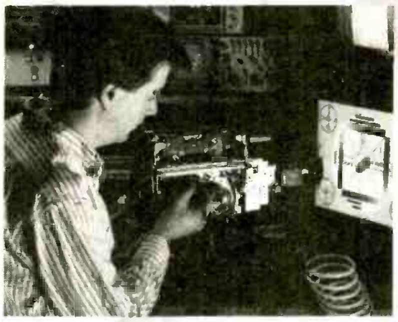

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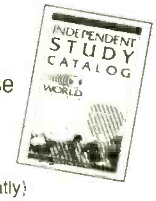

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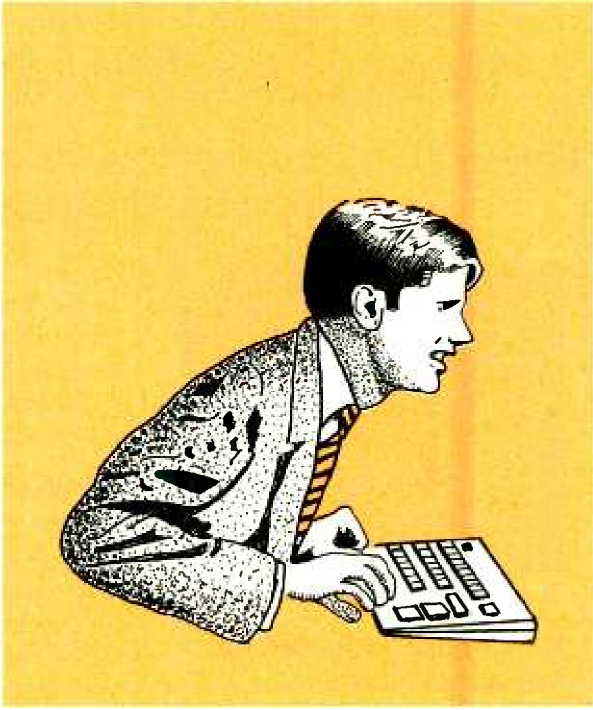
Build this POCSAG Signal Generator

Generate pager signals with this simple interface and computer program.

ROBERT B. WHITAKER, KI5PG



Not too many years ago, personal pagers were mainly used only by people in the business world. Now pagers have become a popular means for almost everyone to keep in touch with one another. These days, even school children have pagers on their belts or in their backpacks so that they can keep in touch with their parents and friends.

The strange-sounding digital signals that activate pagers and encode their messages are not difficult to generate. We'll show you how to build a simple POCSAG pager-signal generator and encoding system using a small interface circuit to connect an IBM-compatible personal computer and an FSK (frequency-shift keyed) FM-radio transmitter or signal generator.

The software for the pager encoder is readily available over the Internet, and it is free. The interface itself can be built for about $10.00 on a small piece of perfboard.

What is POCSAG? POCSAG is an abbreviation for Post Office Code Standard Advisory Group. It refers to the standard protocol used to send messages to common pocket pagers that many people carry around on their belts or in their purses. As opposed to the radio signals used for voice transmission, POCSAG is based on digital signals. Depending upon the type of pager used, different digital signals can be sent. Some *tone-only* pagers activate when they receive a special tone. With tone-only pagers, you generally have to call the pager service in order to find out what the message is. *Numeric* pagers can receive numeric information such as a telephone number to call to talk directly to the person trying to contact them. *Alphanumeric* pagers have the capability of viewing actual text messages; long messages will usually scroll across a viewing screen. Some people even have the capability of directing their Internet e-mail to their alphanumeric pager so that they can read their e-mail directly from it.

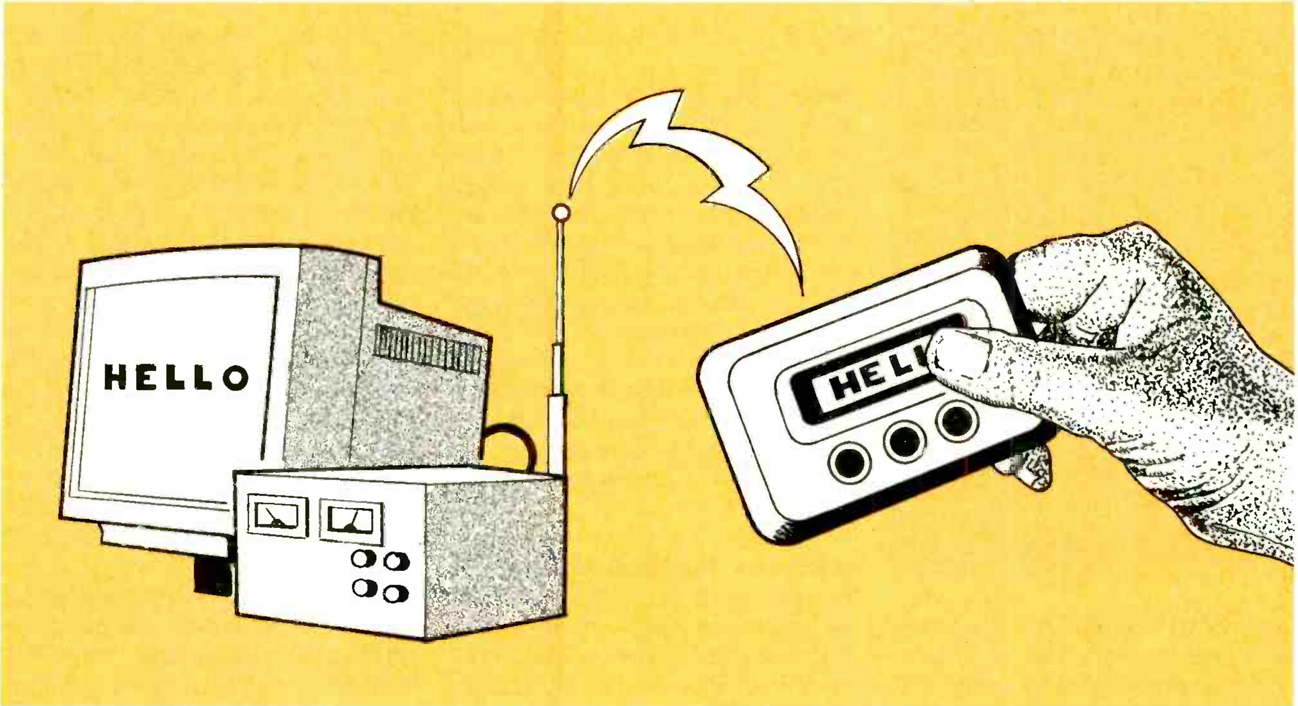
The most common baud rates used by pagers are 512 baud, 1200 baud, and 2400 baud. With just a little experience, a person can distinguish different pager baud rates just by listening to the digital signal over a scanner or radio receiver.

What is FSK? POCSAG signals are sent using a method called *Frequency-Shift Keying*, or FSK for short. With that method, the carrier wave is shifted by 4.5 KHz up or down from the center frequency. Those shifts represent the actual data being sent. For example, a signal sent on 158.100 MHz will shift back and forth between 158.0955 MHz and 158.1045 MHz.

One of the easiest ways to create an FSK signal is to directly control the modulation stage of an FM transmitter. A varactor (a voltage-variable capacitor) is usually used to couple the digital data into the transmitter. The changing voltage fed to the varactor changes it's capacitance. That will change the tuning of the transmitter's modulation stage, causing the transmitter to shift its output frequency in direct response to the digital data.

Ham operators who have 9600-baud packet-capable radios can use those radios to generate POCSAG signals. Many other crystal-controlled FM radios can also be used for FSK work when properly modified. Some older radio equipment that uses phase-locked loop circuits might have problems trying to generate FSK signals. A list of known FSK-capable radios is shown in Table 1.

The Software. An excellent program that can be used to generate POCSAG signals and control a radio transmitter has been written by two British ham-radio enthusiasts, Clive Cooper (G8UKN) and Pete Baston (GW0PJA). The pro-



gram, PE.EXE, can be found at several Internet locations, including http://www.seelect.demon.co.uk/pocsag.html and ftp://ftp.demon.co.uk/pub/ham/scanners/pe-204.zip.

At only 68 kilobytes, PE.EXE is a fairly small DOS-based program that needs only an 80386-based personal computer or better. Text to be sent is typed into the program, which then assembles the data into the POCSAG format and sends that information to an RS-232 port for controlling the radio transmitter. The radio is keyed by shifting the voltage state on the serial port RTS (Request to Send) pin. The POCSAG data is then sent to the transmitter's modulation stage by shifting the voltage state on the DTR (Data Terminal Ready) pin.

When first started, the program asks for the "capcode" of the pager. A capcode is a unique seven-digit identification number that is assigned to each pager. After the capcode is entered, the program asks for the data that will be sent. Once the data is typed in, the program will ask if the data should be sent in the alphanumeric or numeric format. If the data is all numbers, the program will default to numeric format.

The baud rate and serial port can be shifted though the various choices by simply pressing the various control keys. Each press of a certain control key will cycle that individual setting to the next choice. Pages can be sent in normal or inverted mode by keyboard control as well. Different transmitters might invert the digital signal, so try the inverted signal format if the normal mode does not work.

One particularly useful way to use the program is by entering all of the information directly through the DOS command line. That method, which can be used in a "batch" command, is set up as follows:

PE (CAPCODE) (TYPE) ("MESSAGE") (N/I) (COMPORT#) (BAUD)

The first entry, of course, is the program itself. The pagers seven-digit capcode is entered next. The "type" choices are A, N, 1, or 2, which refers to alphabetic, numeric, signal and tone only function 1, or tone only function 2. The message to be sent must be enclosed in quotation marks. One important limitation of the unregistered version of the software is that the message is limited to a maximum of eight characters and spaces. The registered version of the software allows longer text strings. If the signal must be inverted as described above, type an "I" next. Typing an "N" will not invert the signal. Finally, the serial port and baud rate are specified.

A typical command line might look something like:

PE 1281491 N "800 555 1212" I 4 512

In that example, the numeric-only message "800 555 1212" will be sent to pager number 1281491. The inverted signal will be sent to serial port 4 at a rate of 512 baud.

TABLE 1—RADIOS THAT ARE KNOWN TO BE FSK CAPABLE

Alinco DR-1200 Data Radio
GE Mastr Executive II, VHF and UHF
GE Custom MVP, VHF and UHF
Icom IC series: 25, 38, 228, 271, 290, 471
Kenwood TM series: 211, 212, 221, 231, 431, TS series 700 and 770
Motorola Mitrek
MFJ Model 8621 VHF Data Radio
Standard C58, C140
Yaesu FT series: 212, 221, 230

The Interface. Any number of different interface designs between the computer serial port and radio transmitter could be used. A suggested circuit is shown in Fig. 1. That circuit uses a small relay powered directly by the voltage from the serial port's RTS line. The relay provides a reliable switch to turn on and off the radio transmitter. The voltage

PAGER SOURCES

The following businesses have agreed to supply refurbished numeric and alphanumeric pagers without signing a commercial pager contract. For a reasonable charge, the pagers can be re-crystaled for a specific frequency.

McManus Communications
400 North Fifth Street
Blytheville, AR 72315
501-763-6250 (voice)
501-763-6533 (fax)

PageCo International, Inc.
2400 E. Commercial Blvd., Suite 630
Ft. Lauderdale, FL 33308-4033
954-491-9501 (voice)
954-491-6834 (fax)
e-mail: info@pageco.com
Web: http://www.pageco.com

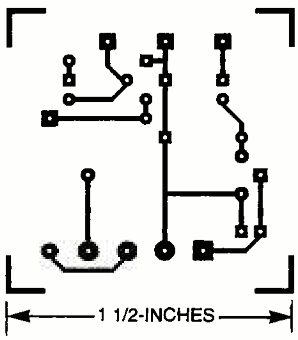
level of the POCSAG data, which is delivered through the serial port DTR pin, can be adjusted with R2. A 2.2-µf non-polarized capacitor (C1) provides DC isolation between the transmitter and the serial port while passing the modulation voltage. A bipolar LED (LED1) is included for a visual indicator of the outgoing modulation data. An additional LED (LED2) shows when the radio is keyed on. That LED also prevents the RTS voltage from closing the relay when the program is idle. Diode D1 is included to sink any possible voltage spikes caused by the collapsing magnetic field when the relay is switched off.

The circuit can easily be built on a small piece of perfboard. For a neater appearance, an etched single-sided PC board can also be used. A foil pattern has been included here for those who wish to use that method for building the interface. A source where you can obtain etched PC boards is given in the Parts List.

If an etched board is used, the parts-placement diagram in Fig. 2 should be followed. Note the polarities of the diodes when assembling the board. The three connections to the computer serial port should be wired to the proper terminals of a suitable connector. The particular pins to be used depend upon the type of connector that will be used. If a 9-pin connector will be used, connect DTR to pin 4, RTS to pin 7, and the ground to pin 5. For a 25-pin connector, use pin 20 for DTR, pin 4 for RTS, and pin 7 for ground.

Using a Signal Generator. A signal generator can also be used with the program and interface to generate POCSAG signals for testing pagers. In that case, the only circuitry needed is a potentiometer wired between the serial port's DTR line and ground. The potentiometer sets the voltage level of the signal from the serial port. Set the signal generator to external modulation and attach interface's the ground and potentiometer wiper to the generator's external-modulation input.

In Case of Problems. Although the software and hardware interface are relatively simple in operation, diagnosing problems could be a little difficult. The first step in problem solving would be to make sure that the program is operating properly. The best diagnostic tool for that is an RS-232 tester such as RadioShack catalog No. 276-1401. That device has red and green LEDs that light up to show serial port activity. No LED activity at all probably indicates that the wrong serial port has been picked. The tester's LED for the RTS pin should shift color when the radio is keyed up to send a page. At the same time the RTS line is shifted, the LED on the DTR line should flicker to show that the POCSAG data is being sent to the transmitter. If an RS-232 tester is not available, the voltage on the RTS and DTR pins can be checked with a standard multimeter. The voltage on the serial port's RTS and DTR pins should shift between −10 to −12 volts DC and +10 to +12 volts DC.



The POCSAG interface is simple enough to be laid out on a single-sided PC board.

If the program and the serial port appear to be working properly, the hardware interface and transmitter should be checked. Make sure that the transmitter is being keyed when pages are being sent. The program will indicate "Transmitting" on the status line at the bottom of the screen, and the RTS pin on the serial line will shift from +12 volts to −12 volts.

Most transmitters are turned on and off by a control line that is switched on and off to ground. The output of the hardware interface should change the resistance from a high resistance state to near ground potential state that should activate the transmitter's push-to-talk (PTT) switch. In case the keying of the radio is reversed, change the polarity of the LED2. If the relay does not work at all, try reversing the

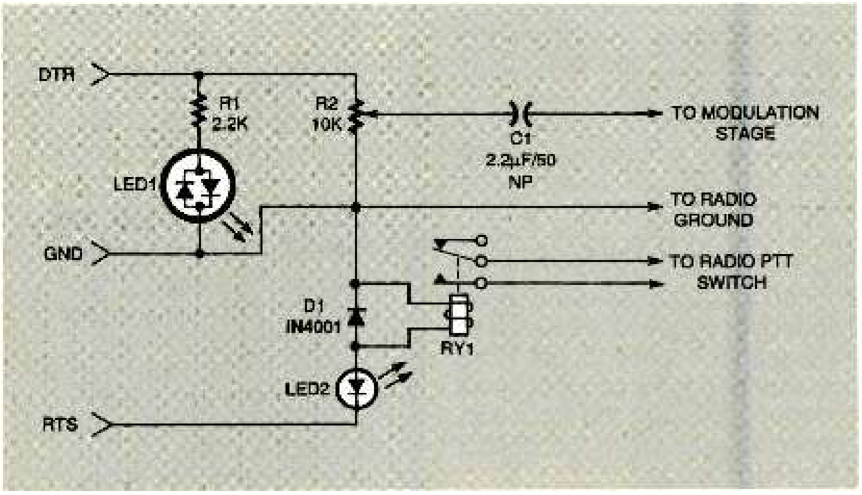


Fig. 1. The interface circuit for the POCSAG encoder is very simple. Light-emitting diodes give a visual indication of activity during transmission.

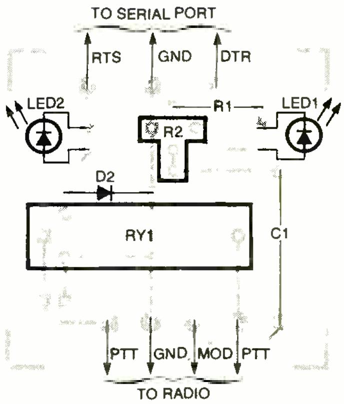


Fig. 2. Use this parts-placement diagram if you build the interface circuit on an etched PC board.

polarity of D1.

If the radio keys up properly, monitor the transmitted signal with a scanner or another radio. POCSAG signals are very distinctive. The easiest way to check your transmitter volume level (deviation) without expensive test equipment is simply by listening to a commercial pager transmission and setting your signal level to about the same level. If a commercial signal is not available for comparison, just set your output level to a sound level comparable with normal voice transmissions. Signals that are cut short or sound especially distorted or garbled are probably at too high a level. Reduce the level of voltage output though R2. Also, some transmitters might work better if you remove capacitor C1.

If you still have problems, your radio might not be FSK capable or you might not be injecting the signal to the proper modulation stage on your radio. Remember, you are sending data by direct frequency shifting. Using the regular transmitter microphone input for this application simply will not work.

What You Can Do With a POCSAG Encoder. This project lends itself to quite a number of useful applications. First, it is quite educational. You can learn about POCSAG signals and how pagers function. The project can be used to demonstrate POCSAG operation to others. Using a second PC with a POCSAG decoder, such as the unit described in the May 1997 issue of **Electronics Now**, allows a complete POCSAG transmission and reception system to be demonstrated.

Commercial paging companies and technicians will enjoy using the POCSAG encoder program to test and diagnose pagers without the need to use expensive page-generating equipment. Amateur operators could use the program to set up their own personal- or club-paging system on the ham bands. Using the paging capabilities from the DOS command prompt, pages could even be sent remotely using remote-computer-control programs such as pcAnywhere from Symantec Corporation.

POCSAG encoding is really fairly simple. The software and hardware interface described here can be used to generate POCSAG digital signals for a wide variety of diagnostic, demonstration, and actual applications. Ω

PARTS LIST FOR THE POCSAG ENCODER

LED1—Light-emitting diode, bi-polar
LED2—Light-emitting diode, green
D1—1N4001, silicon diode
R1—2200-ohm ¼-watt, 5% resistor
R2—10,000-ohm potentiometer
C1—2.2-µF, 50 WVDC, electrolytic capacitor, non-polarized
RY1—12-volt DC relay, single-pole, single-throw (RadioShack 275-233 or similar)
Wire, PC board, 9- or 25-pin connector, hardware, etc.

The POCSAG encoding program can be found at http://www.seelect.demon.co.uk/pocsag.html and ftp://ftp.demon.co.uk/pub/ham/scanners/pc-204.zip. United States purchasers can obtain registered copies of PE, the POCSAG encoding program, from Robert B. Whitaker, Trustee, P.O. Box 1266, Victoria, TX 77902-1266. The registered, full-function software costs $39.95, postage paid. Unregistered software, for those without Internet access, can also be purchased for $12.50, postage paid.

