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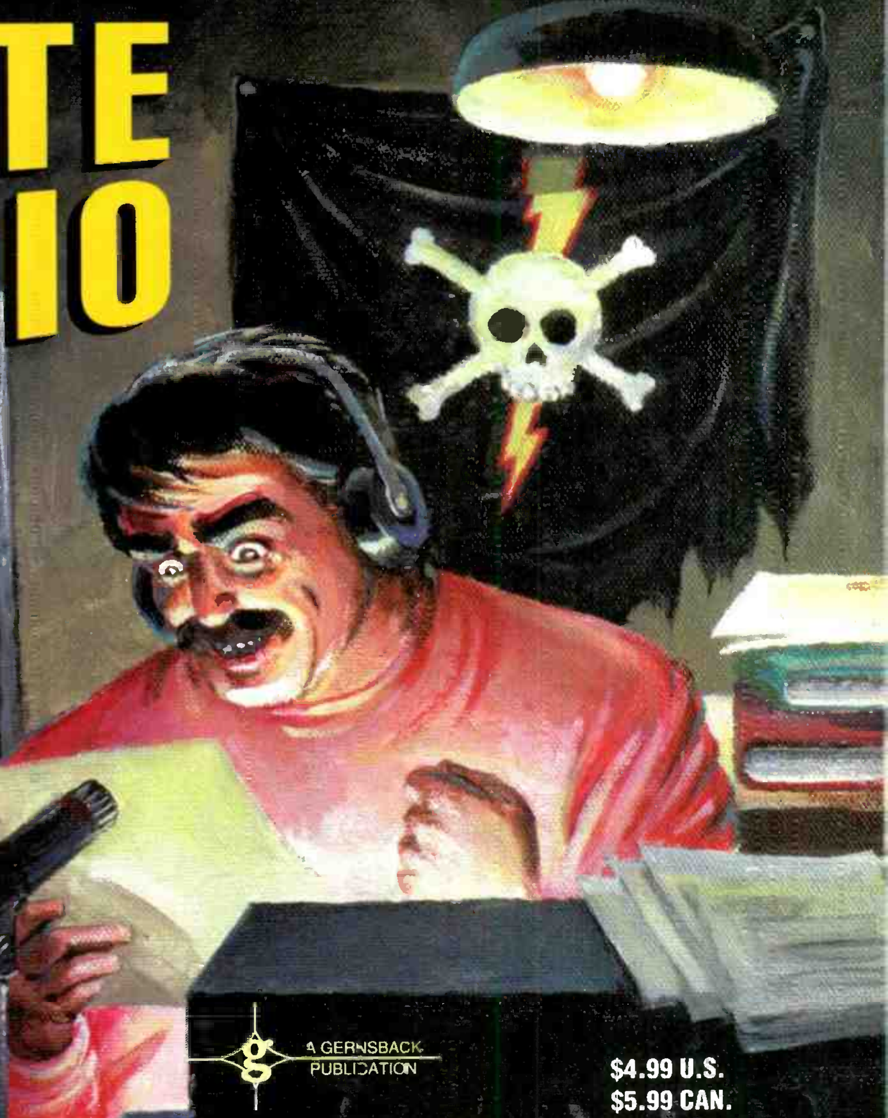

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JUNE 1999

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# EDITORIAL

## Fips Lives!

As most readers of **Electronics Now** know, our parent company, Gernsback Publications, was founded by the legendary Hugo Gernsback. Hugo was an inventor, and innovator, a force in the electronics industry, and was the first to publish electronics magazines. He also was a man with an incredible sense of humor. One expression of that sense of humor was a series of articles published most Aprils under the pseudonym "Mohammed Ulysses Fips."

The Fips' stories, which first appeared in the 1930s, were clearly fictitious, with numerous technical giveaways scattered throughout, and they always ended with the words April 1, April First, or April Fools. Yet they were cleverly crafted, with just enough of an air of believability that some would miss the fact that it was a joke completely and either tried to build the described device or contacted the magazine to get more information. **Radio Craft** and **Radio-Electronics** magazines (this magazine's predecessors) would often get piles of mail from irate readers who "fell for the gag." A booklet, *The Collected Works of Mohammed Ulysses Fips*, remains a popular item in our Reprint Bookstore.

Though we lost Hugo many years ago (he passed away in the late 1960s), we've tried to keep some of the values and traditions of his magazines going as best we could. One of those traditions was the April Fools' articles. The sad fact is, however, there are few writers who could spin a parody article with Hugo's flair. Some of the articles worked; more didn't. In the last several years, we've only done a handful of the April Fools' stories (sometimes nothing more than a fictitious product announcement) between the two magazines we publish (**Electronics Now** and **Popular Electronics**). The reason was simply a lack of suitable material.