A high-quality printed circuit board with silkscreen artwork for parts placement is available from FAR Circuits, 18N640 Field Ct., Dundee, IL, 60118-9269 for $3.75. A fully assembled and tested interface kit is available for $29.95, plus $5.05 for shipping and handling, from Robert B. Whitaker, P.O. Box 1266, Victoria, TX, 77902-1266.

RESTORING A "REEL" RECORDER

Here's what you need to know and do to bring your open-reel audio tape recorder back to life.

PHIL VAN PRAAG

This month, we begin a series of articles about repairing and restoring audio tape recorders. Specifically, it focuses on vintage open-reel machines of the 1940s through the early 1970s—a time that saw explosive growth in the field in terms of both features and performance. Just as with the 'muscle cars" of the 1950s and '60s, the "big-iron" tape recorders—such as the ones shown in the beginning of this article and in Fig. 1—still draw head-turning attention, not only from the "Baby-Boomer" crowd, but from "post-Boomers" as well! In addition, when properly restored and tuned, these machines can still provide countless hours of enjoyment with all the clarity and response they provided when new.

Note: The material presented here and in subsequent articles is taken from the author's book *Evolution of the Audio Recorder*; details on that book, including ordering information, can be found in the "For More Information" box that is located elsewhere in this article.

The Dilemma. Pity the poor tape-recorder repair person of the 1960s or '70s, having to cope with a seemingly endless array of models and maladies, both electronic and mechanical. For the non-manufacturer-specific repair shop, it was especially tough, given the lack of key service manuals and repair bulletins. Even some of the so-called "simple" single-motor machines, such as the 1950s Webcor (an internal view of that machine is shown in Fig. 2), were a real challenge to repair. As if that weren't bad enough, let's "fast forward" to the present, where added to this situation is the age of most of these classic analog machines: from 20 to over 40 years old!

That unnerving fact adds a whole new level of difficulty if your goal is to get that old machine working again. Not only do you have to repair the original problem (the one that most likely sidelined it in the first place), but now you're faced with an extreme parts scarcity, deteriorated rubber components, dried up or seized bearings, frequently faulty capacitors, and, in most cases, a total lack of servicing information!

Well, never fear, as the purpose of this article, and the ones that follow, is to prepare you for this challenging task. And it is a task that is worthwhile as it can be most rewarding personally to breathe life back into these wonderful old "talk back" machines. Plus, when you're done, you will have both a useful tool and a valued keepsake.

We will explain the differences between repairs and restorations, let you know what test equipment you'll need, and then get into the restoration process itself. As you can see, we've a lot to do, so let's get started.

Repair vs. Restoration. All vintage tape recorders—irrespective of complexity or quality when designed and manufactured—require periodic maintenance. Rubber parts wear, harden, and otherwise decompose; vacuum tubes wear out with use; capacitors deteriorate over time; heads and other tape-path components become contaminated and gradually acquire permanent magnetism; grease sloughs off and becomes mixed with dirt; oil dissipates . . . sounds really bleak, doesn't it! Well, that is all part of the normal aging process, some of which occurs whether or not the recorder is used. Add to that the consequences of abuse, poor storage conditions, and neglect for long periods of time (certain parts, such as belts and idlers, should be rotated from time to time), and the result is likely to be a candidate for complete restoration.

One major issue here is that, even if you have been lucky enough to obtain the original manufacturer's service manual, the manual will not address the steps that must be taken to overcome the various aging effects. A number of those steps should be taken even before powering up a machine for the first time after a long period of storage.

There's actually a very important distinction between "repair" and "restoration"—and it's one that's often not fully understood. That lack of understanding can wind up being both frustrating and expen-

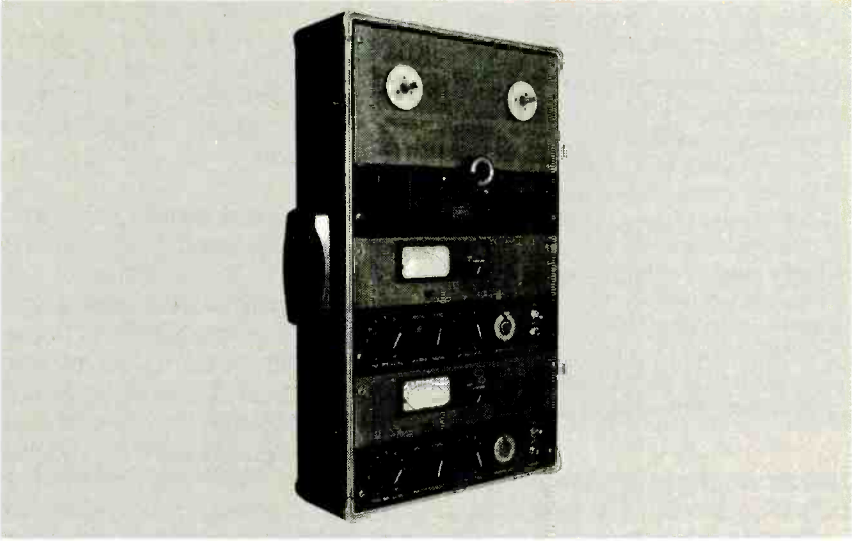


Fig. 1. The Ampex Model 602-2 tape deck is a vintage vacuum-tube machine with professional, timeless styling—and performance to match.

sive. Once you do understand the difference and decide what path you want or are willing to take, you can better determine what to look for before you buy; what questions to ask; and how to evaluate what you already own. Now you can get mentally prepared for the service or restoration process before you dig into the machine.

Repairs, by definition, tightly focus on specifically targeted trouble spots. Typically, those service operations should be clearly identified at the outset—and if you are using the services of a repair shop, thoroughly agreed upon by both yourself and the technician. Note that there may be additional faulty components or alignments needed beyond the identified symptoms; you and the technician need to discuss what to do if such problems are encountered. That will ensure that both parties understand how much work will be done. To do otherwise could easily result in repairs costing more than two times the amount needed to just fix the immediate problem.

Once again, repair means: "fix the following problem(s); eliminate the following symptom(s); and do nothing else, unless specifically agreed upon beforehand by both parties."

Restoration, on the other hand, means do everything necessary to bring this machine back to original specs, additionally ensuring that all appropriate manufacturer's periodic maintenance steps are followed. It might optionally also include complete cosmetic renovation—not simply cleaning, but restoring original finishes and repairing cabinet cracks or separations. While that might seem to be all-inclusive, there are still decisions to be made, such as whether to replace all capacitors, or even just all electrolytic capacitors.

Which Way to Go? Now, you may be thinking: "I don't want a complete restoration, but I also don't want to overlook something that will fail soon, or may wear out prematurely due to lack of lubrication; also, I want it to look nice." Well, here's the tough part. A failing component doesn't always hang out a shingle saying: "Hey, replace me now because I'm going to fail soon." Further, if you don't reconcile just how far you want to go with this work, you will probably be disappointed with the results. It might cost too much, take too long, or not look as good or work as well as you would like.

If you take the machine to someone else with a non-specific, non-detailed repair order, that will doom the poor technician no matter what he does. If he scrupulously just repairs the immediate problem—only those components and adjustments directly accounting for the current malady—then there's a good likelihood the machine will come back soon with some other—or even the same—symptom. If, on the other hand, he or she—just as scrupulously—repairs, replaces, or adjusts all weaknesses associated in any way with the problem . . . well, that can be a much more expensive proposition.

The relevance of all this is that whether or not you decide to have others help you get your machine fixed, you first need to reconcile exactly what it is you want accom-

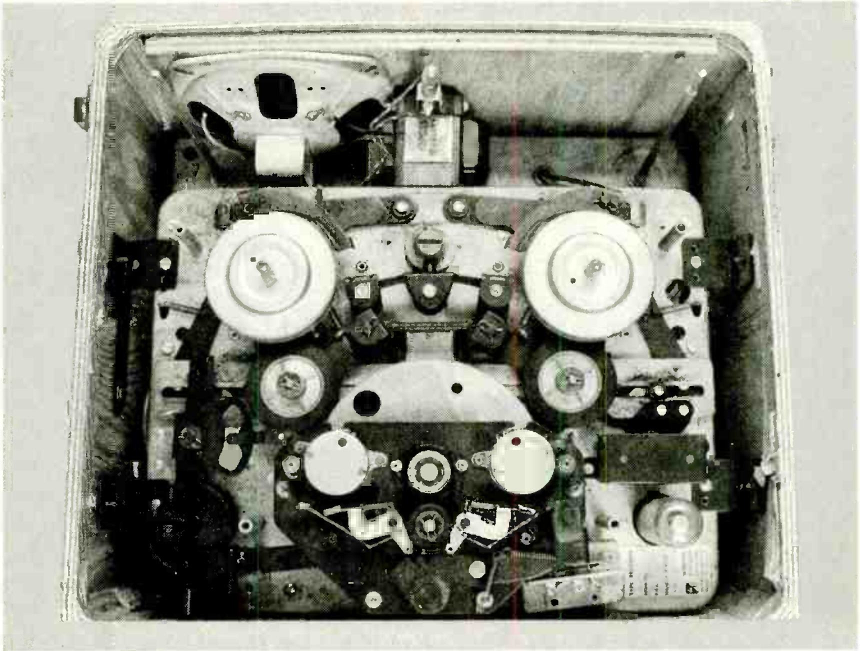


Fig. 2. The internal mechanics of a typical 1950's single-motor recorder transport.

plished. What is it that you really want this machine to be; what role do you want it to play in your life? Is it to be simply a display item? Is it to provide a means for occasional, recreational recording, where it's "no big deal" if things don't work out during a particular session? Or is it to play a serious role in critical applications, where breakdowns or substandard performance are intolerable?

Once you've thought the above through, it is important to communicate your intentions to your technician. Be realistic about what we've been saying concerning the deterioration that comes with time, use, abuse, and storage. Consider the complexities of the mechanics and electronics, and all of the tests and alignments that must be performed to truly recreate the machine that you may want (but may not be prepared to pay for).

Doing it Yourself. Assuming you have the financial resources, and can find a technician or repair shop willing to accept the challenge of restoring or repairing your machine (note that while some will, most won't), that is a perfectly legitimate way to handle this task. But there is another, potentially more rewarding way to go: doing the work yourself. However, no matter how skilled you are around a test bench, there is plenty of potential frustration attached to this task as well. Before you dive in, we need to discuss what you will need in terms of test gear and other resources.

TABLE 1—AUDIO OSCILLATOR RECOMMENDATIONS

Frequency range: 20 Hz–20,000 Hz
Accuracy: within ± 5%
Frequency response: ± 1 dB (although greater amplitude change with frequency is okay as long as you remember to reset level each time you change frequency)
Output level: 1 volt into 600 ohms is usually sufficient
Distortion (THD): Better than 0.5 % is adequate; also, you can get by if your unit can meet that spec at just a single frequency, either 400 Hz or 1 kHz

One of those resources is time. On average, it can easily take a full day or more to completely restore a relatively simple vintage recorder that is cosmetically still in good shape and still at least partially operational. A complex machine that's a basket case can easily take two or three days. If major rebuilding of mechanical components is needed, or major re-wiring or component replacement is required, or extensive cabinet and cosmetic work is specified, this can add another day or two. Note that those time estimates are for experienced technicians, with many similar restorations already completed. Of course, that can translate into huge costs if you have others perform this work.

On the other hand, if you're ready, willing, and able, read on to find out how you can do most or all of the work yourself. In this way you could save 80% or more of the total cost that usually constitutes the labor portion.

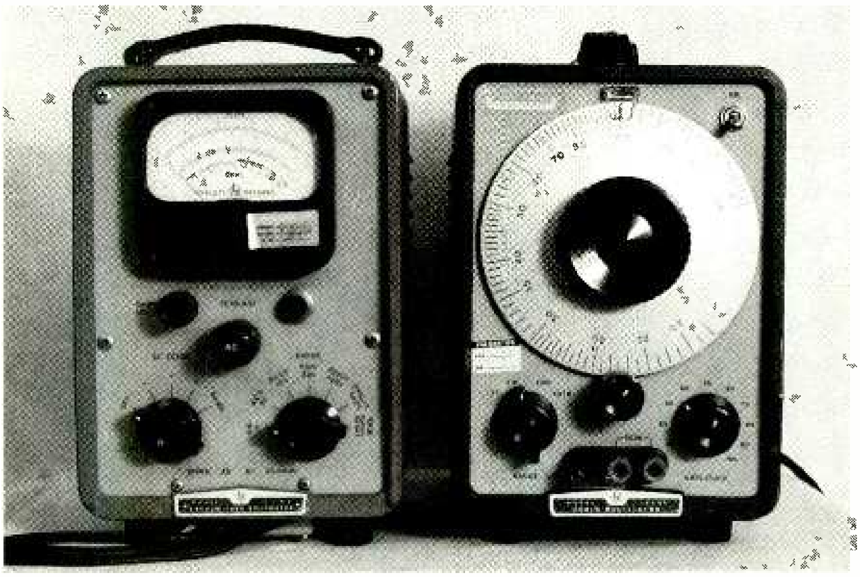


Fig. 3. Two examples of vintage vacuum-tube test equipment from Hewlett Packard: a Model 410 VTVM (left) and a Model 200 audio oscillator.

Test Equipment Needs. Let's talk a bit about test equipment. Now, I'm not trying to scare those of you thinking about possibly doing your own repairs or restorations at home, but we do need to be realistic about just what it takes to do the job right. Further, even if you can't do the entire job yourself, there may be aspects of it that you can do, and thus reduce the cost for professional help to finish the repair or restoration task. Finally, once you understand exactly what's needed and where to get it, you may find it surprisingly inexpensive.

The two most basic pieces of gear you need are an audio oscillator and voltmeter that is "audio-capable" (more on that in a moment). If you have both on hand, great. If not, the purchase of those two items could easily set you back about $250. One way to cut that cost is to look at a local "flea market" or amateur-radio swap meet ("hamfest"). Of course, if you do that you will face the problem of ensuring that they both work properly, and at least come close to meeting their original specs. One compromise would be to purchase older, but guaranteed, instruments from a used-equipment dealer; you can often find ads for those in the back pages of **Electronics Now**. That way you will pay more than at a flea market, but you will at least be sure that the items work.

Two of my own "flea market finds" are shown in Fig. 3: a Hewlett Packard (HP) Model 200 audio oscillator and an HP Model 410 VTVM (vacuum-tube voltmeter). The HP 200 is one of a long-lived series of similar oscillators that were an outstanding success for Hewlett Packard. These were truly "workhorse" machines, rarely requiring service. Many thousands of these were "excessed" by industry when transistorized gear became the standard, but those vacuum-tube units perform about as well as many new designs.

Fig. 4. Two wow/flutter meters: the 3M Model 8160 (top) and the Woelke Model ME-106 (bottom).

That unit meets or exceeds what is needed to service any audio recorder manufactured through at least the 1970s. If you go with another unit, the basic specs you should look for are given in Table 1.

Note that the HP410 shown is not an "audio VTVM". It's important to understand the difference. With most VTVMs, like the 410, the smallest AC-voltage range is 1-volt full scale. Due to reading interpretation, that generally translates to an ability to read voltages as low as about 20 millivolts. That is okay for most troubleshooting and alignments, except S/N. For that, you will need an audio voltmeter with at least a 3-millivolt scale (thereby capable of reading 100 microvolts). One unit that you might find on the surplus/hamfest market is the HP403B. It has a 1 millivolt scale—more than what's needed for tape-recorder work. As an alternative, if you choose to purchase a surplus distortion analyzer (our next topic), you may find that an audio voltmeter is also built in to that instrument.

As a final note on voltmeters, many ordinary VTVMs and VOMs (volt-ohm-meter) do have sufficient frequency response to cover the audio spectrum. An old favorite, the Simpson Model 260 Series 4, for example, has an AC frequency response up to 500 kHz.

Next, let's take a look at distortion analyzers. Harmonic distortion is the standard distortion test and calibration used by tape-recorder manufacturers. Distortion analyzers can be expensive new, but can also be found from used/surplus/hamfest sources. For example, the modest but adequate Heath Model IM-58 can still be found at hamfests for about $30 to $45. While it doesn't have specs as impressive as the HP analyzers, such as the Model 331A (which still sells for about $150 or more), it can be used quite effectively for all but the most demanding measurements. It also has a built-in audio voltmeter.

An oscilloscope is not absolutely required for most tape-recorder servicing. After all, armed with your oscillator, distortion analyzer, and audio voltmeter, you can perform the necessary checks and alignments on a machine whose electronic components are functioning well. However, if you don't have an oscilloscope, "Murphy's Law" will surely kick in. This will occur in the form of a noisy pre-amp stage, or the inexplicable loss of signal deep within a record or play amp, or any number of other maladies for which the oscilloscope is a worthwhile, if not required, diagnostic tool.

The subject of oscilloscopes usually conjures up notions of the family savings quickly evaporating. True, a new, triggered-sweep, 50-MHz analog scope can set you back at least $600 or so. The new digital scopes, despite their small size, carry a hefty price tag—generally exceeding $1,000. However, a trip to your local flea market (once again, hamfests are particularly good for this), plus a little patience, will likely yield something useful in the $50 to $150 range. Because of the relatively modest requirements associated with working in the audio-frequency range (and even considering bias/erase oscillators that operate at, say, 180 kHz), even the lowest-frequency-response scopes are suitable for tape recorder use. I do recommend that you purchase one with a "triggered-sweep" option. However, other than getting a decent probe, that's about it.

And don't necessarily ignore the older vacuum-tube scopes. Although they are not in fashion anymore (translation: they can be had cheap), if you find one that's not rusty and that appears in good cosmetic and functional condition, it may provide you with many years of flawless operation when used judiciously. Just allow adequate warm-up time (around 20 minutes or so), and remember to switch it off when you're done!

A good wow/flutter (W/F) meter is indispensable for mechanical adjustments and alignment. Very briefly, W/F is a measure of short-term speed accuracy; that is, speed variations of less than one second, up to about two seconds (corresponding to a frequency range of about 200 Hz down to about 0.5 Hz). We'll get into this much more in a later installment.

There are many different possible causes for poor W/F. I have seen good technicians virtually pulling their hair out in vain attempts to correct W/F problems. There is literally no way of doing this effectively without the assistance of wow/flutter measurements.

The principal issue for those on a limited budget is that used commercial W/F meters are rather expensive and seldom found. This is probably due to their restricted application, and therefore relatively few being manufactured. When you can find one, prices of $70 to $150 are not unusual. Two popular commercial models were the 3M 8160 and the (German) Woelke ME-106, as pictured in Fig.4. Either of

Fig. 5. Here are various measurement tools used to check tensions, speed, and wear.

these will do the job nicely. While a sensitivity of 0.3% full scale is acceptable, both of these particular units exceed that capability.

If budget or availability becomes a problem, and time is not a pressure, here is another alternative: Franklin Miller, as part of the audio test-gear series currently running in his "Audio Update" column in this magazine, is scheduled to do a simple W/F meter in a future installment. In fact, if you are comfortable doing construction work, many of the pieces of equipment outlined above will be appearing in future issues, and an audio oscillator has already appeared (see "Audio Update," **Electronics Now,** July, September, and October 1997).