Then, lo and behold, a gem appeared. It was "The EC909-12 Analog Microprocessor" by Ken Kemski (April 1999). When we saw the piece, we knew it was perfect. Unfortunately, we did not fully realize how perfect!

Let's just say that the spirit of Fips has been reborn—with a vengeance! While most saw through the gag, and we got some really funny reader responses in reaction, more than a few fell for it completely. We really felt there were enough big, red, technological stop signs in this story that everyone would realize it was a put-on by the end, but it seems that many were so caught up in the incredible (and we do mean incredible!) advances that this fictitious processor promised that they ran right through all of them. We have been deluged by those looking for more information. Fortunately, most took it well when they realized they'd been had. A few weren't as forgiving, and we do sincerely regret any discomfort we caused anyone.

Oh, and by the way, there were also a couple of "suspect" items in April's "Prototype" section.

A cross section of reader reaction to the story appears in this month's "Letters" column. Our only problem is what will we do for an encore?

Carl Laron

Carl Laron
Editor

# Q & A

READERS' QUESTIONS, EDITORS' ANSWERS

CONDUCTED BY MICHAEL A. COVINGTON, N4TMI

## Gently Falling Frequency

**Q** *I need a design for an oscillator circuit, preferably 555-based, that will start out at approximately 500 Hz and decay to 0 Hz over a period of eight to ten seconds while maintaining an amplitude high enough to drive other digital ICs. Any help you could give would be greatly appreciated.—J. A. S., Smyrna, GA*

**A** This is not easy to do with a 555 (I won't say impossible, because next month I'll probably hear from someone who has done it!). Figure 1 shows how to do it with an LM331N voltage-controlled oscillator. The frequency of oscillation is set by R3, C4, and the control voltage at pin 7. When you apply power, C1 and C2 charge, with most of the voltage ending up on C1; pin 7 reaches about 1 volt and the oscillator runs at 500 Hz. Immediately, C2 starts discharging through R1, and the frequency drops over a period of several seconds, until oscillation stops completely with the output high (+5V). Connected to a speaker, this gives a nice "Eeeeeeeeuuuuwwww...pop...pop...pop" sound effect, and it's fully compatible with TTL and CMOS logic circuits. If you're not driving logic chips, the supply voltage doesn't have to be exactly 5 volts.

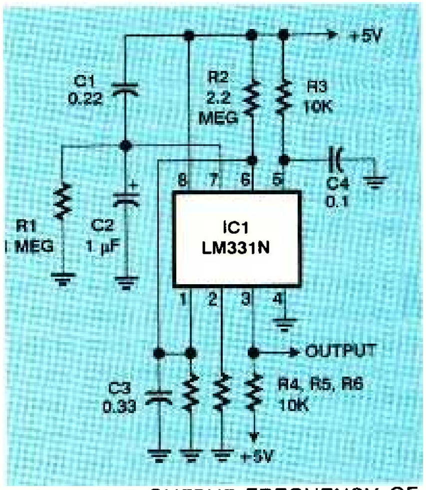


**FIG. 1—THE OUTPUT FREQUENCY OF** this oscillator falls from 500 Hz to 0 Hz, reaching a steady +5 volts after several seconds.

The purpose of R2, which you won't find in most LM331N circuits, is to bias the voltage-controlled oscillator slightly so that the oscillation will definitely stop when the input voltage falls to zero, rather than continuing at a very low frequency. Resistor R6 is the pull-up resistor for the open-collector outputs. For the functions of the other components, see the LM331N data sheet (available online at www.nsc.com).

Another way to get a falling frequency is to program a microcontroller to toggle an output bit at a steadily decreasing rate. Figure 2 shows *pseudocode* (an English-like outline of a computer program) indicating how this might be done. We'd appreciate feedback from readers as to whether pseudocode is a good way of documenting microcontroller software; the actual assembly code would be much longer and harder to read and would apply to only one type of CPU.

The key idea is to delay N milliseconds between output transitions, where N is a steadily increasing number, and then stop altogether when N gets high enough. As shown, the program takes 10 seconds to stop, but the frequency decrease is nonlinear; the frequency drops very rapidly at first, then slowly trails off. Instead of just adding 2 to N each time, you might want to compute something like:

If N>8 then N:=N/8 else N:=N+1

so that the increase in N is proportional to N itself. Note that N/8 is easy to compute in binary; all you do is shift the number 3 bits to the right. However, if you start with a number less than 8, you get zero, and in that situation, it's necessary to add 1 rather than 0, or N will never change and you'll be stuck. Or you can compute a more complicated function and make the frequency fall exactly the way you want. You could even use a memory lookup table for a series of steadily increasing time delays.

```
   N := 1;
A: Delay N milliseconds;
   Toggle output bit;
   N := N + 2;
   If N < 200 then go to A;
   Stop.
```

**FIG. 2—HERE'S THE PSUEDOCODE** for a microprocessor program to generate a signal whose frequency gradually falls to zero.

Since it only needs one output pin, this application might be a good job for one of the new low-cost 8-pin PIC microcontrollers (PIC12C508 and the like). Microchip Technology has just announced an 8-pin PIC with an on-board voltage regulator so that it doesn't need a 5-volt supply. Information is available online from www.microchip.com or by writing to Microchip Technology, Inc., 2355 W. Chandler Blvd., Chandler, AZ 85224.

## Mystery Outlet

**Q** *I have a digital electric alarm clock that began gaining time. I wrote it off to a lightning hit we took a few weeks ago and bought a new one. I plugged it in and it, too, ran about 25% fast. I then plugged both clocks into other outlets in the same room and they both are working correctly. I am completely baffled. Do you have any ideas?—R. E. S., Watkinsville, GA*

**A** Two words: *electrical noise.* As shown in Fig. 3, a line-powered digital clock keeps time by counting cycles of the 60-Hz AC power. (This is normally more

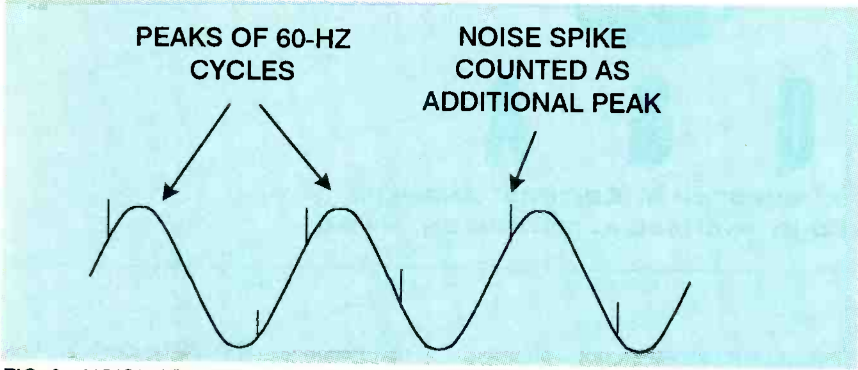

**FIG. 3**—NOISE SPIKES in a the electrical power lines could make a digital clock run fast.

accurate than using a quartz crystal.) Apparently, your power line has some noise spikes on it that are occasionally being counted as extra cycles. This may have started when the lightning strike took out some protective capacitors or MOVs inside another appliance nearby, probably either a light dimmer or something involving an electric motor. Connecting an oscilloscope to the line through an isolation transformer would give a definite answer; you might also try unplugging appliances that might be the source of the noise.

## Cheap, Precise 0.5-Hz Oscillator

**Q** *I'm sure many people could use a cheap, $2, thrift-store pulse frequency standard. I bought a battery-powered quartz-controlled clock with an analog dial, removed the 390-ohm coil, and replaced it with a 390-ohm resistor. I got a waveform of alternating 0.7-volt pulses (Fig. 5, upper trace). Is there some way I could get all positive-going pulses?—C. R., Matthews, NC*

**A** I tried the same thing, using an old Copal analog-dial quartz clock (vintage 1980). Clocks of this kind are driven by an electromagnet (coil) that gets a pulse of current once per second, moving the analog mechanism along every time it does so. I found that I could get a stronger signal by removing the coil altogether, rather than replacing it with a resistor. I then got 1.5-volt-high pulses.

One way to convert this into logic-level pulses is shown in Fig. 4. Resistors R1 and R2 raise the baseline voltage of the signal to 2.5 V. Then it swings from +1.0 to +4.0 V instead of -1.5 to +1.5. This signal is fed into a 555 timer IC, which changes state when its input swings above 2/3 or below 1/3 of the supply voltage. The result is a 0.5-Hz square wave.