Other equipment you will need includes tube/transistor testers and power supplies (if you will be performing electronic repairs), a variable voltage AC transformer ("Variac" is a common trade name), a tape-head demagnetizer, a soldering iron with a fine tip, and various hand tools. In addition, to perform mechanical adjustments and to check manufacturer specs in this area, you will need tension gauges such as those pictured in Fig. 5. Also shown in that photo is a play-speed strobe wheel, and an illuminated magnifier (less than $10 at Radio Shack). Finally, if you will be restoring cabinetry, etc., you will need wood- and metal-working tools, plus strippers, cleaners, polishers, and refinishing coatings.

The only other items needed are tapes for test recordings, plus a music source and playback gear to check out your accomplishments. If you will be testing or adjusting head alignment, equalization, or playback response, then a standard alignment tape is very desirable. More about this tape will be covered in a future installment. If you would like information on obtaining an open-reel alignment tape, write to the author c/o EC Designs at the address given in the "For More Information" box.

FOR MORE INFORMATION

This article is based on the new book, *Evolution of the Audio Recorder* by the author, Phil Van Praag. It contains over 500 pages of history, evolution, restoration, photos, and a price guide. It's available at $39.95, postpaid, from EC Designs, P.O. Box 33, Genesee Depot, WI 53127.

Cost and Commitment. From a cost standpoint, the equipment described above would total about $500 or less, if a conservative "used- or build-only" strategy is followed. Perhaps a more difficult decision to be made is whether to invest the time to acquire the knowledge needed to perform the various mechanical and electronic tasks associated with repairs and restorations. Much of this, of course, will have to do with whether you intend to continue doing repairs and restorations, or whether this is pretty much a one-time event. Of course I'm biased in this matter, but I believe this is an excellent hobby—it's a great way to increase your overall understanding of mechanics and electronics in general, and to gain a heightened appreciation and enjoyment of your tape recorder specifically.

However, if you don't have the time or desire to make a commitment to this, then you're probably better off leaving the work to others. It's possible to do great damage to a tape recorder if improper repairs are performed. In fact, technicians will often charge more to work on a machine if faulty repair efforts have been made. Efficient repairs by professional technicians depend on certain assumptions that are based on previous experience coupled with subtle observations during the troubleshooting process. This process can be seriously impeded if things have been "stirred up" by someone else. Adjustments might have been disturbed, and components that were still okay before the aborted repair attempt might now be defective (bent, broken, shorted out, electrically or mechanically stressed beyond their design limits, etc.). This often complicates subsequent repair attempts. So, read through the repair and restoration descriptions in the upcoming installments carefully, and then decide whether this is something you want to tackle.

In the next installment, we'll begin the actual restoration process! See you then. Ω

BUILD THIS PRECISION VOLTAGE/ CURRENT REFERENCE

Add this easy-to-build and inexpensive accessory to your test bench for lab-quality measurements and calibration.

SKIP CAMPISI

If you enjoy experimenting with both linear and non-linear analog-electronic circuits, you've probably gotten aggravated having to breadboard a precise reference circuit every time one is required. A standard linear power supply with variable voltage and current limiting can sometimes be used if the application is not too critical.

However, those methods leave a lot to be desired when precise, drift-free performance is required. Wouldn't it be great if you had such a piece of test equipment available on your test bench to handle such tasks?

The Precision Reference presented here has a typical stability of better than ±100-parts-per-million-per-degree Celsius when assembled with the suggested components. Even better, the cost of the entire project is less than the cost of a standard power supply! The outputs include a voltage output that can range between 1 millivolt and 10 volts, and a current output that can be set anywhere from 1 microamp to 10 milliamps. A range-select switch can set the output range to 0, 1, 10, 100, or 1000 millivolts or microamps. Two independent 10-turn precision potentiometers with turn counters let each range be multiplied by 1 through 10 according to the dial setting.

Using the 1% metal-film resistors specified, you can expect an accuracy of about 0.2% of the dial setting for the 10, 100, and 1000 range-switch settings. Typically, the accuracy is better than 0.1% overall. The lowest range has an accuracy of 1%, and it typically can be as good as 0.5%. A built-in 3½-digit LCD panel meter can display the load voltage present at either output. It has its own range selector switch.

Fixed current limiting is provided for the voltage-output section of the circuit. That provides a maximum of about 30 milliamps at the 10-volt-output level, increasing to about 80 milliamps at the 1-millivolt-output level. This method has the added benefit of short-circuit protection.

The current output has a variable "compliance" control in order to protect any voltage-sensitive devices being tested. The voltage at the current output is adjustable between about 1.5 volts at the minimum setting and about 11 volts at the maximum position.

Circuit Description. The Precision Voltage/Current Reference design can be divided into four basic sections: the voltage-reference inputs, the voltage-current-reference outputs, the power supply, and the panel-meter display.

The schematic diagram in Fig. 1 shows the simplicity of the circuit. A 1-volt reference is supplied by D1 to the current-reference circuit, with D2 supplying a 1-volt reference to the voltage-reference section. Both diodes are temperature-stable ICL8069 band-gap reference diodes. The 1-volt reference from D1 appears on the wiper of R3 when R3 is set to its maximum rotation. At the minimum setting of R3, 100 millivolts appears. That voltage is buffered by IC2, an LF356 JFET op-amp. The buffered reference voltage is applied to Q1. Since Q1 is a part of the feedback loop of IC2, the reference voltage is placed across the range resistor (R6–R9) as selected by S1-a.

Due to the high gain of Q1, the output current at its collector is the same as the reference voltage divided by the selected range resistor. That output current is connected to J1. The maximum output voltage at J1 is set with R13 and Q2, which is configured as an emitter follower. The bias on D3 lets the output of IC2 stay in its active-voltage range.

The 1-volt reference from D2 feeds the voltage divider composed of R17–R21. The range from that divider is selected by S1-b and is buffered by IC1, a TLC271 CMOS op-amp. It is configured as a non-inverting amplifier with a variable gain set by R24. High-current capacity for the voltage output is provided by Q3, a 2N2219 NPN transistor. It is a part of IC1's feedback loop. Current limiting and short-circuit protection for Q3 is provided by R26, a 100-ohm, 2-watt resistor.

The power-supply portion of the circuit is shown in Fig. 2. The power

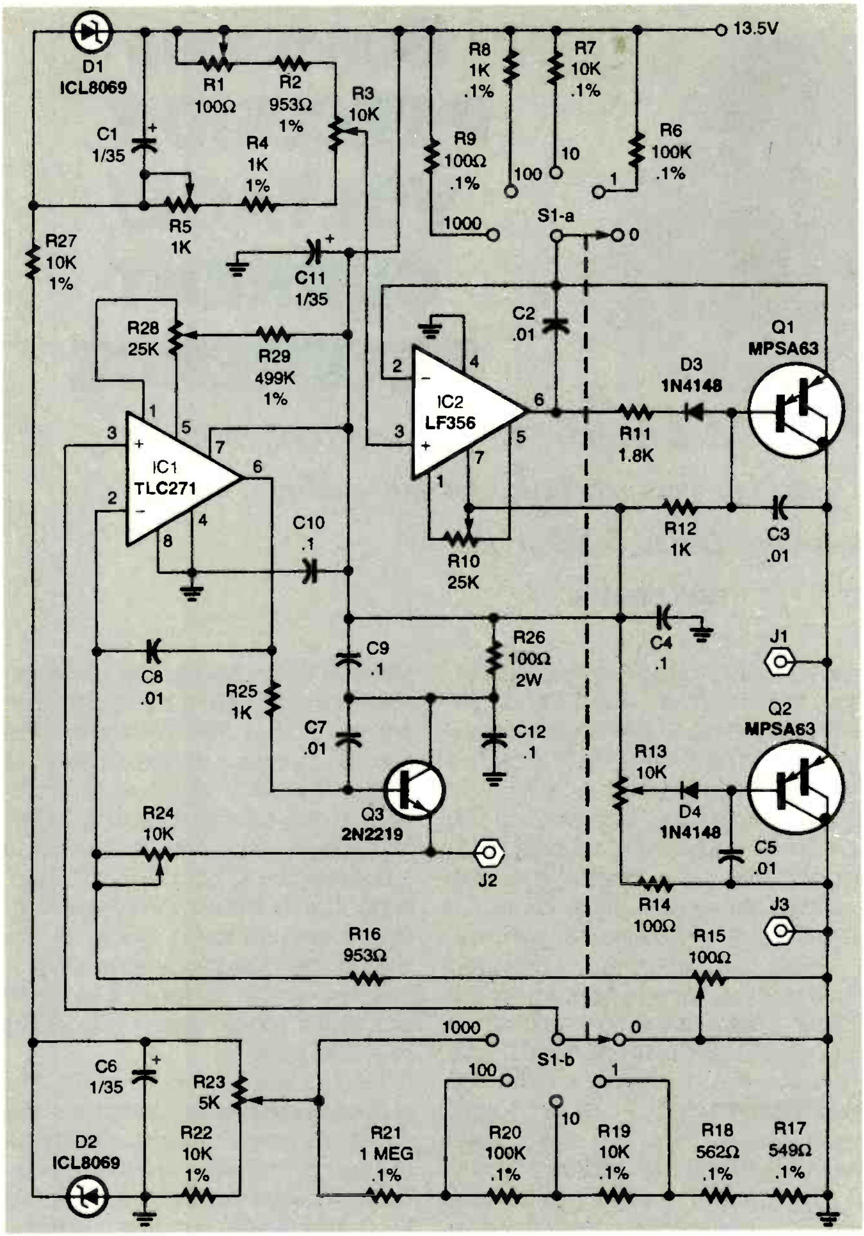


Fig. 1. Although it might look complicated, the Precision Voltage/Current Reference is actually a straightforward circuit that is built around several high-precision op-amps. The circuit is easy to calibrate using only an accurate digital voltmeter.

supply has some unusual design features that are needed for the circuit to work properly. There are two isolated outputs: 13.5 volts for the main circuit and 9 volts for the digital-panel meter, DISP1. Because DISP1 uses an on-board reference, its supply *must* be completely isolated from the rest of the circuit!

The isolated outputs are achieved by choosing a "split-bobbin" transformer for T1. That type of transformer has two separate 120-volt primaries and two separate 12-volt secondaries. In effect, the transformer is two separate transformers that share a common core.

The input to the display circuit is switched by S4. That lets the input measure the load voltage at J1 (the current reference) or J2 (the voltage reference). The voltage is applied to IC4, a TLC271 CMOS op-amp wired as a unity-gain buffer. The output of IC4 drives another voltage divider consisting of R34 through R37. The output of IC4 is loaded by R38 so that it can approach ground potential if needed.

The range of DISP1 is set by S3. The resistor-divider network lets DISP1 display voltages beyond its normal 200-millivolt range. One half of S3 selects the range from the divider network, while the other half selects the proper decimal-point location for the display.

Construction Tips. The actual layout and construction of the Precision Current/Voltage Reference is not critical to circuit performance. However, following the guidelines mentioned here will assure success and accuracy with the project.

Choose a suitably-sized cabinet that will be big enough to hold all of the circuitry and all of the controls. The author's prototype was assembled in a sloping plastic cabinet about 7½-inches wide and 4¾-inches deep. The cabinet's aluminum top panel on which most of the controls were installed is an excellent ground plane.

Point-to-point wiring was used on standard 0.1-inch-grid perfboard with copper-foil pads. The power-supply section was mounted on a separate board, supported by DISP1's mounting lugs. The power cord enters the cabinet near the supply with S2 mounted next to it. Be sure to drill several ventilation holes in the cabinet near the transformer.

The references and meter driver were constructed on another board; the voltage-current-output sections are contained on a third board. Both of those boards were mounted away from the power-supply board in order to avoid picking up any 60-cycle "hum". All of the connections between the components on the boards were made with 22-gauge bus wire. Insulated stranded wire was used for any connections between boards or anywhere there was a possibility that the wires could come in contact with another conductor. For the long runs between the boards and the panel components, the insulated wires were twisted together in pairs.

Mount 0.1% metal-film resistors R17–R21 directly onto the appropriate lugs of S1-b. One lead of R17 should be connected to a panel ground lug. Mount R6–R9 from S1-a to the lug on R13 that will be connected to the positive power source. The positive lead of R26 should be connected directly to that lug, also. Note that the 13.5-

volt power leads from all of the boards, including the power supply, should be run to that same lug. That arrangement is called a "star" because all of the connections radiate out from one central point. In that way, there is no accumulated resistance from the individual wires if they were to be run sequentially from point to point in a "daisy-chain" style.

Make a "star" connection for the ground in the same way. Connect each board's ground lead to the panel ground lug connected to R17. The common-output ground terminal, J3, should also be connected to that lug with a short piece of bus wire. For best decoupling, install bypass capacitors C9 and C12 right on the body of R26 with very short leads.

DISP1, a 3½-digit LCD-panel voltmeter, is available from many surplus and overstock sources for less than $10. Brand new units can be bought from several major mail-order sources, but those sources might charge $50 and up. The unit that you choose should have a maximum input range of 200 millivolts, and can be powered by an isolated supply of 9 volts, as mentioned before. You have the option of using a 4½-digit digital-panel meter (DPM) at about twice the cost. If you require further information on DPMs, refer to the excellent article by Bill Stiles in the October 1996 issue of **Popular Electronics** magazine.

Install and wire DISP1 according to its instruction sheet. Although a typical hookup is shown on Fig. 2, you should follow any recommendations for the actual unit that you will be using. Install R34–R37 on the appropriate lugs of S3-a. One lead from R37 is connected to a panel ground lug, as with R17 and SI-b. Wire S3-b to select the decimal point.

Before connecting 10-turn precision potentiometers R3 and R24, the "dead space" at the ends of their rotations must be eliminated. Start by securely mounting R3 and R24 in their holes on the top panel. With a DMM, make a note of the exact resistance between lugs 1 and 3 on R3.

Connect the DMM between lugs 1 and 2. Rotate R3's shaft until you read exactly 10% of the previous resistance. Take one of the 10-turn dial counters, set it for 2.00 (two turns clockwise from 0.00), and lock the setting. Install the counter on R3 without moving the shaft. Check the resistance on R3 once again to be sure that the shaft hasn't moved and lock the set screws securely.

Rotate the counter dial counterclockwise until it stops. You will note that it now reads a couple of "clicks" below 1.00. That shows that the installation is correct. Rotating the counter nine turns clockwise will give an indication of 0.00, which is to be taken as 10.00. Ten-turn counter dials do not have the number "10" on their dial. Turning the dial an additional clockwise turn will indicate 1.00 again, which is now equal to 11.00.

You can, of course, use a 15-turn counter dial for true indications. However, the Precision Reference might not work correctly beyond the "10.00" setting because of the design of the circuit. Using the same techniques, install the other counter dial on R24, and complete the wiring of the controls.

Double check all of your wiring and interconnections before calibrating the unit. Turn on the power and check the 13.5-volt supply to make sure it is within ±0.5 volt. If it is over 14 volts, add an infra-red LED in parallel with LED1. If it is under 13

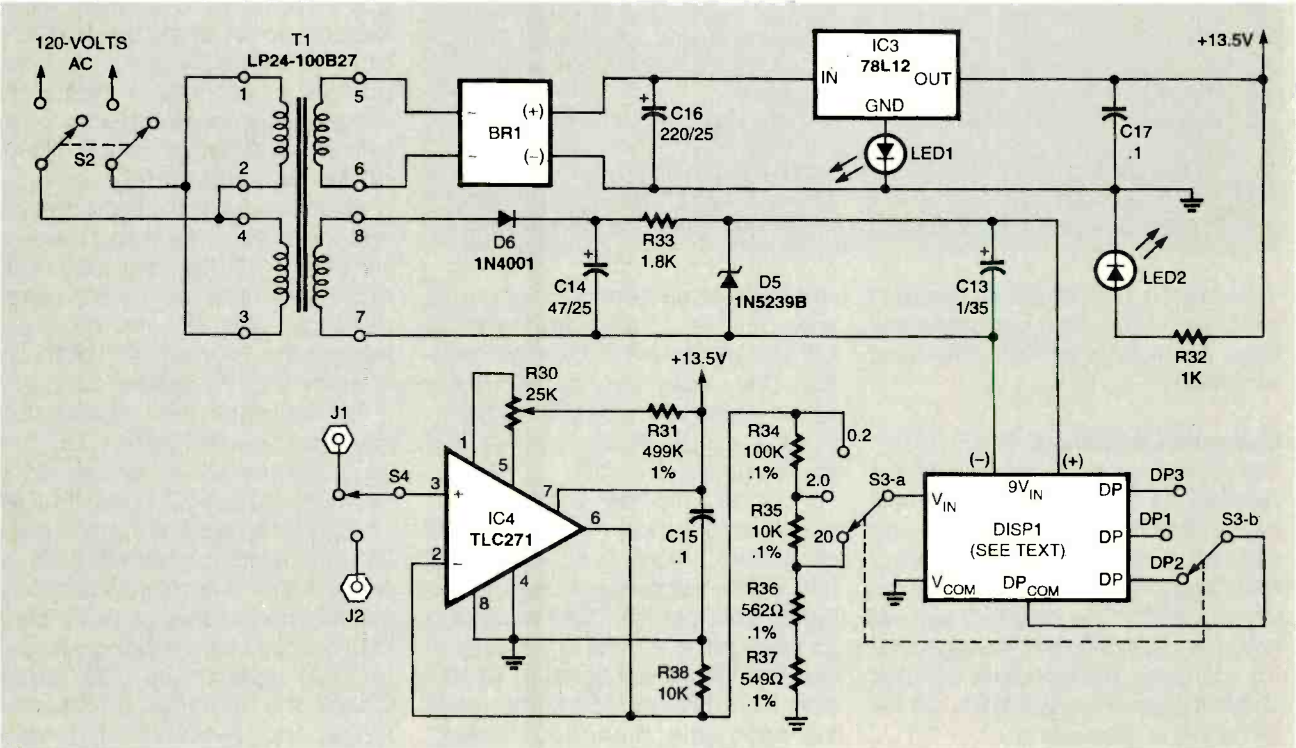


Fig. 2. The Precision Reference's power supply uses a split-secondary transformer in order to have two isolated power sources in a compact size. The digital-panel meter allows for easy monitoring of the outputs.