If you want one pulse per second, rather than one every two seconds, use two comparators as shown in Fig. 6. Be sure to use comparators that have open-collector outputs, not op-amps, so that the outputs can be tied together in the manner shown. This circuit is known as a

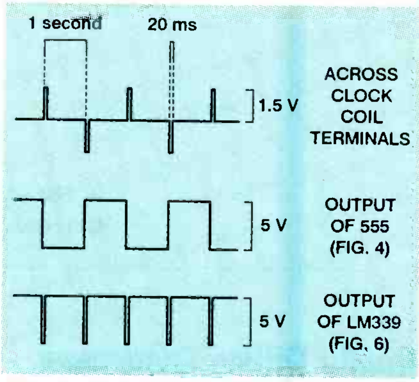

**FIG. 5**—THE UPPER TWO WAVEFORMS are taken from across the clock-coil terminals and at the output of the 555 in Fig. 4. The bottom waveform is from the output of the 555 in Fig. 6.

"window comparator"—it detects whether or not the signal voltage falls within a small "window" around 2.5 V. Specifically, whenever the voltage on pins 4 and 7 swings either higher than pin 5 or lower than pin 6, the output goes low. Thus, you get a logic-level pulse for every cycle of the clock oscillator.

## And Speaking Of Quartz Clocks...

**Q** *I would be very glad if you could identify a replacement for an IC designated HD44001; this chip is from an analog clock in an automobile. It's a 16-pin DIP with a 4914.5-kHz crystal across pins 9 and 10; pins 14 and 16 connect to a solenoid that operates the clock mechanism.—G.C.T., Sayao, Philippines*

**A** There is no HD44001 listed in the standard ECG or NTE replacement cross-reference indexes, nor even in the online IC Master (www.icmaster.com). I fear what you've run into is "house numbering"—the clock manufacturer bought a large number of chips and had them labeled with his own part number, rather than the manufacturer's standard one.

Not all ICs are available in small quantities to individuals. This isn't a general-purpose IC like op-amps, voltage regulators, or microcontrollers; nor is it part of something that is likely to be repaired on the component level, such as a TV or stereo system. Few people take their analog clocks to the repair shop. Accordingly, this chip probably isn't stocked by distributors at all; it goes straight from the chip maker to the clock maker, and that's probably who

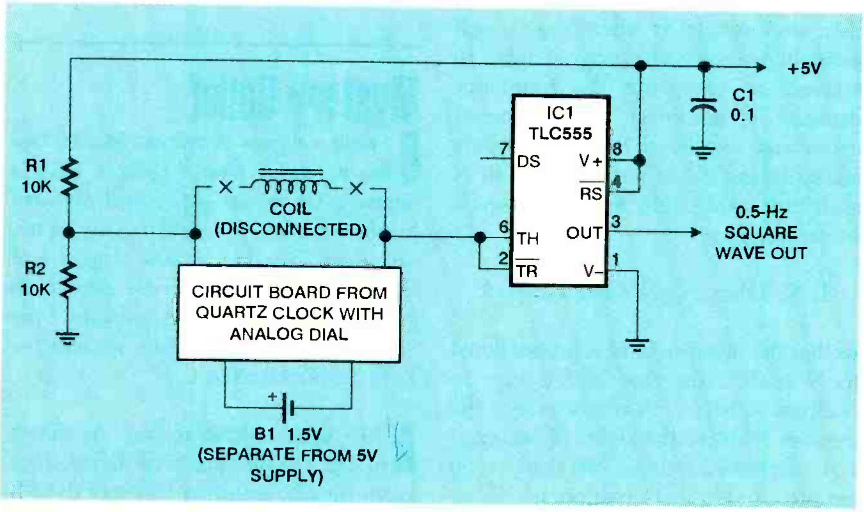

**FIG. 4**—THIS SCHMITT-TRIGGER CIRCUIT converts a standard clock circuit into a digital time base.

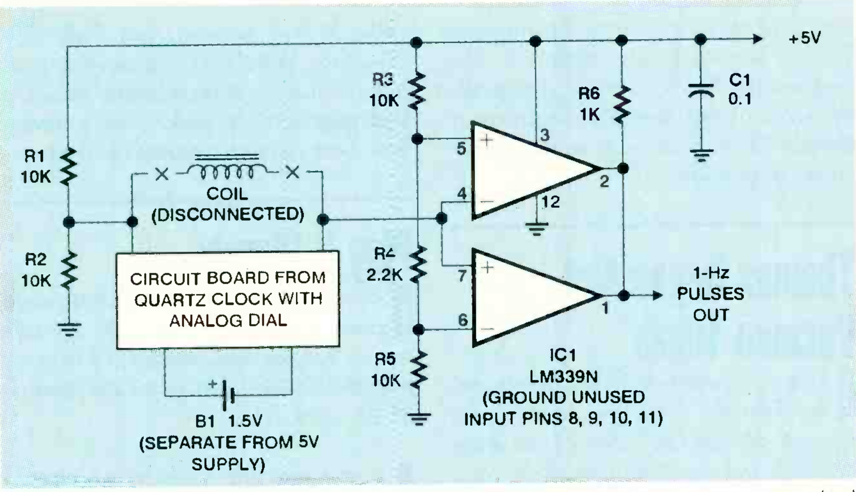


FIG. 6—THIS WINDOW COMPARATOR generates 1-Hz logic-level pulses from a standard clock circuit.

you'll have to contact to get a replacement. Or a reader may recognize it as equivalent to a chip sold under another name. Readers?