PARTS LIST FOR THE PRECISION VOLTAGE/CURRENT REFERENCE

SEMICONDUCTORS

IC1, IC4—TLC271 or TL091 CMOS op-amp, integrated circuit
IC2—LF356 JFET-input op-amp, integrated circuit
IC3—78L12 voltage regulator, integrated circuit (TO-92 package)
Q1, Q2—MPSA63 or MPSA64, PNP Darlington transistor
Q3—2N2219, NPN transistor
BR1—1 amp, 50-volt bridge rectifier
LED1—T-1 light-emitting diode, red
LED2—T-1¾ light-emitting diode (any color)
D1, D2—ICL8069 band-gap reference diode
D3, D4—1N4148 silicon diode
D5—1N5239B Zener diode, 9.1-volts
D6—1N4001 silicon diode

RESISTORS

(All resistors are ¼-watt, 5% units unless otherwise noted.)
R1, R15—100-ohm, single-turn trimmer potentiometer
R2, R16—953-ohm, ¼-watt, 1% metal-film
R3, R24—10,000-ohm, 10-turn, panel-mount, precision potentiometer
R4—1000-ohm, ¼-watt, 1% metal-film
R5—1000-ohm multi-turn trimmer potentiometer
R6, R20, R34—100,000-ohm, ¼-watt, 0.1% metal-film
R7, R19, R35—10,000-ohm, ¼-watt, 0.1% metal-film
R8—1000-ohm, ¼-watt, 0.1% metal-film
R9—100-ohm, ¼-watt, 0.1% metal-film
R10, R28, R30—25,000-ohm multi-turn trimpot
R11, R33—1800-ohm
R12, R25, R32—1000-ohm
R13—10,000-ohm, panel-mount, single-turn potentiometer
R14—100-ohm
R17, R37—549-ohm, ¼-watt, 0.1% metal-film
R18, R36—562-ohm, ¼-watt, 0.1% metal-film
R21—1 megohm, 0.1%, ¼-watt, metal-film
R22, R27—10,000-ohm, ¼-watt, 1% metal-film
R23—5000-ohm multi-turn trimpot
R26—100-ohm, 2-watt, 5%, wire-wound
R29, R31—499,000-ohm, ¼-watt, 1% metal-film
R38—10,000-ohm

CAPACITORS

C1, C6, C11, C13—1-µF, 35-WVDC, solid tantalum
C2, C3, C5, C7, C8—0.01-µF, ceramic-disc
C4, C9, C10, C12, C15, C17—0.1-µF, ceramic-disc
C14—47-µF, 25-WVDC, aluminum electrolytic
C16—220-µF, 25-WVDC, aluminum electrolytic

ADDITIONAL PARTS AND MATERIALS

T1—Dual 12-volt, 100-mA secondary, split-bobbin transformer
DISP1—3½- or 4½-digit liquid-crystal display panel-mount voltmeter (see text)
S1, S3—2-pole, 6-position rotary switch, panel-mount, non-shorting
S2—double-pole, double-throw toggle switch
S4—single-pole, double-throw toggle switch
J1–J3—binding posts
10-turn counting dials for R3 and R24, case, line cord, wire, hardware, etc.

volts, add a 1N4148 silicon diode in series with LED1. That will assure the best operation of the Precision Reference.

Calibration Procedure. The Precision Reference needs to be calibrated properly in order to get the most benefit from the circuit. Although the calibration procedure given here is fairly straightforward, it should be followed exactly. The only tool you will need is a good-quality 4½-digit digital voltmeter. An accurate 3½-digit DVM will also work, but there will be some loss of accuracy.

Turn on the power and allow the unit to warm up for a minute or so. Set S4 to connect J2 to the panel-display circuit. Range switch S3 should be set to the highest setting (20 volts). Rotate R13 to its "off" position (the wiper connected to the supply voltage) and set S1 to the 1-millivolt range. Both R3 and R24 should be set to "1.00".

To calibrate the voltage-reference section, connect the DVM across pins 2 and 3 on IC1. Adjust R28 for a reading of exactly 0.00 millivolts. Connect the DVM to J2 and J3 and adjust R23 for a reading of exactly 1.00 millivolt. Set S1 to 10, 100, and 1000 millivolts, noting the reading each time. If needed, "tweak" R23 for accuracy over the entire range. With S1 set at 1000 millivolts, set R24 to "10.00" and adjust R15 for a reading of exactly 10.000 volts. Switch S1 to 1 millivolt and "tweak" R28 for a reading of exactly 10.00 millivolts. Note that that adjustment is very sensitive. Return R24 to the "1.00" setting and re-check your calibration results.

To calibrate the current-reference section, set S1 to 1 microamp. Connect the DVM across pins 2 and 3 of IC2 and adjust R10 for a reading of exactly 0.00 millivolts. If you can't get that setting, replace IC2. Set R3 to "10.00" and connect the DVM between the 13.5-volt "star" connection and the wiper of R3. Adjust R5 for a reading of exactly 1.0000 volts. Reset R3 down to "1.00" and adjust R1 for a reading of exactly 100.00 millivolts. As those last two adjustments interact slightly, reset R3 back to "10.00" and note the reading. "Tweak" R5 again if necessary, and recheck the reading with R3 set at "1.00". Keep repeating the process until you are satisfied.

With S1 set to 1 microamp, connect the DVM across R6 and set R3 to "1.00". The reading should be 100 millivolts. Advance R3 to "10.00" and the reading should advance linearly with the counter dial up to a 1.00-volt reading. If not, replace IC2 with a unit made by a different manufacturer. Some chips are known to have problems working near their positive supply rails. A good chip should not have a problem working with its inputs as high as 100 millivolts above the positive rail.

Finally, connect the DVM in its current-measuring mode to J1 and J3. Set S1 to 1, 10, 100, and 1000 microamps and note the actual current readings with R3 set at "1.00". Repeat the process at "10.00" and re-calibrate, if necessary.

To calibrate the digital-panel-meter section, set R24 to "1.00", S1 to 1000 millivolts, S4 to connect to J2, and S3 to 2.0 volts. Connect the DVM across pins 2 and 3 of IC4 and adjust R30 for a reading of exactly 0.00 millivolts. Adjust the reference-calibration trimmer located on DISP1 as per its data sheet for a reading of exactly 1.000 volts on its LCD display. Check the readings on all other ranges and "tweak" the trimmer as needed for overall accuracy.

If the display refuses to go down low enough to indicate the lower output ranges, try swapping IC4 with IC1, or replace IC4 altogether. Maximum output swings for the TLC271 can vary from unit to unit, although they will normally go down to within a few hundred microvolts above ground.

Operating Hints. The Precision Voltage/Current Reference is extremely accurate and simple to operate. Aside from the obvious uses such as the calibration of analog circuitry, metering equipment, and the like, the unit has many other applications. Only a few examples will be discussed here—you will surely find many others uses.

If you need to put high current into a low-impedance load, you might want to use "remote sensing" to maintain an accurate load voltage. That is easily done by bringing the lead from lug 1 on R24 out to a separate binding post rather than connecting it to Q3 and J2. Likewise, connect the ground connections of R15 and R17, along with D2, C6, and R22 to another binding post rather than J3.

Run separate leads from J2 and the binding post from R24 to one side of the load, and separate leads from J3 and the other new binding post to the other side of the load. For normal operation with a "light" load, simply short J2 to its companion binding post and J3 to the other binding post with short lengths of solid bus wire. That will restore the original connections and only two leads will be needed for the load.

If long leads are used for "remote sensing", output instability might be a problem. If that is the case, shielded cables should be used. Also, increasing the value of C8 by one or two decades might be quite helpful.

Of course, the Precision Reference makes an excellent oscilloscope calibrator. If you have a dual-trace oscilloscope, you can even use the Precision Reference as a voltage-cursor display! Input a signal into one channel of the oscilloscope and adjust the scope to show a normal display. Set the scope's attenuators to their "calibrated" position. Connect J2 and J3 from the Precision Reference to the scope's second channel. Set S1 to 0.0 millivolts and set the scope to "alternate" or "chop" so that both traces will be displayed superimposed on each other

The input signal from the first channel will be shown on the scope's display with a straight horizontal line through it. That line represents the "zero"-volt cursor from the Precision Reference. By using the second channel's vertical-position control, the zero cursor can be moved to any position vertically on the trace from which you wish to begin your measurement.

Note the approximate signal voltage being displayed on the first channel and set up the second channel to display a similar voltage available from the Precision Reference. Set S1 on the Precision Reference to the appropriate range required and advance R24 until the cursor reaches the measurement endpoint. Since you already know the approximate voltage from the CRT display, it is a simple matter to read the precise, actual voltage from the Reference controls.

The current reference can be easily used as a precision ohmmeter simply by connecting the resistance to J1 and J3. Leave R3 set at "1.00", set S4 to read current from J1, set S3 to 2.0 volts, and raise compliance control R13 so that there is no "compliance". Advance S1 from 1 to 1000 microamps and find the highest voltage reading that can be displayed on DISP1. Dividing the voltage by the current setting gives the resistance. If you need to read higher or lower resistance readings than normal, set S3 to 200 millivolts or 20 volts and set R3 to "10.00", if required.

The current source output can also be used to precisely forward or reverse bias a semiconductor junction, with the display measuring the resulting voltage drop. Reverse voltages of up to about 11 volts can be measured with R13 in the "off" position. Zener diodes, signal diodes, LEDs, and laser diodes are easily tested. Be sure not to exceed the maximum reverse voltage on the component or it will be destroyed. Light-emitting diodes and laser diodes are especially sensitive to reverse voltages. Keeping the reverse voltage below 3 volts will protect most LEDs.

Laser diodes will not "lase" at very low currents levels when being tested by the Precision Reference. It is quite easy to identify the package leads in laser diodes, as the PIN photo-diode will have a forward drop of about 0.7 volts, while the laser diode will exhibit a forward drop of about 2.0 volts.

You can also identify the leads on bipolar transistors the same way. As most emitter-base reverse-breakdown voltages on silicon transistors are below 11 volts, the Reference should be used at a setting of about 10 to 100 microamps to locate that junction. The collector-base reverse-breakdown voltages are usually well above 20 volts. Of course, the forward voltages of both junctions are about 0.7 volts.

As you can see, the Precision Reference has unlimited applications. The display is only for showing the load voltages at the current source output—the voltage-source output-control settings have much more resolution than the 3½-digit display. If you're more interested in ultimate display accuracy, it's a good idea to invest in a 4½-digit digital-panel meter which will have higher resolution. Ω

MULTICHANNEL TRIGGER

(continued from page 36)

arrangement for fitting the PC board into the enclosure given in the Parts List is shown in Fig. 3. Using a different case will probably need a different arrangement. The only requirement is that the switches and jacks be readily accessible.

Using the Multichannel Oscilloscope Trigger. To use the Multichannel Oscilloscope Trigger, locate a 5-volt source and ground connection on the circuit you will be testing. Attach the 5-volt source to pin 14 of J1, and connect pin 1 to ground. If you didn't permanently ground the enable input (pin 13), that pin should also be either grounded or connected to a signal that is low during the time that you want to trigger your oscilloscope.

As mentioned before, there are three ways to use the Multichannel Oscilloscope Trigger. The mode with the fastest speed is the eight-bit mode. Operation at speeds over 100 MHz is possible. To use that mode, set the qualifier and counter switch in S1 to the off position and set the S2 switches to the desired pattern of on and off states. The eight settings on S2 will be compared to the inputs on J1. A negative-going pulse will appear at J2 when a match is detected.

Probably the most common mode of operation will be the 10-bit mode. With that mode, you can typically decode a full byte of data on a computer's data bus during a read or write operation along with an enable signal. The 10-bit mode works the same as the eight-bit mode, except that it will only decode at rates up to 50 MHz. To use the 10-bit mode, the qualifier and counter switch in S1 must be on.

To use the Multichannel Oscilloscope Trigger in the counter mode, simply set the count switches as shown in Table 1. The counter mode lets the trigger output toggle on every second, third, or fourth occurrence of a match on the input pins.

TABLE 1

Count 1 (S1-b)	Count 2 (S1-a)	Trigger Function
OFF	OFF	Every occurrence
OFF	ON	Every second occurrence
ON	OFF	Every third occurence
ON	ON	Every fourth occurence

If you want to use the trigger to qualify fewer than 8 or 10 inputs, simply set the S1 switches for the unused inputs to logic ones. The internal pull-up resistors on IC1 will automatically set the unused pins to the same state, making them valid. That will let the Multichannel Oscilloscope Trigger pulse its output based upon the other inputs.

To troubleshoot complex circuits, you might want to have several units available on your bench. Connecting the output of one device into the enable pin of another will let you see the state of some very complex signal combinations. Ω

GREAT COMPRESSION

(continued from page 38)

on this discussion, the MPEG organization was formed in April 1988.

At the time, international compression-coding standards for video telephones were already being discussed. Initially, MPEG members believed that adopting those standards for film and television compression would be a simple matter, but their research turned up problems.

Figure 3 shows a moving image reproduced using the motion-compensated interframe-coding method already described. The P (predicted) images are generated one after another by incorporated data about the portion of image I (the original image) that has experienced motion. Although this is a very good method for compressing data, it has one fatal flaw. That flaw is that compression coding cannot start from a P image, but only from the original I image. (This can be compared to switching television channels in the middle of a broadcast: Without the original I image, the subsequent P images cannot be generated.) In addition, rewind playback, playing a video or film backwards, is also impossible. This shortcoming in the compression coding of television broadcasts has no place in the current video culture. Thus, MPEG's work began with the search for compression-coding standards under which channel-surfing, fast-forward playback, and rewind playback would be possible.

The eventual solution to this problem is shown in Fig. 4. As seen there, the series of still images are broken down into units of 12 to 15 photographs called a GOP (Group of Pictures). The initial image is always the original I image. As long as there is an I image, all the problems are resolved. However, an original image at the head of each GOP cuts into the degree of compression possible. To solve this problem, the degree of movement from one still image to the next is predicted using not only the previous image but future images as well. That is, the B (bi-directional) frame is an image created with motion compensation from past and future P frames or the I frame. The fifth B frame, for instance, was created with reference to the fourth and seventh P frames. This technique serves to both improve the accuracy of the predictions and cut back on amount of data required.

Faultless Timing. Despite its technological breakthroughs, MPEG would not have succeeded without the benefits of good luck and good timing. With the participation of many top scientists and researchers and under good, positive leadership, the standards were hammered out in a short period. Due to the swift movement, standardization coincided with the rise in popularity of the Internet and the standards were widely adopted.

MPEG is now firmly entrenched as the compression method of choice for a wide variety of audio/video technologies in the U.S., Japan, and throughout the world. In recognition of its technological achievements and its wide acceptance, particularly in the area of broadcast video, MPEG (including its predecessor, JPEG) were awarded an Emmy by the U.S. National Academy of Television Arts and Science in October 1996. Ω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NEW LITERATURE

USE THE FREE INFORMATION CARD FOR FAST RESPONSE

The ARRL Handbook for Radio Amateurs 1998 Edition

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Fax: 860-594-0259
E-mail: pubsales@arrl.org
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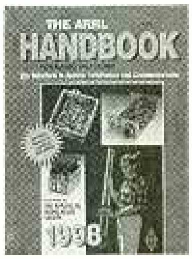

CIRCLE 338 ON FREE INFORMATIONS CARD

The 1998 ARRL Handbook, the 75th edition published by the American Radio Relay League, covers the state of Amateur Radio as the 21st century approaches. Over the course of 75 years, this handbook has meant many things to several generations of hams, engineers, and technicians. It's been an unimpeachable source of reference data, project ideas, and electronics theory. The book has served as an overview of what hams do and how they do it. To the technician and engineer, the guide has been an invaluable supplement to their reference books and data sheets. For newcomers to the hobby, it's provided a primer on the modes and equipment hams use, as well as an introduction to basic theory.

Among the new material in this edition are three items that are shown on the front cover. They are N1TEV's super-regenerative receiver, which readers will enjoy building and using; K9EK's integrated L-band satellite antenna and amplifier; and a high-power antenna tuner by N6BV. In response to reader comments on the last edition, this book has been redesigned to be more user-friendly, with the addition of a mini-table of contents and index tabs at the start of each chapter.

The handbook is divided into 30 chapters grouped under five headings: Introduction, Fundamental Theory, Practical Design and Projects, Construction Techniques, and Operating Practices. In addition to the ones already mentioned, projects include power supplies, RF power amps, modulators and demodulators, receivers and transmitters, and antennas.

Since bundling a disk with the book increased its cost, the software for the book is now available separately. It can be downloaded from either the ARRL Web site above or from the League's *Hiram* BBS, or it can be ordered for a nominal cost.

Mouser Electronics Catalog

Mouser Electronics
958 North Main Street
Mansfield, TX 76063
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Fax: 817-483-0931
E-mail: catalog@mouser.com
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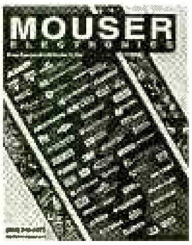

CIRCLE 339 ON FREE INFORMATIONS CARD

Updated and expanded to 356 pages, the Mouser Electronics Catalog is an excellent guide for anyone who needs electronic components. It offers over 69,000 products from more than 135 of today's leading electronic manufacturers. Free copies of the catalog or CD can be obtained by using either the telephone or fax numbers, or the e-mail or web addresses listed above.

In addition to the paper catalog, a CD-ROM version is also available. This user-friendly disk includes the entire catalog cover-to-cover, a new-products section, product and vendor listings, service options that offer order forms and credit applications, a direct link to the Web site, and over 1850 of their available spec sheets.

Mouser has an established line of quality electronic components from such industry leaders as 3M, AMP, Amphenol, Dale, Mallory, NEC, SGS-Thomson, Spectrol, Sprague, Thomson-Passive, and many more.

Now Hear This! Electronic Eavesdropping Equipment Design

by Winston Arrington
Sheffield Electronics Co.
P.O. Box 377940
Chicago, IL 60637-7940
Tel: 773-324-2196
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This 126-page revised edition contains explanatory text and 117 schematic diagrams of electronic eavesdropping equipment. Knowledge of electronics, including how to build projects from a schematic, is essential for building this equipment.

In the introduction, the author discusses surveillance techniques and presents an extract from Title III, the law on wiretapping and electronic surveillance. There are plans for 29 crystal-controlled transmitters of all types, 35 room-surveillance transmitters—both battery-powered and plug-in—and 32 telephone devices. Schematics for phantom zero-subcarrier transmitters, infrared units, and high-impedance recorder activators are also included. Each chapter starts with a discussion of the theory behind those devices, and their advantages and disadvantages.

Counter-surveillance techniques and countermeasure-detection equipment are covered in detail. The chapter on counter-surveillance techniques is written by Kevin Murray, an expert in the field.

TechAmerica Catalog

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CIRCLE 341 ON FREE INFORMATIONS CARD

The recently published full-color 500-page catalog from TechAmerica is designed to serve the needs of small business and individual purchasers. Readers can easily order individual electronic components, test equipment, and specialized tools from the extensive and comprehensive collection included here.

Seven new categories have been added: home automation, home and auto security, satellite products, computer cables and switch boxes, video, weather equipment, and metal detectors. Also featured is a collection of technical books, do-it-yourself kits, and soldering equipment. Containing color photographs, in-depth descriptions, and useful reference materials, the catalog is a handy resource of parts and components from resistors to cables for hobbyists and electronics professionals.

Network Maintenance and Troubleshooting Guide: First Edition

by Neal Allen
Fluke Corporation
P.O. Box 9090
Everett, WA 98206
Tel: 800-44FLUKE or 206-356-6600
Fax: 800-FLUKE-FAX or 206-356-5116
E-mail: fluke-info@tc.fluke.com
Web: www.fluke.com/nettools
$29.95


CIRCLE 342 ON FREE INFORMATIONS CARD

Fluke Corporation has published a 176-page reference guide for troubleshooting and maintaining local-area networks (LANs). Written for the network administrator, MIS director, and others responsible for maintaining networks, the guide covers how to operate a healthy network; and how to anticipate, prevent, and solve problems.

Five key steps to successful troubleshooting are presented: collect information, localize the problem, isolate the problem, correct the problem, and verify problem resolution. Each of these steps is explained in detail, and methods of putting them into practice are also illustrated.