## Calling Beckman...

**Q** *I have a Beckman Industrial digital multimeter, model DM 800. It needs repair, but my letter to Beckman's address in Brea, California, was returned by the Postal Service. Can you tell me the present address?—E. B. C., Chestertown, MD*

**A** Certainly. Beckman's test equipment line has been acquired by Wavetek, Wandell & Goltermann Inc., whom you can reach at 9045 Balboa Avenue, San Diego, CA 92123, Web: www.wavetek.com; e-mail: testsupport@wavetek.com; Tel: 619-279-2200. They still make the same fine products, as well as many new ones.

A couple of years ago I accidentally fried my Beckman DM25L by connecting it to a high voltage, and to my delight, all the internal parts turned out to be replaceable—not one of them was a custom IC, and there was even a schematic in the instruction leaflet. All I had to do was put in some new op-amps, re-do the calibration, and the meter worked fine. Clearly, this instrument was designed to be repaired, a rare feature nowadays. The display and the selector switch are presumably custom items, since they could hardly be otherwise, but almost everything else is a standard industrial component.

## Checking Flybacks

**Q** *Can you tell me where I can find information about how to check a flyback transformer from a TV set?—W. R., London, Ontario, Canada*

**A** There's a web page on this very subject at www.repairfaq.org/REPAIR/F_flytest.html, which is part of a large

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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. www.questlink.com features IC data sheets and gives you the ability to buy many of the ICs in small quantities using a credit card. You can also get detailed IC information from www.icmaster.com, which is now free of charge although it formerly required a subscription.Extensive information about how to repair consumer electronic devices and computers can be found at www.repairfaq.org

**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 1994 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.

library of repair information maintained by our Service Clinic columnist, Sam Goldwasser. By coincidence, that is also the topic of this month's installment of Service Clinic, which can be found elsewhere in this issue.

## Thomas Organ And Vacuum Tubes

**Q** *I have a Thomas model AL-2 organ dating from the 1960s and need to get it repaired. Do you know where I can obtain schematic and troubleshooting advice? Also, where can I obtain a vacuum tube manual like they used to have in the past, showing the elements and pin connections of tubes?—E. C., Coventry, RI*

**A** The tube manual is easy—get in touch with Antique Electronic Supply, 6221 S. Maple Ave., Tempe, AZ 85283; Tel: 602-820-5411. They sell reprints of tube manuals as well as plenty of tubes and other old-style parts.

According to his Web page, you can get technical information, service manuals, and advice from Paul E. Doerr at ORGAN-ized Services, Inc., Tel: 609-387-2633; Web: www.organizedservices.com (no mailing address given). Read the Web page first—it's packed with information about electronic organs of all types.

## Play It Slowly

**Q** *Is there an easy way to slow a cassette tape recorder's speed down by half? My wife receives books on tape, recorded at half speed, from the National Library for the Blind.—M. M., Elko, NV*

**A** If you slow the motor down electrically, it won't have very much torque. Instead, change the size of one or more pulleys in the drive system. You can salvage a pulley from another tape recorder, find one at a hobby shop, or even reduce the size of an existing pulley by filing or grinding it.

## Minding Our Bs And Hs

**Q** *The web address for closed-caption decoding information that you gave in your October column, www.broubaba.com/..., doesn't work.—S. B., Missisauga, Ont., Canada*

**A** Well... it was the November column, not October, and the address was *brouhaha* (with one B and two H's). The full address is: www.brouhaha.com/~eric/pic/caption.html, and as of this writing it still works, although of course we have no control over it.