Directions on how to use this book suggest that readers designing a new network begin at the beginning with Chapter 1. However, if there is a panic situation, the place to start is Chapter 2. Chapter 3 goes on to give an overview on how to form a network-maintenance strategy. Useful appendices discuss important aspects of networks. It is recommended that people new to the field start by looking at Appendix B: Operation. The guidebook concludes with a glossary of LAN terms.

The Troubleshooting Guide serves both as a reference for networking professionals and an educational text for novices interested in learning more about network operation.

Catalog 97/'98

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Fax: 847-520-0085
E-mail: elenco@elenco.com
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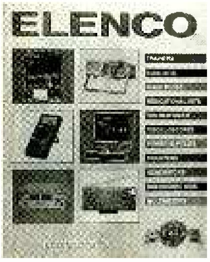

CIRCLE 343 ON FREE INFORMATION CARD

The 25th anniversary issue of Elenco Electronics' 48-page color catalog is now available. It features trainers, hand tools, oscilloscopes, power supplies, counters, generators, multimeters, and breadboard accessories. Educational kits of all types are also included, such as robot kits, an electronic keyboard kit, and a remote-control car kit. Two radio kits complete with training courses make excellent projects for the classroom. Elenco specializes in building kits for many of the largest schools in the country.

Among the new products highlighted in the catalog are the XK-700 deluxe digital/analog tester, a complete mini-lab for building, testing, and prototyping analog and digital circuits; a digital temperature meter; and a function generator kit that includes a training course on working with surface-mount components (surface mount components are used in the generator itself). Photographs and specifications are provided for each product.

HiQ Brochure

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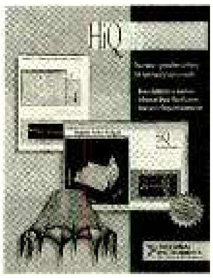

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This eight-page brochure describes National Instruments' HiQ interactive problem-solving software for technical professionals. The brochure highlights some of HiQ's hundreds of built-in functions, including data fitting, geometry, integral equations, numerical integration, and more. Advanced features include powerful built-in analysis, data visualization, and interactive report generation. Scientists and engineers can use HiQ to generate two- and three-dimensional graphs from both data and functions and immediately view the results. Users also can import data from other applications, for example, from Excel and LabVIEW. HiQ is available for Windows NT and 95 and Macintosh. A free evaluation copy can be downloaded from the National Instruments Web site, listed above.

The Futuretech Sourcebook

by Larry Ball
Futuretech
P.O. Box 6291
Gulf Breeze, FL 32561
Tel: 850-932-9682
$11.95 plus $3 S&H (Florida residents, add 7% sales tax)

Locating parts and equipment is a problem for electronics professionals and hobbyists. This directory of electronics and technical vendors makes that problem easier to handle. The 63-page booklet contains 394 categories, organized in both table and index formats.

Most of the product lines of the mail-order vendors, including transistors,

CIRCLE 345 ON FREE INFORMATION CARD

resistors, capacitors, and oscilloscopes, are listed. There is information on the types of products carried; minimum order requirements, if any; if there are toll-free numbers and Web sites; and if credit cards are accepted. The organization of the tables makes it easy to compare the product lines of various companies, and it can eliminate the need to order from multiple vendors to assemble all the parts needed for one project. In the alphabetical index, there are 147 vendors—most of which were previously cited, as well as over 30 additional specialized suppliers who are only listed there. This index includes address, phone, and web information; a short description of the product lines; and anything of note about the vendor.

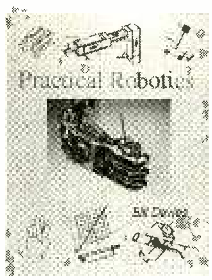
This convenient booklet helps you locate various items from air muscles to custom-made crystals. You can even find Van De Graff generators, voice changers, and fog machines in these pages.

Practical Robotics

by Bill Davies
WERD Technology Inc.
Unit 35, Suite 155
10520 Yonge Street
Richmond Hill, Ontario
Canada L4C 3C7
$69

It is difficult to find information about robotics. When you do find it, it is often bits and pieces in many different places. This book, the first in a projected series on robotics, takes care of that problem with a wealth of material on robotics, both theoretical and practical.

It starts with an introduction to the electronic equipment needed by the robot builder, such as oscilloscopes, meters, and logic probes. That is followed by a chapter reviewing basic electronics. The rest of the book offers detailed descriptions of the components used in robotics—what they are and how to use them. Power sources, sensors, force transducers, motors, magnetic forces, resistors, and capacitors are thoroughly explained and illustrated.



CIRCLE 346 ON FREE INFORMATION CARD

This 337-page compendium is profusely illustrated with over 250 drawings and photographs. Useful appendices present a bibliography of robotics publications and a list of manufacturers and suppliers. Aimed at students primarily, it will also be a handy reference for hobbyists, teachers, and professionals—anyone interested in robotics. EN

NEW PRODUCTS

continued from page 31

for use with Fluke LAN testers.

Accessories in each of the kits include two 50-ohm BNC cables; two BNC-male-to-Grabber breakouts with Minigrabber and Mini-gator test clips; BNC termination plugs for 50-, 75-, and 100-ohm impedances; Type-N termination plugs for 50- and 75-ohm impedances; and eight BNC and Type-N adapters.

All connection interfaces feature gold-plated center contact pins and PTFE dielectrics for high connection integrity and reliability. Insulated in Teflon with a tarnish-resistant brass shell, Pomona 50-ohm coax connectors are typically rated at 500 volts rms.

The Model 6201 and Model 6202 test accessory kits are priced at $200 each.

ITT POMONA ELECTRONICS
1500 East Ninth Street
Pomona, CA 91766-3835
Tel: 909-469-2900
Fax: 909-629-3317

Desktop FM Transceiver

R.L. Drake has returned to the amateur-radio market with the TR270 FM Transceiver. It is the only desktop FM transceiver dedicated specifically to two meter operation. Two radios in one, the TR270 permits both full two-meter capability (142-150 MHz) and independent dual-band reception (136-174 MHz and 420-470- MHz). This broad range lets listeners hear public service, marine, weather, and amateur bands.

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Internal card slots are used for integrating 1200/9600 bps packet-radio, satellite, weather-fax, and data reception. The optional TNC270 Terminal Node Controller and DEMOD270 Demodulator plug-in cards fit neatly inside the TR270. Those cards eliminate the need to jury-rig multiple components together, as well as eliminate the tangled web of cabling that often accompanies multiple pieces of equipment.

Its five modes of operation provide the amateur-radio user with a wider variety of options than previously found in one transceiver. This transceiver caters to the preferences of the operator and can be customized to meet the individual user's needs. Selecting filters, setting memory scan, or customizing channel lists for both receiver and transmitter can easily be done with setup menus and front-panel inputs. The TR270 boasts 400 total channel memories, and it can remember favorite frequencies in voice, satellite, or data modes.

The unit comes with a built-in 140-watt, 115/230 VAC switching power supply, and has three jacks: external audio-in, external speaker, and telephone. Other features of this unit include an external DC input for mobile or emergency-power operation and a transmit time-out timer. DTMF and CTCSS tone-encoding and decoding ability for both two-meter and wideband receivers is also provided. Among the accessories included with this Drake transceiver is a high-quality dynamic microphone.

The TR270 FM transceiver retails for $999.

R. L. Drake Company
230 Industrial Drive
Franklin, OH 45005-4496
Tel: 513-746-4556
Fax: 513-746-4510
Web: http://www.rldrake.com

EN

BY SAM GOLDWASSER

Printer and Copier Basics

THIS MONTH, WE ARE GOING TO DO SOMETHING THAT'S A LITTLE DIFFERENT: RATHER THAN DEALING WITH SPECIFIC SERVICING PROBLEMS AND SOLUTIONS, WE ARE GOING TO PRESENT A BRIEF OVERVIEW OF COMPUTER PRINTERS AND HOW THEY work. Note that some of the following information was sent to my Web site by others; in those cases, I have given credit to the original contributor.

Let's start off by taking a look at dot-matrix printers. In that printer, a set of steel pins—as few as 9 and as many as 24—strike the paper through a fabric or carbon-film ribbon. The pins are activated by solenoids that are controlled by the printer's control logic. Multiple passes are sometimes used to increase the effective number of pins and improve print quality (letter versus draft mode).

For text, an internal character generator (ROM) converts ASCII codes to pin-firing patterns. For arbitrary graphics, the actual bitmap is read out and used to control the pin drive. The paper, carriage, and sometimes ribbon movement are all controlled by stepper motors. Those motors, their drivers, or the interconnect cables, are the most common problem areas. Note that dot-matrix printers are about the only type of impact printers still in wide use, and fewer and fewer are being sold each year.

Ink-Jet Printer Basics

Much of what follows on ink-jet printers comes from Tony Hardman (tony@f54x19.demon.co.uk): There is a US publication called *The Hard Copy OBSERVER* from Lyra Research Inc., Tel: 617-322-0708. It discusses the latest technologies and who does what. It may not cover the print-head technology in very great detail, but it is still a good read if you are into print technology in general. There are many companies that sell variable print processes. One I have heard of is RALFLATAC. They publish a brochure that presents an excellent brief of most technologies available for printing. They have locations in the UK (and around Europe) and the US. By telephone, you can reach them in the UK at 01732-583661, and in the US at 704-684-3931. I have no idea if you can get copies of either publication from them, so here is a very brief description:

DOT-MATRIX PRINTERS are the only type of impact printers widely sold today.

There are two main types of ink-jet printing—continuous ink jet (CIJ) and drop-on-demand (DOD) impulse printing. Each of those can use either a single jet or an array of jets. CIJ is a continuous jet of ink cycling round a system and occasionally (when required) a drop is deflected out of the stream onto the paper. The stream is modulated to break it into a consistent drop size. The deflection works like the beam on an oscilloscope. If you charge one drop and pass it between two high-voltage plates, it is deflected. This system also requires cunning mechanics, but the support electronics is much more complex, and probably one of the reasons for its performance limitations; the calculations of the aerodynamics of drops being deflected is no small task, even if look-up tables are used. For the most part, CIJ, as a single jet, is used in high-speed industrial applications, such as product marking (sell-by dates, serial numbers, etc.).

In contrast, DOD most often uses an array of small jets and is the system used in most desk-top printers. In principle, DOD works like a dot-matrix pin printer, but instead of firing a pin at a ribbon, a drop of ink is fired at the paper. The drop is fired by either a piezoelectric crystal squeezing the ink out of a small tube, or by boiling the ink and having the vapor force the ink out of the chamber. The key to both of those processes is in the mechanical design of very small components. The control electronics is a bit cunning, too, but I figure that is the easy bit.

How Many Colors?

I use a Hewlett-Packard DeskJet 680C in the office. It has two cartridges: one for black and one for color. If the printer fires one drop of each ink at a given point, we can have only six different colors (ignoring white and black). If it can fire two or more drops at a given point, maybe we can have more colors, but I suspect that the printer uses this to control the quality of the presentation, not the number of colors (does anybody knows for sure?). With dithering it can make more colors, with reduced resolution.

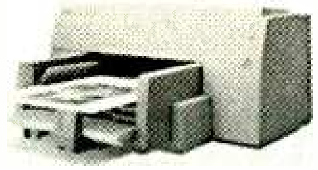
As in most print processes, you only have a limited selection of inks to use. Full color can be derived from three colors, just like a monitor. For monitors, those colors are red, green, and blue because monitors emit light, resulting in an additive color process. Inks, on the other hand, absorb light, so printing is a subtractive process. The resulting inks should then be cyan (blue plus green or blue minus red), magenta (red plus blue or red minus green), and yellow (red plus green or red minus blue). Therefore, the colors used in common ink-jet printers are not really capable of producing true full-spectrum, photo-realistic quality since they are red (not magenta), blue (not cyan), and yellow. Those inks are optimized for nice saturated primary colors when used independently. One of the newest color inkjet printers is the Epson Stylus Photo. It uses a five-color ink cartridge, in addition to black, to create high-quality realistic color images.

From Tony Hardman comes the following: If you can vary the drop size, you can change the drop spread on the paper. That can be done by firing bigger slugs of ink, or multiples of the drop at the same position. As you can understand, the ink will either spread and make a bigger drop, or stay the same size and become denser. Depending on the resolution you want, either technique could improve color density, depending on two key components: the ink, and the paper.

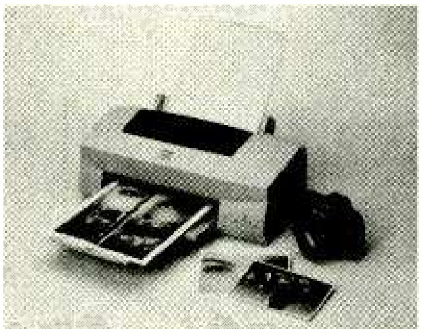
The problems with laying down multiple drops on paper is that if you do a large block, the paper will curl and the overall image becomes worse. That is why you can pay as much as $1 for a sheet of really high-quality, really white paper.

Another problem with this is speed. Firing two drops in the exact same place is difficult unless the head is stationary, but that is not good either. You may notice that most DOD printers operating in their high-resolution mode do a number of passes over the same place. That allows dithering and other techniques that improve resolution/color enhancement. These printers usually only print while going in one direction for improved mechanical control.

Inks are a problem too. They can dry at different rates because of the different dyes used, or they may not mix the way you expect if you place two colors on top of each other. It's only ink, but to get the best balance of surface tension, drying time, viscosity, color, stability and more is not as straightforward as it might seem. I have noticed that the water-based inks are improving, and there are some that do not run if they get wet (after drying on the paper).



THE HEWLETT-PACKARD DESKJET 680C has two ink cartridges: One for black ink and one for the three color inks.



THIS COLOR INKJET PRINTER from Epson uses a five-color ink cartridge (plus black) to provide more realistic colors.

Laser Printers

Some of the information in this section was sent to me by Copenhagen Cowboy (cowboy@fastlane.net): Copiers and laser printers have a lot in common. The major difference between them is in how the image is formed on a photosensitive drum. A copier uses a bright light and lens to focus an image of the original (actually, a strip at a time is scanned in most modern low- to medium-performance copiers) onto the drum. Adjusting the lens-to-original and the lens-to-drum distance is used to vary the reduction or magnification.

A laser printer uses a low-power, sharply focused laser beam to scan one line at a time on the drum. Modern laser printers use infrared, solid-state laser diodes similar to those used in CD players and optical disk drives. The digital image is generated from a bit map stored in the printer's memory and modulates the laser beam. Scanning is mechanical—a high-speed motor spins a multifaceted deflection mirror to get the X-axis, and the paper moves to get the Y axis. LED "page printers" use a large array of LEDs as the image source, but are otherwise similar to laser printers. Plain-paper fax machines also use similar techniques in their printing mechanism.

The only other significant difference between copiers and laser printers is that copiers use a positive process (dark areas in the original result in marks on the paper) and laser printers commonly use a negative process (a spot of light results in a dark mark on the paper).

The photosensitive drum is the heart of the laser printer or copier. In larger machines, it may be a separately replaceable unit. In many laser printers and smaller copiers, it is part of the toner cartridge and is a throw-away (or could be recycled). The drum is coated with a photosensitive material that has an extremely high resistance when in darkness. Its resistance drops to a low value when illuminated.

All of the following takes place as a continuous process as the drum rotates. Note that the actual photosensitive drum in most copiers and laser printers has a circumference that is much smaller than the length of the printed page. Therefore, only a portion fits at any given time; and the charging, exposure, transfer to the paper, cleaning, and erasing is a continuous process.

The drum's surface is charged to a high positive voltage (typically 5 to 6 kilovolts DC) by a set of charging corona wires in close proximity to the drum. The exposure process differs for copiers and laser printers.

For copiers, a swath of the original is focused onto the drum. As the drum turns, a quartz lamp and strip mirror moves along the original, with a second strip mirror moving at half the speed of the first. The result is that the entire original image is kind of "peeled" onto the rotating drum. (Look through the glass platform that supports the original as the machine is copying, and you will see what I mean.) For laser printers, the negative image of the page stored in the printer's buffer memory (the laser is turned on where the print is to be black) is read out and scanned onto the drum one line (e.g., 1/300th or 1/600th of an inch) at a time. Where the light hits the drum's surface, its resistance drops dramatically and the charge in those areas is dissipated.

Regardless of the machine type, at that point, a swath of the image of your ultimate copied or printed page resides as areas of electrostatic charge on the drum. That is a "latent" image and must be "developed."

As the drum continues to turn, the

latent image rotates past the developer unit, which contains a mixture of developer and toner. For the most part, developer is not really used up during the printing process, but some is lost and may need to be replenished from time to time (depends on the machine's design).

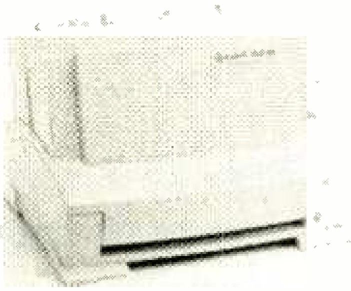
Developer is a material that includes powdered iron or another powder that is attracted by a magnet. Toner is the actual ink and consists of very finely powdered, thermoplastic particles. Those are "fixed" in the fuser by literally melting the image onto the paper. Depending on design, the developer material may be separate or actually combined with the toner. A magnet in the developer unit, which is as long as the page is wide, causes the developer along with trapped toner to stand out, following the lines of force off of its long N-S pole pieces. That forms a kind of brush of toner and developer material that is in contact with the drum as it rotates with its latent image. Normally, the developer-material brush is C-shaped, and toner particles are carried in the C-shape (the back of the "C" is against the drum).

Here is where the developing processes of copiers and laser printers differ. For copiers, the relative charges of the drum and toner are set up so that toner is drawn to the unexposed (dark parts of the original) portions of the drum resulting in a positive image on the paper. For laser printers, the relative charges of the drum and toner are set up so that toner is drawn to the exposed (where the laser beam was turned on) portions of the drum resulting in a negative image on the paper.

The drum continues to rotate around and comes in contact with the paper. Below the paper is another corona, the "transfer corona." Another high voltage is applied to the back of the paper (around 7 or 8 kilovolts DC) to draw the toner from the drum to the paper. Remember, all that is going on in a continual cycle and it is all in motion.

Depending on the manufacturer of the machine, there may or may not be a third corona, the "separation corona". That is needed to separate the paper from the drum, but not disturb the toner on the paper. The separation corona is usually at around 4 or 5 kilovolts AC (if it was DC, you would separate the paper from the drum, but will have very smeared toner all over the page, making it unreadable). The separation corona usually has guides over it to keep the paper from dipping down too far into the corona shell.

Paper is then transported to the fuser, which fixes the toner to the paper via heat (to soften the toner particles) and pressure (to embed them in the paper fiber). There are parts in the fuser that also keep the paper from sticking to the hot rollers. A thermostatically-controlled quartz-tube lamp provides the heat inside the anti-stick (Teflon-coated) fuser roller.



LASER PRINTERS, like this one from Hewlett-Packard, work very much like laser copiers, though there are some significant differences.

Finally, your copy or printed page is ready. However, we are not completely done as there is still some toner on the drum—it is not possible to get it all off electrically—so there is usually a rubber or plastic blade that rubs in direct contact with the drum. That drum blade scrapes the toner off the drum, and the recovery blade catches it to keep it from falling back into the machine. A used-toner auger transports the used toner, which is now changed both physically and electrically, and is also contaminated with paper dust. Don't reuse your used toner, because it will eventually damage the developer unit, cleaning blades, fuser sections, and other parts of the mechanism.

Now that all the toner has been scraped off the drum, there is still some residual charge on the drum from the previous exposure process. You obviously can't scrape the static charge off the drum, so the cleaned drum is now fully exposed to a bright light to discharge the drum surface and prepare it for the next charge.

That is the basic process. Many variations are possible and, depending upon the machine and manufacturer, some of this may be a little different in your printer or copier. Where a toner cartridge is used, many of the components mentioned—typically the drum, the toner and developer (usually combined into a single powder), developer magnet, cleaning blades, and some of the corona wires—are part of that cartridge and are replaced each time the cartridge is changed.

Wrap Up

Well, I told you that it was going to be different this time. While we did not get to any hard-core servicing information, I felt that, since so little information on printers is readily available, the information I did have was worth presenting.

Anyway, that's all for this month. Between now and my next column, why not visit my sci.electronics.repair FAQ site on the internet at www.repairfaq.org. If you wish, you can reach me directly via e-mail at sam@stdavids.picker.com. See you next time. EN

BY FRANKLIN J. MILLER

Building a Capacitance-Substitution Box

IF YOU WERE INTERESTED IN THE RESISTANCE SUBSTITUTION BOX WE DESCRIBED IN THE DECEMBER 1997 ISSUE, IT IS LIKELY THAT YOU HAVE BY NOW BUILT IT AND PUT IT TO WORK. THIS MONTH, WE WILL SHOW YOU ANOTHER USEFUL ACCESSORY for audio testing. It is a capacitance-substitution box, or C box; it is very similar to the R-box, and it too will help make your audio-testing chores easier.

A Capacitor-Substitution Box

Our C Box provides capacitance outputs from 10 pF to 11.1110 µF just by pushing the appropriate combination of buttons on the front panel. If you decide to build the box, be sure to use only precision components. Particularly, close capacitor tolerances are a must. Ideally, you need 1% components to make a very accurate box. Unfortunately, such tolerances are nearly impossible to find, and what is available is very expensive. To get around this problem, I purchased a large number of readily available 20% tolerance ceramic-disc capacitors. Then I measured them carefully with a capacitance bridge, and I selected sets of capacitors that came closest to the needed values. I also made sure that they all fell to the same side of the optimum value. I know that this is a time-consuming process, but it is the only practical way to get the precise values of capacitance you need if you decide to build the box without the benefit of the available kit (see the Parts List). The parts in my kit are selected in the fashion described, and all of the capacitors swing in the same direction so their actual values track.

A photograph of the finished unit is shown in Fig. 1. Just like the R-box, you select the value you want to use by simply punching in the capacitance value you need using the pushbutton pad. The selected value then appears across the terminals labeled CX at the top of the unit.

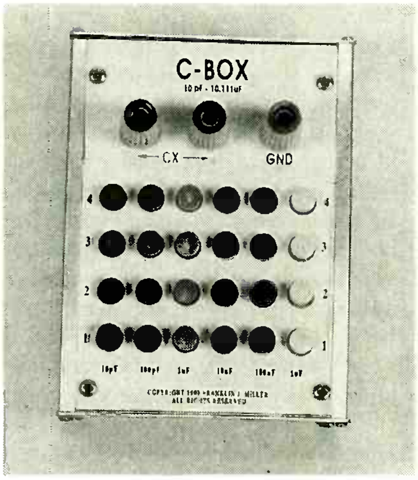


FIG. 1—HERE'S HOW THE C-BOX will look when finished. As you can see, the look is very similar to December's R-Box.

Note that the unit is labeled in nanofarads (nF) rather than the more familiar microfarads (µF). (Actually, outside of this country, capacitors are often marked in nanofarads rather than microfarads). To make the conversion, just move the decimal point three places to the left. For example, 562 nF is 0.562 µF.

Now, let's see how we would get the C Box to output that 562 nF. If you built or remember our R Box you have a head start, as the process is pretty much identical. First, you would push the 4 key and the 1 key in the row above 100 nF—that gives you 500 nF at the terminals. Then you would depress the 4 key in the 10-nF row and the 2 key in the same row. That adds 60 nF to the 500 nF. The switches stay down, and the selected value is available across the CX terminals. For the final 2 nF, push the 2 button in the 1-nF row. It is just that easy.

Putting It Together

The complete schematic for the substitution box is shown in Fig. 2. For easiest construction, a PC board is recommended and is provided elsewhere in this column. The parts-placement diagram for that board is shown in Fig. 3. As indicated there by the dotted lines, the capacitors are all mounted on the foil side of the board; that's done to make the entire assembly as compact as possible. The switches mount on the component side of the board in the usual manner.

Note that both the PC pattern and the schematic show DPDT switches, although only one section of each is used. Those switches are used because they are easier to find than latching SPDT pushbuttons; they are probably less expensive, too.

Construction is straightforward. All 24 switches mount right on the PC board. Make sure that you insert them so that they fit flat and tight against the board. This is important! If you do not get it right, the knobs will not fit properly through the top plate. Note: If you elect not to use the available kit, make sure you select an enclosure that is deep enough to accommodate the switches that you do use. The critical dimension here is the depth of the box; it should be deep enough so that when you mount the PC board inside, the switch buttons pro-

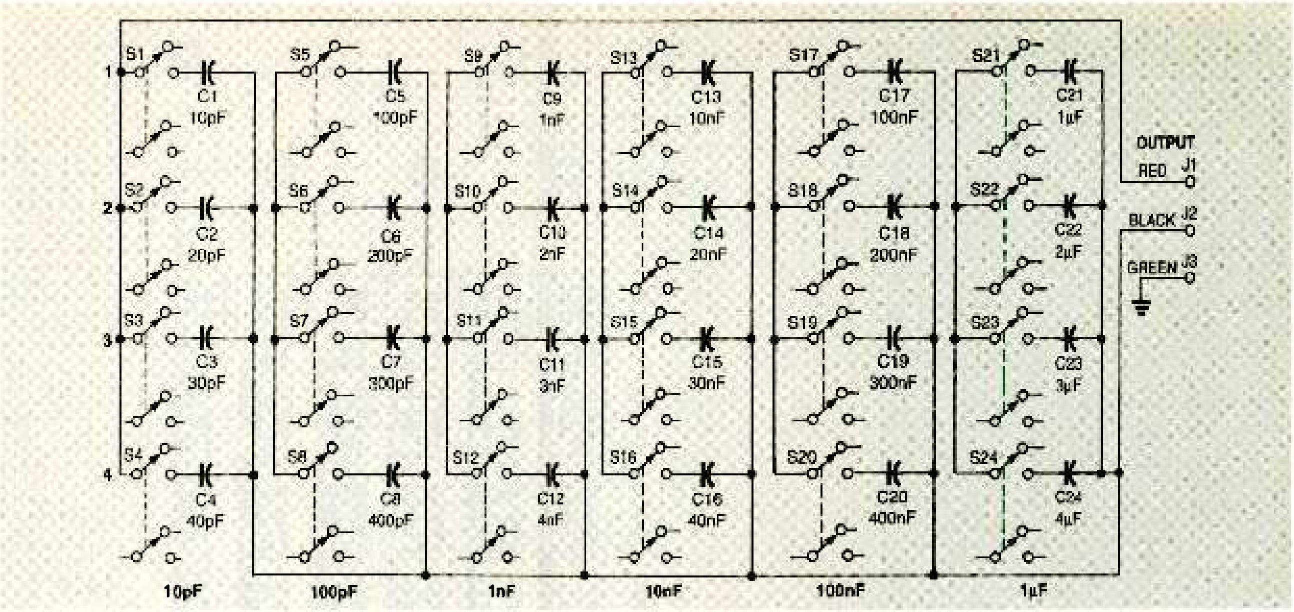


FIG. 2—AS YOU CAN SEE IN THIS SCHEMATIC, the C-Box circuit is simply a combination of capacitors and switches.

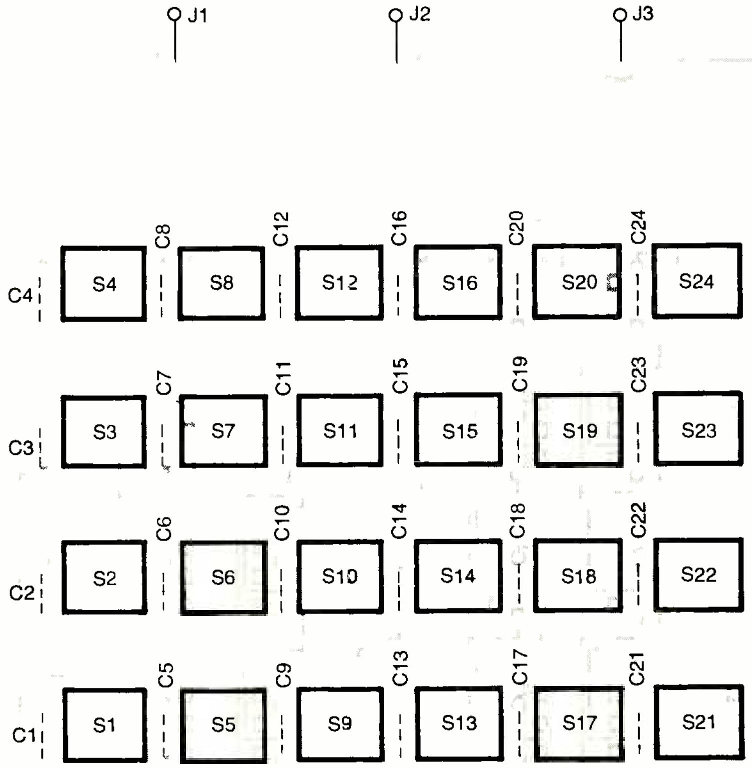


FIG. 3—WHEN BUILDING THE BOARD, remember that the switches go on the component side of the board, and the capacitors go on the foil side.

trude far enough through the top plate for you to attach the switch knobs. Once the switches are in place, mount the capacitors on the foil side of the board. Do not install J1–J3 at this time.

Once you have mounted all of the components (except J1–J3), carefully inspect the PC-board assembly for the usual construction errors. When you are satisfied all is well, put it aside for the time being.

The next step is to apply the front-panel overlay. If you choose to buy the kit, an overlay and pre-punched enclosure are provided. If you elect not to use the kit, you should create your own overlay. The appropriate markings can be seen in the photograph back in Fig. 1. If you want a drilling guide for the front panel, use the one for the R-Box, which was shown in Fig. 4 in the December 1997 issue. It is identical to the one for this unit. In fact, when we get around to building an inductance box (L Box) in a future issue, it too uses the same drilling pattern.

The overlay supplied with the kit has an adhesive backing. To ensure that it will adhere properly, you must make sure that the front panel is very clean. A small amount of acetone, which can be purchased at any paint store, will do the job nicely. It will remove any grease or dirt that might interfere with attaching the overlay. Since its vapors can be hazardous, make sure you are in a well-ventilated area when you work with acetone.

Now you need a small bottle of water with a spray attachment. It will allow you to move the overlay around for precise

PARTS LIST

CAPACITORS

(All capacitors are 20%, 50-volt, ceramic disc, selected as described in the text to get the 1% values needed.)

C1—10-pF
C2—20-pF
C3—30-pF
C4—40-pF
C5—100-pF
C6—200-pF
C7—300-pF
C8—400-pF
C9—1-nF (0.001-µF)
C10—2-nF (0.002-µF)
C11—3-nF (0.003-µF)
C12—4-nF (0.004-µF)
C13—10-nF (0.01-µF)
C14—20-nF (0.02-µF)
C15—30-nF (0.03-µF)
C16—40-nF (0.04-µF)
C17—100-nF (0.1-µF)
C18—200-nF (0.2-µF)
C19—300-nF (0.3-µF)
C20—400-nF (0.4-µF)
C21—1-µF
C22—2-µF
C23—3-µF
C24—4-µF

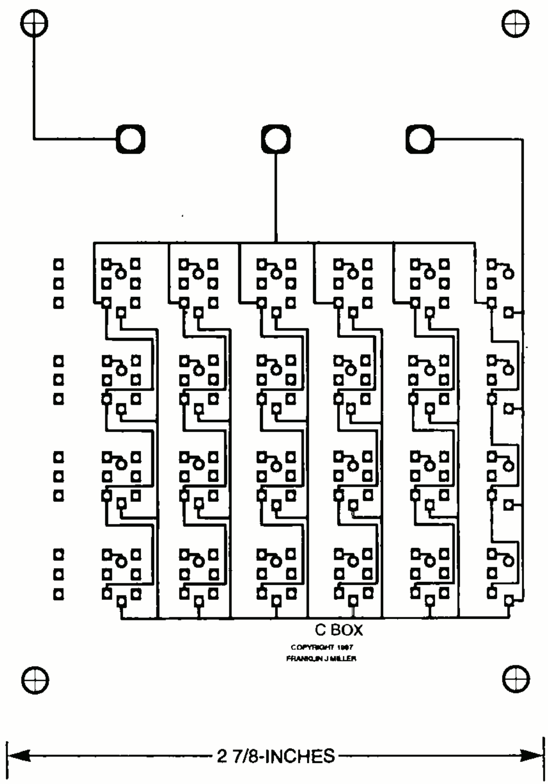
ADDITIONAL PARTS AND MATERIALS

S1–S24—Pushbutton switch, DPDT, see text
J1—Banana jack, red
J2—Banana jack, black
J3—Banana jack, green
Switch knobs (four each black, red, yellow, green, blue, and white), enclosure (see text); PC board, top-panel overlay, hardware, wire, solder, etc.

Note: The following items are available from Franklin J. Miller, 2100 Ward Drive, Henderson, NV 89015. A complete kit, including pre-drilled aluminum case, front-panel label, pushbutton knobs, PC board and all other components, for $95.00 postpaid.

placement. Place both the front panel and the overlay in front of you, with the three holes at the top. Remove the overlay backing and align the upper-left corner of both pieces. Once the label is aligned, gradually smooth the balance of the overlay down using the side of your hand. After this is done, use an orange stick (available in the beauty section of any supermarket) as a rolling device to get out all the bubbles. Let the front panel dry overnight to be sure all of the water has evaporated. Do not use heat! It will ruin the overlay material.

The next step is to put the knobs (supplied with the kit) on the switches.



USE THIS FOIL PATTERN when building the C-Box.

Position the PC board in front of you, with the three pads for J1, J2 and J3 toward the top. There are four rows and six columns. Use black buttons for the first column, on the far left. As you go to your right, use the red, yellow, green, and blue buttons in order for each row. Use the white buttons for the row on the extreme right, and you are done. Note that the buttons will just snap on. As you install each one, be sure that you hear a snap, indicating that each button knob is properly seated.

Now install the banana jacks through the front panel. Go from left to right and insert red, black, and green, in order, tightening the nuts that hold them in place as you go. There are four 2.5-mm × 10-mm long screws, four ⅛-inch long spacers, four nuts, three lock washers, and one ground-lug washer that are inserted in each one of the four corners of the front panel. Insert the four screws and turn the assembly over (put a small piece of cardboard over the top to hold the screws in place while you do this). Slip the spacers over the screws. Now the PC board should fit onto the spacers, followed by the lock washers in three corners and the ground-lug washer in one. Finally, place the nuts on the screws and tighten them only finger tight. Turn the unit over to be sure that all of the push buttons work without any problems. Once that is confirmed, tighten the four screws and nuts to the final fit. Now you can solder the banana jacks to the PC board. The last step is to assemble the rest of the case.

You have just built a very important test fixture. The C-box is extremely useful when you need to find out about passive and active filters. Also, capacitors determine the low- and high-frequency response of amplifiers. Next time, we will put our new C-box to work. **EN**

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20 character x 8 line
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The built-in controller allows you to do text and graphics.

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640x200	Toshiba	$15.00	240x128 (backlit)	Optrex	$20.00
480x128 (backlit)	ALPS	$10.00	240x64	Epson	$15.00
			160x128	Optrex	$15.00

6" VGA LCD 640X480, Sanyo LMDK55-22 **$25⁰⁰**

Laser Products

HeNe Laser Head (10Mw max. output) TEMOO. 15.5" long MFG: NEC **$89.⁰⁰**
Laser Power Supply (for HeNe tube) **$79.⁰⁰**

Laser Scanner Assembly $19.⁰⁰
Assembly intended for a laser printer. Includes laser diode, polygon motor (6 sided) and misc. optics and lenses.

LASER DIODE (5mW) with collimator **$20.⁰⁰**

VISIBLE LASER DIODE: 5mw at 670nm **$15.⁰⁰**
Index guided. Threshold current 40 ma typical.

3 and 4mW, 1,300nm LASER DIODES, 5.6mm package, $15⁰⁰
Mitsubishi Electric part number ML701BIR-E21A, General specs are:
1. Vop=1.25, Beam Divergence 25.6° x 28.6°; 2. Tc=24°C, Iop=19 to 20mA, ITH=10.7mA; 3. Wavelength range between 1,280nm and 1,330 nm

POLYGON MOTOR UNIT & DRIVER $69⁰⁰
Ten-sided first surface mirror mounted on an armature that spins at 125 revolutions per second yielding a beam sweep rate of 1250 sweeps per second. The driver for the polygon unit requires 24 volts and plus and minus 12 volts to operate. There is also an f-theta lens in front of the polygon scanning mechanism with a three inch diameter. Great for optical experiments, etc. Very high quality units. (MFR: JAPAN ELECTRONICS)

Pos & Bar Code

MAGNETIC CARD READER $25.⁰⁰
Includes: • 20 character dot matrix display with full alpha-numeric capability • keypanel with full alpha-numeric entry • separate 7.5 VDC/0.5 Amp power supply • standard telephone interface extension cord • lithium battery and flat-cone speaker.

HP bar code wand (HBCS 2300)......................$25.00

Power Supplys

SWITCHING POWER SUPPLYS $12.00 or 2 for $20.00 115/230 Volts
73 WATT (2) 4 pin power connectors attached • Dim: 8.5" L x 4.5" W x 2" H
Output: +5V @ 2-9.75, A, +12V @ 0-1.5 A, -5V @ 0-0.4 A, -12V @ 0-0.5 A
60 WATT Dim: 8¾ x 4¼ x 3 • Output:5V @ 6A + 12V @ 1A - 5V @ 1A - 12V @ 1A

Charge Coupled Devices

"The Spy In The Sky" $29.⁰⁰ **MATRIX TYPE**

Thomson 576X550 pixel CCD
400-1,100nm resolution and responsivity. **$500⁰⁰ Original cost device**

Sony CCD Imager - designed for black and white composite video cameras. Picture elements: 384 (H) x 491 (V) $29⁰⁰
Chip size 10.7 (H) x 9.3 (V) mm² • Unit cell size 23.0 (H) x 13.4 (V) um².
Ceramic 24 pin DIP package • Mfr: Sony, Part# 016AL

LINEAR TYPE

4096 element CCD $15.00
1024 element CCD $10.00
2048 element CCD $10.00 • 1728 element CCD $10.00

Miscellaneous

ADAPTEC 4070A (RLL) OR 4000A (MFM), SCSI Controller, your choice $25⁰⁰

IBM 370 option XT and AT emulation boards $25⁰⁰

Monitors

Non-Enclosed TTL
Comes with pinout. 12V at 1.4 Amp input • Horizontal frequency 15Khz. • Ability to do 40 and 80 column.
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9 inch Amber or Green $25.00

5" COLOR MONITOR $39.⁰⁰

• Flat Faceplate • 320 x 200 Dot Resolution • CGA & Hercules Compatible
• 12 VDC Operation • 15.75 KHz Horiz. Freq. • 60 Hz Vert. Sync. Freq.
• Open Frame Construction • Standard Interface Connector • Degaussing Coil included • Mfr. Samtron

9" COLOR SVGA MONITOR $249.⁰⁰
Fully Enclosed – Tilt and swivel type.