## Writing to Q&A

As always, we welcome your questions. The most interesting ones are answered in print. Please be sure to include plenty of background information (we'll shorten your letter for publication) and give your full name and address (we'll only print your initials). *If you are asking about a circuit, please include a complete diagram.* Due to the volume of mail, we regret that we cannot give personal replies. Send to Q&A, **Electronics Now** Magazine, 500 Bi-County Blvd., Farmingdale, NY 11735. Questions can also be e-mailed to q&a@gernsback.com, but please do not expect an immediate reply (being a monthly magazine, we have to maintain a backlog) and please don't send graphics files larger than 100K. EN

# LETTERS

SEND YOUR COMMENTS TO THE EDITORS OF ELECTRONICS NOW MAGAZINE

## Brainwave Correction

It has come to our attention that there was an error in the schematic diagram for the "Learn to Relax with a Brainwave Synchronizer" that appeared in the April 1999 issue. In Fig. 2, on page 30, a connection is shown between R1/R2/C1 and R3/R4/C2. There should not be any connection between the two nodes; C1 and R3 should not be connected together. If the unit is built according to the schematic, the oscillators will not work. The foil pattern for the PC board, on the other hand, is correct. We apologize for the error.—*Editor*

## Attenuator Series

It has come to our attention that there was an error in the schematic diagram for the "Build a Step Attenuator" that was published in the April issue. Although the text was correct in saying that the various attenuator circuits are wired in *series*, the drawing in Fig. 5 showed the circuits wired in *parallel*. A corrected schematic diagram is shown here as Fig. 1. We apologize for any confusion that arose from this error.—*Editor*

## SmartProbe Errors

It has come to our attention that there were two errors in the article "Test Digital Circuits with the SmartProbe" (**Electronics Now**, March 1999). In the "How It Works" section on page 45, column 3, the second sentence of the paragraph that begins "The SmartProbe's tip is connected to one of the inputs on each comparator," the following sentence should read "Note that two of the comparators ('a' and 'c') …"

The second error is in the schematic diagram (Fig. 1) that appears on page 46. There should not be a connection between R2 and R3. All four comparators should have their outputs connected to the printer-port inputs the same way: a signal diode and a pull-up resistor.—*Editor*

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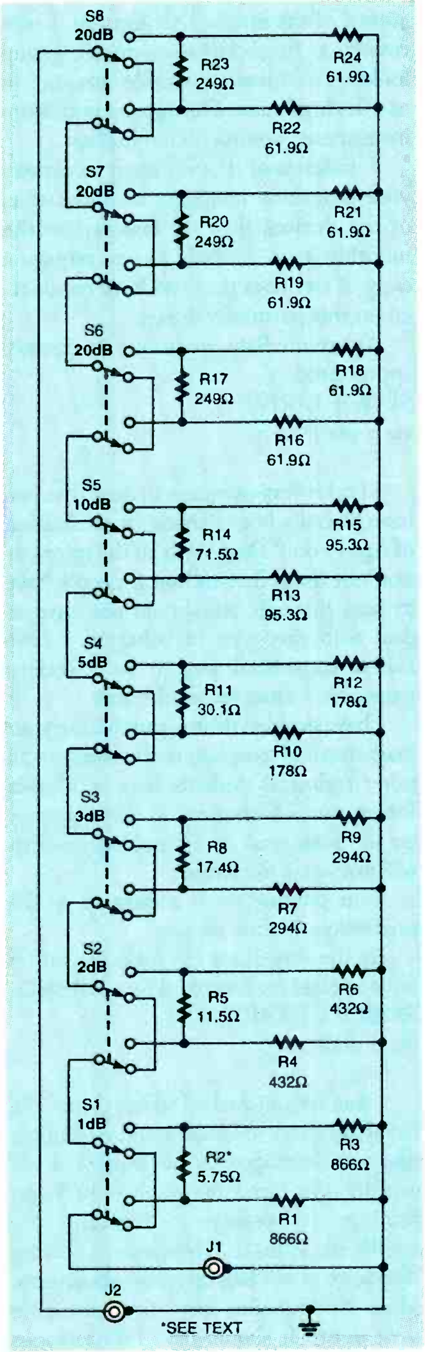


Fig. 1.

## Excellent Review

Regarding the recent excellent review of The Soundsmith's new CDT-4 Automated Audio Tester "Equipment Report" (**Electronics Now**, April 1999), we would like to make the following comments:

The CDT-4 not only tests CD Players, CD ROMs, and DVDs, but also pre-amps, amplifiers, VCRs/Camcorders, DATs/Tape Decks, Tuners, or anywhere an analog signal can go. It can also be used to test complete computer systems, including hard drives, memory and sound cards for long-term integrity.

Now available as an accessory for the CDT-4 is our modified MP3 player for use as a signal source, eliminating the need to use a "known good" CD player as the source. While the suggested user price of the CDT-4 Automated Audio Tester is $1099.95, we are pleased to continue our introductory price of $749.95 until further notice.

We welcome customer inquiries at either our Web site: www.sound-smith.com or our toll-free number: 800-942-8009.

PETER LEDERMAN, President
The Soundsmith Corporation

## April Fooled

I read the entire article "The EC909-12 Analog Microprocessor" (**Electronics Now**, April 1999) by Ken Kemski (although I stumbled over the part where it describes the amount of light output versus energy input—didn't that violate physical laws—but I wanted to believe). After all, I was excited: A microprocessor that fit into a Pentium II slot, ran at the equivalent of 900,000 MHz, allowed you to turn a 4 GB hard drive into a 16,000 GB hard drive and allow gigabytes of RAM!?!?!? Then I thought—this is too good to be true. Finally, I noticed the last sentence: "The scheduled release date is April 1." I checked out the name of the company: Ecraf ("pronounce EK-raff"); spelled backwards "farce." And I thought: YOU GOT ME!

Cheers.

STEVEN ALEXANDER
via e-mail

Nice article in your April edition about the EC909-12. I fell out of my chair laughing.

BRIAN COVERSTONE
via e-mail

Great article! I actually spent half an hour desperately searching the Internet for Ecraf Technology Corp. until I came to the slow realization that this was an April Fools' joke.

DAVID EISENBERG
via e-mail

While you people may think it funny, I just can't see the humor in your April Fools' article about the analog processor. The reason that I bought your magazine was to try and find out about this device. I feel that you owe me my money back for printing this pack of lies called informational journalism.

If this is true, please tell me where to contact this company. If this is not true, I want my money back!

JAMES SMITH
via e-mail

Could the "Ecraf" Barrier Reflex Diode possibly be a "Farce" diode spelled backwards? Barrier Reflex Diode. Can't think of a reason for that name. Apparently, no one else can either.

900 GHz speed? Will it wash my floors and do my laundry and cook my food for me too? Enough power to light a room at 1.2V and MICRO amps!!

Loved it. Great article. Nice to see SOMEONE has a sense of humor.

JACK DONOGHUE
via e-mail

I wonder how many people are going to order the analog processor that was in your magazine. I would sure like to have their names. I have some beach front lots for sale in Oklahoma, also for $12 apiece. (Same price as processor.) Thanks for the informative article.

URA FARCE
via e-mail

I was really taken by the article "The EC909-12 Analog Microprocessor" in the April issue. Can you send me any information you have about this company (Ecraf Technology Corp.) or if not I would like to get in touch with the author of the article Ken Kemski. I represent a financial investment group looking to invest a sizable amount in new technologies. Our typical minimum investments are over $500 million.

I understand that on many occasions your magazine conducts in-house tests of the devices that are featured in the monthly issue. I would like to request a copy of any tests that you have conducted on this particular device.

An immediate response is greatly appreciated.

SLOOF LIRPA
via e-mail

I find it very offensive to hear that you have placed a bogus article in celebration of April Fools' Day. With all the information out there that technical people have to scan through, we should not have to deal with this type of behavior. I have always considered you to be a serious magazine. I must reconsider that.

I have decided to stop purchasing your magazine and have sent this message to all other technical students here at Florida International University, so that they may do the same and find a publication that will not waste their time.

Your publication is a disgrace to the profession. Shame on you.

By the way, I got the joke: "Ecraf" is farce spelled backwards. How original!

ROBERT BARRUECO
via e-mail

I was very disturbed to learn that the Ecraf brothers are marketing a product that was developed by our firm. Let me explain. We hired the duplicitous Ecraf brothers as acrobats to entertain our employees at lunch. Unbeknownst to us, they were in our labs copying our designs, while we thought they were changing their tights. It should have been obvious to us that acrobats do not have to change clothing so often, but we were told that something in the water here was causing them intestinal distress, and so we allowed them free access to our facilities for over six months. Now, we find that they are attempting to pass off our EC909-12 as their own product.

The public needs to know that the dangers of the Barrier Reflex Diode (BRD) are not fully understood at this time even by our own researchers. This product has caused several cases of spontaneous combustion in our labs and would be very dangerous in the wrong hands. As to the so-called "Drs. Ecraf," please be advised that none of these men even has the US equivalent of a grammar school education, much less advanced degrees. These men are circus acrobats, good ones I have to admit, but certainly not capable of understanding or controlling the astonishing power of the EC909-12.

In addition, since it was not mentioned in your article, your readers need to be advised that further development in our labs has produced the Forward Access Time Termination Interface (FATTI) that returns the answer to the requested instruction prior to the completion of the request itself. We consider this the key to use of the EC909-12. The ability to anticipate what it is being asked to do makes it even more powerful than the best digital processors.