Hacker Corner

Encased Spread Spectrum RF Modem $199⁰⁰

The ProxLink Radio Module is a small communication device which replaces cables between RS-232 devices with wireless RF (Radio Frequency) technology. Attaching a pair of ProxLinks to any two devices with three wire asynchronous RS-232 ports allows wireless data transmittal at rates up to 19.2 Kbaud (full duplex) over a range of 500 - 800 feet. Modules use 900 MZ spread spectrum radio for communication which does not require an FCC site license. A variety of configuration information (radio channel, baud rate, serial port configuration, etc.) can be programmed into module's non-volatile memory by host PC to provide compatibility and avoid overlapping systems. Configuration changes are supported by menu driven, on-board software. Commonly used Terminal Emulation software and transfer protocols can be used for configuring modules and transferring data between computers. ProxLinks require only 6-9 VDC (350 mA), RS-232 (9 pin sub - D) interface, and small (~ 4") whip antenna for operation. Unit size is 4.0" x 6.5" x 0.75". Installation schematics and application details available.

US made Micronics 486 VLB ALL in ONE $39⁰⁰ or 2 for $69⁰⁰
motherboard, supports 3.4 or 5V CPU, at either 25 or 33 mhz basic clock. Can use AMD or Intel from 486SX25 thru 486DX4-100 to HOT new AMD 5X86-133 cpu. On board SVGA video. On board 1 meg video ram expandable to 2 meg with ATI Mach 2 chip set. On board 2 high speed serial ports, 1 printer port, floppy and IDE hard drive controller. On board 256K cache. Uses 72 pin simm memory. Landmark speed rating of 479 with AMD chip.

Board will not fit standard All in One case because of non standard location of riser board. VLB riser board is included with motherboard.

COLOR CCD CAMERA $149⁰⁰
• 12 VDC • 1/3-inch. CCD area image sensor • 514 (horizontal) x 491 (vertical) • 2:1 interlaced • 15.734 kHz (horizontal), 59.94 Hz (vertical) • 330 horizontal and 350 vertical lines • 10 lx • 1V, NTSC signal format • Lens: 1/3-inch, fixed focus (F:2.8 f:5.6) • Dimensions: (W) 67 (2.63) x (H) 34 (1.45) x (D) 112.6 (4.43)

SONY Miniature Color LCD Display (LCX005BKB) $29⁰⁰
• 1.4 CM (0.55 inch) Diagonal Full Color Display • Built In Horizontal and Vertical Drivers • Delta Dot Pattern for High Picture Quality - 537 dots (H) x 222 dots (V) • Compatible with NTSC & PAL Format and Sync Inputs • 12 VDC Operation with -1 to +17 V RGB Signal and Driver Input Voltage • Excellent Display for Virtual Reality Projects, Viewfinders, and Miniature Test Equipment Displays • Pin Outs and Specification Included • Unit Requires Clock, Synchronization and Video

CELL SITE TRANSCEIVER $49⁰⁰ 2 for $89⁰⁰

These transceivers were designed for operation in an AMPS (Advanced Mobile Phone Service) cell site. The 20 MHz bandwidth of the transceiver allows it to operate on all 666 channels allocated. The transmit channels are 870.030-889.980 MHz with the receive channels 45 HMz below those frequencies. A digital synthesizer is utilized to generate the selected frequency. Each unit contains two independent receivers to demodulate voice and data with a Receive Signal Strength Indicator (RSSI) circuit to select the one with the best signal strength. The transmitter provides a 1.5 watt modulated signal to drive an external power amplifier. channel selection is accomplished with a 10 bit binary input via a connector on the back panel. Other interface requirements for operation are 26 VDC (unregulated) and an 18.990 MHz reference frequency for the digital synthesizer. The units contain independent boards for receivers, exciter, synthesizer, tunable front end, and interface assembly (which includes power supplies and voltage-controlled oscillator). Service manual, schematics and circuit descriptions included.

Encased Black & White Composite CCD Camera with Adapter
IR viewing to 1000 nm 7 ½ L x 2 ¾ W x 1 ¼ H
Comes complete with CCD camera, mounting nut on bottom of casing. 12VDC power supply. Excellent low light capability, standard RCA NTSC video out. **$89.00**
Great for: entryway security/remote monitoring, video conferencing/desktop video conferencing **2 for $159.00**
This miniature camera is perfect for multimedia computer applications as well as security and surveillance. NTSC output allows use with all popular video digitizing boards for Apple Macintosh and Microsoft video for Windows. Connects directly to any composite monitor or VCR with "video" input. Its razor-sharp wide-angle lens focuses from two inches to infinity and its state-of-the-art CCD technology accurately captures 16 level grayscale images for Quick Time movies and still pictures. Records at 30 frames per second and 260 lines resolution with excellent low light capability. Uses 12VDC (adapter supplied) and standard RCA cable.

POINT OF SALE BANK TERMINAL $39⁰⁰ or 2 for $69⁰⁰
• LCD Display 20 Char. x 4 Line • Printer 16 Column Dot Matrix - Epson • 24 Key Domed Membrane Keypad • Intel 80C32 Processor • 2 PCMCIA Sockets (ICC Slots) • Dallas DS1287 Realtime Clock • 2 Solid State Buzzers (Piezo Electric) • 4 C... • Rockwell Modem Chip • Telephone Line Interface (4 Pin "RJ" Connector) • RS232 Interface (8 Pin "RJ" Connector) • Ni-CAD Battery Pack Inside
Note: We have not been able to bypass an access code in the software. Thus, while time of day and other introductory things are displayed on LCD, the full original capabilities of this unit cannot be guaranteed. Also, we do not have a source for the smart cards that were to go in the PCM CIA sockets. Requires 12 volt adapter for power. (Not included) Dimensions: 9-1/2L x 6-1/4W x 2-1/2 D • Original cost over $450.00

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Low Battery Indication: BAT on Left of LCD Display
Dimensions: 188mm long x 87mm wide x 33mm thick
Net Weight: 400g

$19.00 any qty

DC Voltage (DCV)

Range:	Resolution:	Accuracy:
200mV	100µV	
2000mV	1mV	±(1%rdg+2dgts)
20V	10mV	
200V	100mV	
1000V	1V	

Maximum Allowable Input: 1000V DC or Peak AC.

DC Current (DCA)

Range:	Resolution:	Accuracy:
200µA	100nA	
2000µA	1µA	±(1.2%rdg+2dgts)
20mA	10µA	
200mA	100µA	±(1.2%rdg+2dgts)
10A	10mA	

Overload Protection: mA Input. 2A/250V fuse.

Resistance (Ω)

Range:	Resolution:	Accuracy:
200Ω	100mΩ	
2000Ω	1Ω	
20KΩ	10Ω	±(1.2%rdg+2dgts)
200KΩ	100Ω	
2000KΩ	1KΩ	
20MΩ	10KΩ	±(2%rdg+10dgts)

Maximum Open Circuit Voltage: 2.8V

Diode Test
Measures forward voltage drop of a semiconductor junction in mV test current of 1.5mA Max.

ohFE Test
Measures transistor hFE.
Frequency Range: 45Hz-450Hz
Maximum Allowable Input: 750V rms
Response: Average Responding, Calibrated in rms of a Sine Wave.

AC Voltage (ACV)

Range:	Resolution:	Accuracy:
200V	100mV	±(1.2%rdg+10dgts)
750V	1V	

CAT NO	DESCRIPTION	PRICE
9300G	Rugged High Quality DMM with Rubber Boot	$19.00

Special Offer!

The next generation of Digital Multimeters with 3-3/4 digits, 4000 count, auto-ranging and analog bargraph, 10MHz frequency counter, True RMS mode and RS-232C interface. **LIMITED TIME OFFER! You MUST enter your order by December 31st, 1997 to receive this special price!** Regular C.S.I. price $169.00. ***Plus we'll even include the optional temperature adaptor and K-type thermocouple probe! We even include the holster!***

CAT NO	DESCRIPTION	PRICE
PROTEK506	Digital Multimeter	$139.00

Developer

This product is used as the developer on our positive photo-resist printed circuit boards. Includes instructions. 50 gram package, mixes with water, makes 1 quart.

CAT NO	DESCRIPTION	PRICE EACH 1	10	25
POSDEV	Positive Developer	$ .95	$ .80	$ .50

Etching Chemicals/Ferric Chloride

A dry concentrate that mixes with water to make 1 pint of etchant, enough to etch 400 sq. inches of 1oz board.

CAT NO	DESCRIPTION	PRICE EACH 1	5
ER-3	Makes 1 pint	$3.50	$2.75

Positive Photo Resist Pre-Sensitized Printed Circuit Boards

These pre-sensitized printed circuit boards are ideal for small production runs. They provide high resolution and excellent line width control. High sensitive positive resist coated on 1oz. copper foil allows you to go direct from your computer plot or art work layout. No need to reverse art.

Single-Sided, 1oz. Copper Foil on Paper Phenolic Substrate

CAT NO	DESCRIPTION	PRICE EACH 1	10	50
PP101	100mm x 150mm/3.91" x 5.91"	$2.55	$1.90	$1.70
PP114	114mm x 165mm/4.6" x 6.6"	2.98	2.45	1.98
PP152	150mm x 250mm/5.91" x 9.84"	5.40	3.98	3.60
PP153	150mm x 300mm/5.91" x 11.81"	6.15	4.48	4.10
PP1212	305mm x 305mm/12" x 12"	12.78	10.65	8.52

Single-Sided, 1oz. Copper Foil on Fiberglass Substrate

CAT NO	DESCRIPTION	PRICE EACH 1	10	50
GS101	100mm x 150mm/3.91" x 5.91"	$ 3.90	$2.98	$2.60
GS114	114mm x 165mm/4.6" x 6.6"	4.80	3.49	3.20
GS152	150mm x 250mm/5.91" x 9.84"	8.69	5.98	5.78
GS153	150mm x 300mm/5.91" x 11.81"	10.20	7.20	6.80
GS1212	305mm x 305mm/12" x 12"	18.88	15.73	12.59

Double-Sided, 1oz. Copper Foil on Fiberglass Substrate

CAT NO	DESCRIPTION	PRICE EACH 1	10	50
GD101	100mm x 150mm/3.91" x 5.91"	$ 5.07	$3.68	$3.38
GD114	114mm x 165mm/4.6" x 6.6"	5.95	4.29	3.99
GD152	150mm x 250mm/5.91" x 9.84"	10.47	7.39	6.98
GD153	150mm x 300mm/5.91" x 11.81"	11.95	8.69	8.30
GD1212	305mm x 305mm/12" x 12"	22.09	18.35	14.68

Etching Tank

This handy etching system will handle PC boards up to 8" x 9", two at a time. Ideal for etching your PCB's! System includes an air pump for etchant agitation, a thermostatically controlled heater for keeping etchant at optimum temperature and a tank that holds 1.35 gallons of etchant. A tight fitting lid is also supplied to prevent evaporation when system is not being used. Typical etching time is reduced to 4 minutes on 1oz. copper board!

REDUCES ETCHING TIME!

CAT NO	DESCRIPTION	PRICE
12-700	Etch Tank System	$37.95

1/3" CCD Board Cameras

Available with **PINHOLE LENS** with **AUDIO**; **STANDARD LENS** with **AUDIO**; and **STANDARD LENS** with **INFRA-RED**. These are the world's smallest commercially available CCD board cameras!

World's Smallest B&W Board Cameras

Specifications

Image Pick-Up Device	1/3" CCD area Sensor
Picture Elements	EIA=512(H) x 492(V)
Pixel Pitch	EIA=9.6UM (H) x 7.5UM (V)
Scanning System	2 : 1 Interlace
Scanning Frequency	EIA=525 lines, 60 field/sec (II) 15.750 KHz x 60 HK
Resolution	430 Lines
Minimum Illumination	0.03 LUX
S/N Ratio	45DB
Lens Mounting	4.3mm standard, 5mm pinhole
Video Output	1.0 VP-P/750OHM composite signal
Power Requirement	8-12 VDC (9VDC standard)
Power Consumption	100mA
Operating Temperature	-20C -+ 70 C RH 95% Max
Storage Temperature	-40C -= 85 C RH 95% Max
Audio Pick-Up Sensitivity	-60 DB (0DB = 1B/UBAR, 1KNZ)
Audio Frequency Range	20 Hz to 20KHz
Audio S/N Ratio	More than 35DB
Audio Output Level	1VP-P/600 OHM

WDP-2000

WDS-2005

WDI-4000

Dimensions

WDP-2000	30mm (H) x 30mm (W)
WDS-2005	30mm (H) x 30mm (W)
WDI-4000	44mm (H) x 30mm (W)

CAT NO	DESCRIPTION	PRICE EACH 1	5
WDP-2000	1/3" B&W Pinhole Lens with Audio	$89.00	$77.00
WDS-2005	1/3" B&W Standard Lens with Audio	89.00	77.00
WDI-4000	1/3" B&W Infra-RED (no audio)	89.00	77.00
WDPH-55BW	Plastic Housing Option for B&W Board Cameras	13.00	12.00

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NEW XK-700 Digital / Analog Trainer

Elenco's newest advanced designed Digital / Analog Trainer is specially designed for school projects. It is built on a single PC board for maximum reliability. It includes 5 built-in power supplies, a function generator with continuously sine, triangular and square waveforms and a 1560 tie point bredboard area. Tools and meter shown optional. (Mounted in a professional tool case made of reinforced metal).

XK-700 Assembled and Tested
$189.95

XK-700 - SEMI KIT w/ Fully Assembled PC Board
$174.95

XK-700K - Kit
$159.95

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Volt Alert™ By FLUKE

Volt Alert™ is the new pocket-sized AC line voltage detector from Fluke. Easy to use - just touch the tip to an outlet or cord. When it glows red, you know there's voltage in the line.
Electrician's, maintenance, service, and safety personel can quickly test for energized circuits and defective grounds on the factory floor, in the shop, or at home.

- Fits in shirt pocket for convenience.
- All outer surfaces are unconductive for safety.

Detects voltage metallic contact.

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DIGITAL LCR METER
Model LCR-1810 NEW

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- Inductance 1µH to 20H
- Resistance .01Ω to 2000MΩ
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20MHz Sweep / Function Generator with Freq Counter
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- 0.2Hz to 20MHz
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Model M-6100

The M-6100 is Elenco's most sophisticated meter with almost every possible feature available. The M-6100 even has a computer interface for viewing and storing data on a personal computer. It comes complete with software, RS-232 cable, test leads and manual.

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Model XP-581

4 Fully Regulated DC Power Supplies in One Unit
4 DC voltages: 3 fixed - +5V @ 3A, +12V @ 1A, -12V @ 1A
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Model SF-100A

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Digital Multimeter
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For high-performance digital multimeters that are accurate, reliable, and rugged, the DMM900 Series extends the Tektronix line of already affordable DMMs. Twice the accuracy. Up to 10 times the resolution. And a full range of capability that spans voltage, current, digital multimeters features a dual numeric display, 3-year warranty, and autoranging capability. All backed by the reliability of the Tektronix brand.

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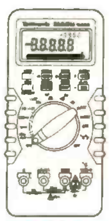
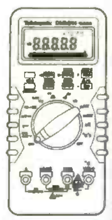
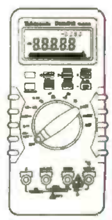
- Resistance Ranges from 400Ω to 40MΩ
- Capacitance Ranges from 4nF to 40µF
- Frequency Ranges from 400Hz to 2MHz
- Temperature Measurements from -50°C to +980°C (DMM916, DMM914)
- 3 Year Warranty
- CE Marking



DMM 912 $189



DMM 914 $235



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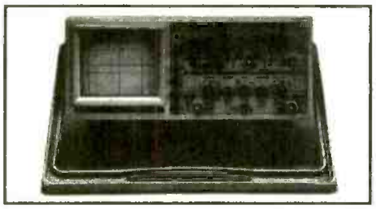

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Tektronix 475A	250 MHz	$899.00

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Does your Desoldering Tool really SUCK?

If not, try one of my two favorites.

I have attended many trade shows worldwide in the last few years and these are the top two Desoldering Tools that I have found. You have probably seen the testimonials on the **DEN-ON SC-7000Z** in the last several issues. If you wish to see a copy or referrals from technicians in your state, call toll free and we will fax it to you immediately.

Sale Price $395.00

New Features and Specifications

- Totally Self Contained diaphragm vacuum pump and AC motor (In the handle) for high vacuum suction or reversible hot air blow for SMD removal.
- 100Watt Ceramic heater with zero-crossover switching heater control circuit which prevents spikes and leakage currents.
- Unique patented long lasting filter cartridge design. Solder builds up on easily cleaned baffle, while air flows around the outside of baffle.
- Totally ESD Safe. The housing contains carbon and the tip is at ground potential for complete ESD Protection.
- Maximum vacuum of 650mmHg is attained in 100 milliseconds.
- Temperature adjustable from 300°C - 500°C (572°F - 932°F).

Voltage	AC100v,120V,230V,50/60HZ
Power Consumption	120W
Pump	Diaphragm Type
Motor Output	2W
Vacuum Attained	650mmHg
Temperature Range	300°C—500°C (572°F—932°F)
Air Flow Rate	15 Liter/Minute (Open)
Heater	100W (Ceramic)
Control System	Feed Back Zero Cross-over Type
Net Weight	420Grams

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EDSYN has redesigned and improved their most popular ZD500 SOLDA-PULLT Hot Tip Self-Contained Desoldering Station and renamed it the ZD500DX .

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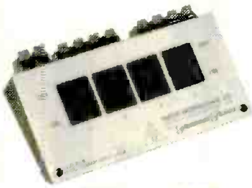

Control up to 4 pairs of speakers with this compact speaker selector switch. Features circuit protector, heavy duty rocker switches, spring loaded terminals, and silver plated switch connectors. Includes one pair of amplifier inputs. Load to amplifier is minimum 4 ohms (with 8 ohm speakers) or 220 ohms with all speakers switched off. Net weight: 1 lb.

	WAS	NOW
#EN-309-030	$22.50 EACH	$15.00 EACH

Peak Instrument Co.

"The Woofer Tester"

Peak Instrument Co. proudly introduces "The Woofer Tester". Just ask any loudspeaker engineer, and they will tell that the only way to design enclosures of the correct size and tuning is to measure the Thiele-Small parameters for the actual drivers to be used. The reason? Manufacturers published specs can be off by as much as 50%! But until now, measuring the parameters yourself required expensive test equipment and tedious calculations, or super expensive measurement systems ($1,200 to $20,000). The Woofer Tester changes all that. Finally, a cost effective, yet extremely accurate way to derive Thiele-Small parameters, in only minutes! The Woofer Tester is a combination hardware and software system that will run on any IBM compatible computer that has EGA or better graphics capability and an RS232 serial port. The Woofer Tester will generate the following parameters. Raw driver data: Fs, Qms, Qes, Qts, Vas, BL, Re, Le, SPL @ 1W/1m, Mmd, Cm, and Rm. Sealed box data: Fsb and system Q. Vented box data: Fsb, ha, alpha, and Q loss. The Woofer Tester system includes hardware, test leads, serial cable, AC wall adaptor, detailed instructions, and software.

#EN-390-800 .... $249.00 EACH

"The Sound Bridge" FM Stereo Wireless Transmitter

HOT NEW ITEM!

The Sound Bridge is a mini FM wireless transmitter that can be used to broadcast stereo sound from any audio source like portable CD players, TVs, electronic games, CD-ROM, even computer soundcards, to your home stereo receiver! Adjustable from 89 to 95.5 MHz.

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900 MHz Wireless Speaker System

- ◆ 900 MHz technology sends signal up to 180 ft., through walls, floors and ceilings.
- ◆ Ideal for use as rear surround speakers or for adding wireless sound to every room in the house!
- ◆ Full range, bass reflex design with built-in high power, low distortion amplifier.
- ◆ Weather resistant cabinet for outdoor use.
- ◆ Selectable battery (six C size for each speaker) or AC operation, adaptor included. Built-in recharging circuitry for ni-cad batteries.
- ◆ System includes: 900 MHz transmitter, wireless speaker pair, AC adaptors, and all cables necessary to hook up system.
- ◆ Limited availability. ◆ Net weight: 9 lbs.
- ◆ Frequency response: 20-18KHz.

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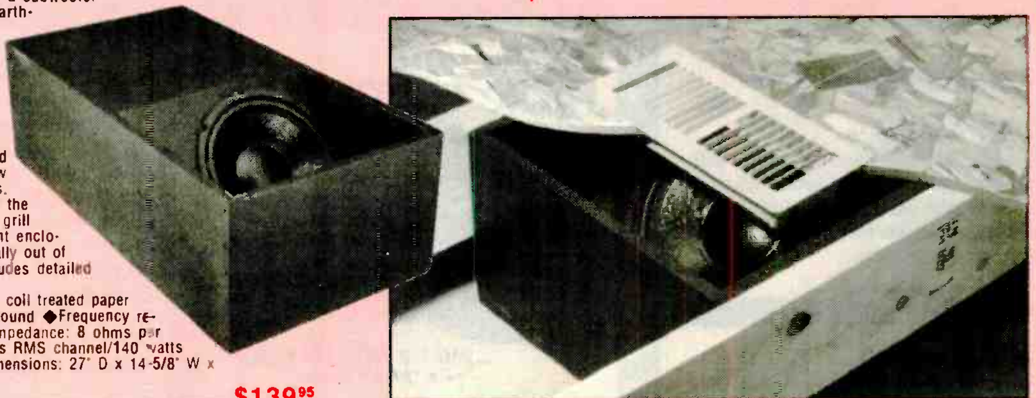
Perfect for a variety of electronic soldering work, this top quality iron features a long life, double coated tip and a quick change, plug-in heater element. Lightweight handle includes a comfortable cushioned grip. Net weight: 1/2 lb.

#EN-372-110 (25 Watt)	$30.90 (1-3)	$28.50 (4-UP)
#EN-372-112 (35 Watt)	$38.90 (1-3)	$34.95 (4-UP)

Home Theatre In-Floor Subwoofer

Dayton Loudspeaker Co.®

To fully appreciate the potential of movie soundtracks, a dual voice coil subwoofer is a must! Many film special effects are extremely demanding in the low frequency range and require a subwoofer that can duplicate explosions, earthquakes, even the footsteps of Tyrannosaurus Rex! This subwoofer fits the bill by featuring a 10" dual voice coil woofer for true stereo operation and high pass filters for your main speakers. The most unique feature of this subwoofer is the fact that it is designed to be mounted in between the floor joists in new and existing home constructions. Simply mount the in-floor sub to the joists and mount a heat register grill above opening in subwoofer front enclosure. The subwoofer is now totally out of view and ready to rumble! Includes detailed installation manual.



Specifications: 10" dual voice coil treated paper cone woofer with poly foam surround ◆Frequency response: 30-100 Hz ◆Nominal impedance: 8 ohms per coil ◆Power handling: 100 watts RMS channel/140 watts max ◆SPL: 89 dB 1W/1m ◆Dimensions: 27" D x 14-5/8" W x 9" H ◆Net weight: 29 lbs.

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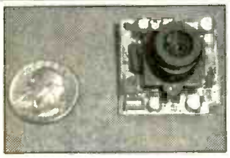
C-2000 Video Transmitter Cube..................................$89.95
C-3000 Video and Audio Transmitter Cube................$149.95

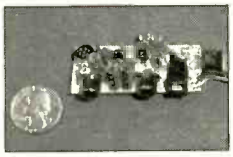


CCD Video Cameras

If you're looking for a good quality CCD board camera, stop right here! Our cameras use top quality Japanese Class 'A' CCD arrays, not the off-spec arrays that are found on many other cameras. You see, the Japanese suppliers grade the CCDs at manufacture and some manufacturers end up with the off-grade chips due to either cost constraints or lack of buying 'clout'. These cameras have nice clean fields and excellent light sensitivity, you'll really see the difference, and if you want to see in the dark, these are super IR (Infra-Red) sensitive! Available with Wide-angle (80°) or super slim Pin-hole style lens. Both run on 9 VDC and produce standard 1 volt p-p video. Add one of our transmitter units for wireless transmission to any TV set, or add our Interface board (below) for Audio sound pick-up and direct wire connection to any Video monitor or TV video/audio input jacks. Fully assembled.

CCDWA-2 CCD Camera, wide-angle lens.....................$99.95
CCDPH-2 CCD Camera, slim fit pin-hole lens.............$99.95

CCD Camera Interface Board



Here's a nifty little kit that eases hook-up of your CCD camera module to any video monitor, VCR or video input TV set. The board provides a voltage regulated and filtered source to power the camera (CCD Cameras require a stable source of power for best operation), sensitive electret condensor mike for great sound pick-up and RCA Phono jacks for both audio and video outputs. Runs on 11 - 20 VDC.

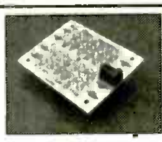
IB-1 Interface Board Kit...$14.95

Budget TV Transmitter

Transmit audio and video to any TV set with this fully assembled transmitter. Although not tiny, it still offers some neat features. Takes standard 1 volt p-p video and audio and transmits on any UHF TV channel of your choice from 17 - 42. Has rugged metal case, includes AC adapter, whip antenna and even RCA phono plug patch cords! Can also run on 12 VDC.

VS-2 Video and Audio Sender, Fully Assembled.........$29.95

IR Illuminator for CCD Cameras



See in total darkness with one of our CCD video cameras and this IR illuminator! IR light can't be seen, illuminate the scene with IR and a CCD camera 'sees' just fine. The array of 24 extra high intensity LEDs are invisible to anybody - except for aliens and Casper! Runs on 12 VDC. Illuminates similar to that of a bright flashlight.

IR-1 IR Illuminator Kit...$24.95

MicroEye CCD Camera & Transmitter Combo

We married together one of our quality CCD cameras, a sensitive electret microphone and a small TV transmitter to give you a super neat - and tiny - all in one, 'knows all, sees all, hears all' package! Small enough to fit into a cigarette pack and powerful enough to transmit up to 150' to any standard TV set. Tunable to operate on TV channels 4, 5, or 6 and runs on 9 to 20 VDC. The sensitive mike picks up normal voice within an average size room. Ideal for private detectives, investigators, hobbyists, babysitters, model rocketeers, RC airplanes and other uses limited only by your imagination. Camera module is fully wired and the transmitter unit is an easy to build kit that goes together in an evening. Includes all parts, handsome jet-black case and clear, concise instructions with ideas for use. And, don't forget, our CCD cameras are very sensitive to IR light - just add the IR-1 IR Illuminator kit for see-in-the-dark operation!

ME-2000 MicroEye TV Transmitter Combo $149.95

Wavecom Wireless Video and Audio Transmission System

Transmit extremely clean and sharp video and audio up to 300 feet. Wavecom transmits in the 2.4 GHz band using FM and circular polarization for state-of-the-art transmission. There is no fading, ghosting, humming, buzzing or picture rolling when using the Wavecom. System consists of two parts, a transmitter unit and a receiver unit. Switch selectable 4 channel operation allows use of multiple Wavecoms in the same geographic area. Connections are video and audio in and out using standard RCA phono jacks. Includes AC wall plug adapters, patch cords, coax cable jumper, TV antenna A/B switch and complete hook-up instructions. Fully assembled with one year warranty.

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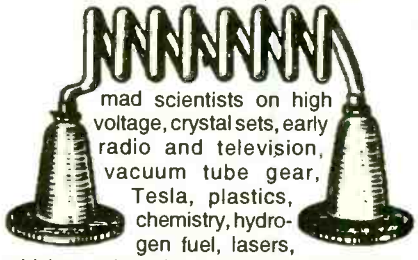

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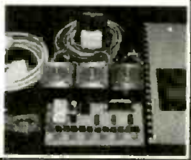

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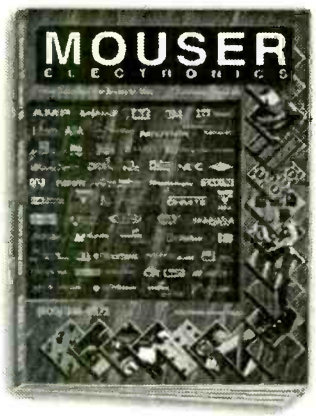

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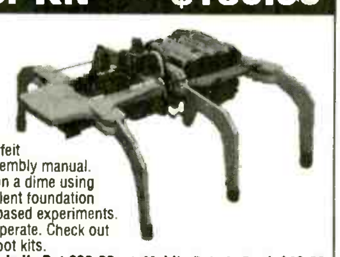

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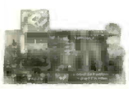
TY-25 ▲



Super fast acting relay protects speakers against destructive DC voltages. Can connect directly to a power amplifier or can use a separate power supply. Has a 3 second turn-on delay to avoid turn-on thumps.

Kit: $ 16.75

Regulated DC Power Supply

TR-503 ▲▲

It is short circuit proof and has overload protection. Output voltage is variable over a range of 0-50 volts. Current limit trip is adjustable up to max of 3A. May use Mark V #002 transformer.

Kit: $ 18.75

Fluorescent Light Driver

TY-2 ▲ (1 lb.)

This unit drives 6-40 watts fluorescent light for portable and emergency use. Works from a 7.2 - 16 VDC battery. Includes a "Hi-Efficiency Switching Mode IC Driving Circuit" suitable for use with different lights.

Kit:$ 14.75

120-250W Mosfet Power Mono Amplifier AF-2 (6 lbs.) ▲▲

Power Output: 250W into 4 ohms RMS(42VX2 6A transformer is used). 120W into 4 ohms RMS(33VX2 4A transformer is used). Frequency Response: 3Hz-22,000Hz. THD: <0.03%. Signal to Noise Ratio: 91dB. Sensitivity: 1V RMS at 47k. Load Impedance: 4 or 8 ohms. Power Requirement: ±46VDC 4A or ±60VDC 6A. May use Mark V model 012 Transformer. Suggested Capacitor 8,200uf 100V Model 020. Suggested Metal Cabinet LG-1925.

Kit: $ ~~89.80~~ 82.80 Asmb.$ 114.80

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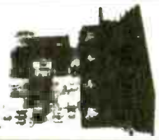
300W High Power Mono Amplifier TA-3600 (5 lbs.) ▲▲▲



Power Output: 300W into 8 ohms RMS. 540W music power into 8 ohms. Frequency Response: 10Hz-20KHz. THD: < 0.05%. Sensitivity: 1V RMS at 47K. Power Requirement: 60 to 75 VDC at 8A. May use Mark V Model 007 or 009 Transformer. Suggested Capacitor: 8,200uf 100V Model 020 Capacitor. Suggested Metal Cabinet LG-1925.

Kit ~~89.00~~ 82.00
Asmb.$ 115.00

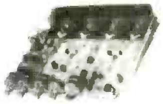
150MHz 8 Digit Frequency Counter

SM-100 (2 lbs.)

It is used for adjustment, test & repair of any kind of high frequency circuit products. It can give up to 8 digit of resolution for a wide frequency range 10Hz - 150 MHz. The last input frequency can HOLD on the display for future reference & comparison. The circuit structure is compact & reliable for the most updated A/D LSI circuitry. The input impedance is 1M ohm.

Kit:$ ~~79.00~~ 68.00
Asmb.$ 99.00

120W + 120W Pre & Main Stereo Amplifier TA-800MK2 (4 lbs.) ▲▲



Power Output: 120W into 4 ohms RMS. 72W into 8 ohms RMS. Frequency Response: 10 - 20 KHZ. THD: < 0.01%. Tone Control: Bass ±12dB, Mid ±8dB, Treble ±8dB. Sensitivity: Phono Input, 3mV into 47K. Line, 0.3V into 47K. Signal to Noise Ratio: 86dB. Power Requirement: 40V DC @ 6A. May use Mark V Model 001 or 008 Transformer. Suggested Metal Cabinet Model LG-1924.

Kit $ 67.92 Asmb.$ 86.95

80W + 80W Pure DC Stereo Main Power Amplifier TA-802 (4 lbs.) ▲▲

Power Output: 80W per channel into 8 ohms. THD: < 0.05%. Frequency Response: DC to 200 KHZ, -0 dB, -3dB @ 1W. Power Requirement: 30V AC X 2 @ 6A. May use Mark V Model 001 or 008 Transformer. Suggested Capacitor 8,200uf 50V Model 017. Suggested Metal Cabinet LG-1924

Kit: $ 49.94
Asmb.$ 69.94

60+60W Stereo Power Amp. ▲▲

SM-302 (11 lbs.)

It provides 3 input jack pairs. One pair accept a high impedance micro-phone. The two remaining pairs are for high & low level input sources. Power Output: 60W per channel into 4 ohms RMS. 20Hz-20KHz. THD:<0.1%. Input Sensitivity :Mic /Guitar 10mV, Hi 380mV, Lo 640mV. Ready to plug in when assembled.

Kit:$ 85.00

30W + 30W Pre & Main Stereo Amplifier TA-323A (1 lb.) ▲

Power Output: 30W into 8 ohms RMS per channel. THD: < 0.1% from 100 HZ to 10 KHZ. Sensitivity: Phono 3mV @ 47K. Tuner, Tape 130mV @47K. Signal to Noise ratio: 80dB. Power Requirement: 22 to 36V AC, 3A. May use Mark V Model 002 Transformer. Suggested Cabinet LG-1684.

Kit: $ 32.50 Asmb.$ 50.50

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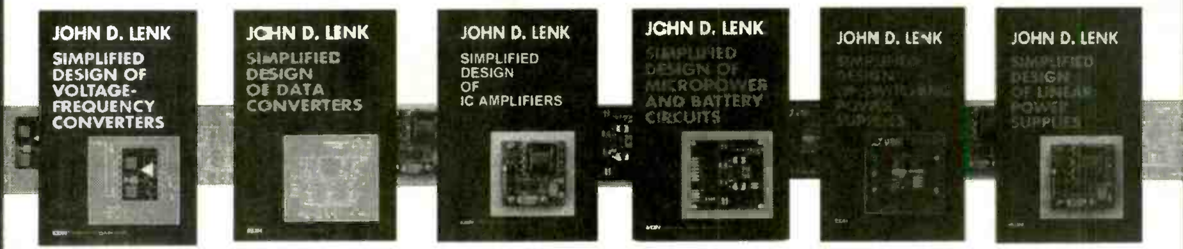
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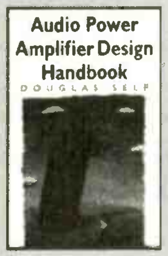
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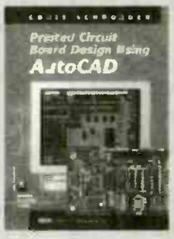
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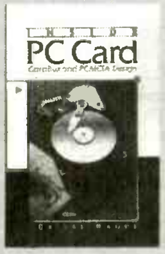
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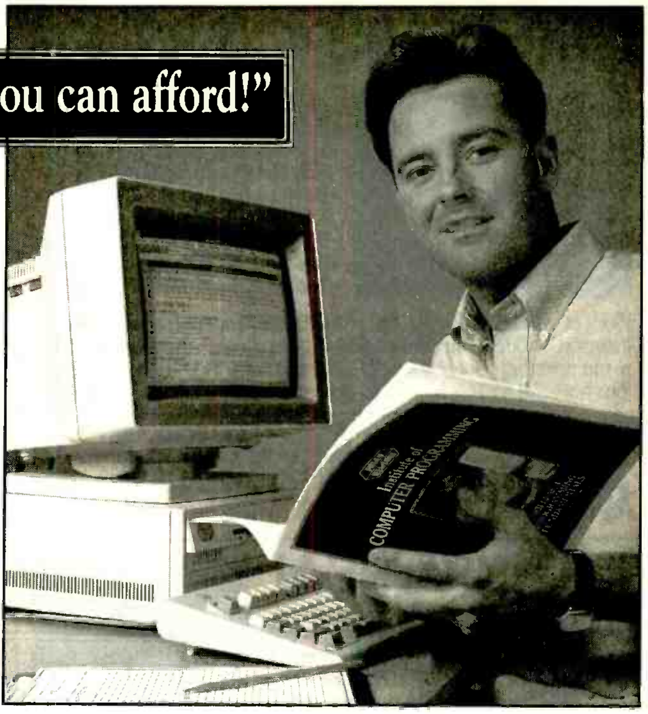

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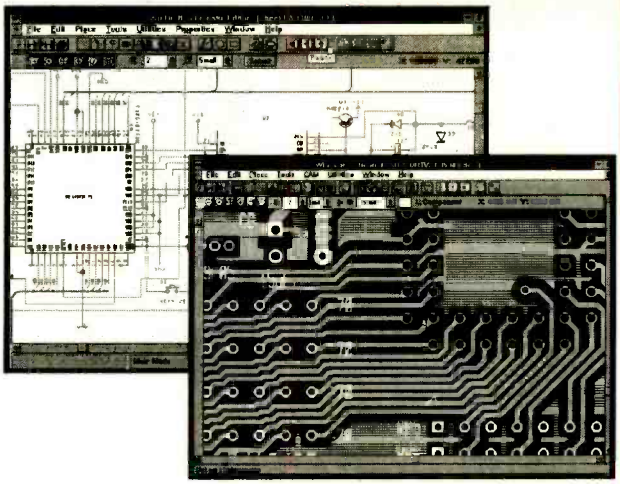

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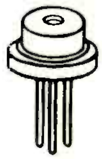

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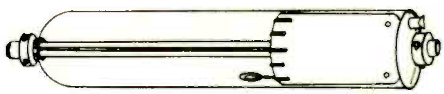

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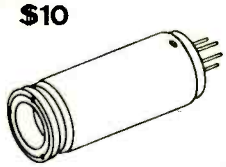

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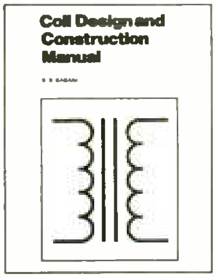

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