In the future, please get your facts straight before publishing such information. A simple phone call to the local number for Ecraf Technology is answered by a message advertising their acrobatic prowess. Please be more careful the next time you provide free publicity for such scoundrels!

ARI VIDERCI
via e-mail

I just picked up the April issue and read the article about Ecraf Technology's analog processor. BRDs? Nice April Fools' joke. You had me going for a moment, because the first time I skimmed it and missed the part about a chip lighting a city with a battery power source. Where can I get one of these?!?

BILL PFEIL
via e-mail

I finally got a chance to sit down tonight and read your April issue. The first thing that caught my eye was "Ken Kemski's" article on the EC909-12. "Wow!," I said to my wife, "They've finally done it—an analog processor that beats out the digital stuff." She laughed, knowing full well my passion for analog and my distaste for anything digital.

I must admit you really had me going for the first half of the article—then the "light" slowly dawned on me: I never heard of the Ecraf Technology Corp. (ETC) or the Barrier Reflex Diode, and I'm always up on new analog devices. Then I saw it: perfect conductor and insulator at ambient temps; wads of "white light" at less than 1 milliamp. Indeed! Okay, you got me: Ecraf = farce. Great article!

SKIP CAMPISI
S. Bound Brook, NJ

What a great gag!!! I'm not a regular reader of **Electronics Now**, but I managed to catch that "review" of the Ecraf EC909-12 and was totally blown away. I went around for days telling all my friends about it. I'm usually not one to fall for something like that, but it was done so well I couldn't help myself.

Congratulations on a great gag. This one article has done more to make me interested in your magazine than anything else could. Keep up the good work!

VAN WILSON
via e-mail

I read your April Fools' article on the EC909-12 microprocessor, as I have read other April Fools' articles year after year. I dislike them as I have no interest in humor. I have no sense of humor. I want to read fact.

NAME WITHHELD
via e-mail

Great article by Ken Kemski in the April issue of **Electronics Now** about the Barrier Reflex Diode. I've heard there is some very sensitive research being done in some very high areas of our government where the "birds" are being integrated with the "Flux Capacitor" in circuits where the first step in time travel has been solved. They have been able to slow down the speed of light. I'll keep my eyes-n-ears open for further developments.

DALE APPLETON
via e-mail

I am glad to see that the "U.S. Less" company is still in business. I first encountered this company in April 1975 when I tried to locate a "Steam Bucket" used by the US Navy. I later encountered them in the food service industry with their famous "Jell-O Stretcher" (April, 1980?). Please inform me when the "DVD Rewinder" will be available at my local Wal-mart. I want to be first in line.

J. KNIGHT
via e-mail

## Mr. Möbius Revisited and Mr. Klein Wanted

In my article, "Möbius Circuit" (**Electronics Now**, November 1998), I discovered a mistake: a fundamental error in my description of the Möbius Strip characteristics. I realized this before the article was published , but as this didn't affect circuit performance, I decided to let it stand and see if people were reading and trying out these circuits—was I really reaching you all out there?

As it turns out, I seem to be doing my job! Several people have already caught the error (see "Letters," **Electronics Now**, January 1999)—cutting the Möbius Strip results in TWO intertwined hoops, not ONE larger hoop as stated. Many thanks to all who responded, renewing my faith in our readers. Now, if you want to see something really strange, try cutting the two intertwined Möbius Strips down *their* centers....

On another note, if anyone out there knows where I can purchase a "Klein Bottle," I'd be very interested in hearing about it. Thanks. EN

SKIP CAMPISI



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**Be sure to include copies of all correspondence.**

# EQUIPMENT REPORT

**CANON POWERSHOT A5 CAMERA AND CD-200 DIGITAL PRINTER**

*Slip into digital photography now with Canon's PowerShot A5 digital camera and print beautiful still images with the CD-200 printer.*

Throughout the early and middle-ages of traditional silver-based photography, getting reprints was as simple a matter as getting the original prints. Generally there was some sort of negative that, if saved, could be used to make new prints at any time—even more than a hundred years later in the case of plate-glass negatives.

More recently, digital cameras have been gaining popularity, and today's better consumer digital cameras, such as Canon's PowerShot A5, provide high-resolution "digital negatives." And Canon's companion CD-200 digital printer makes the best of those images, producing beautiful album-sized color prints from digital images, as well as from any composite or S-Video source.

### Canon PowerShot A5 Camera

The PowerShot A5 has a durable metal alloy body and sleek design. It's small enough to fit in a shirt pocket, yet takes sharp, high-resolution images and has a built-in flash. Its 810,000 pixel CCD allows for a maximum resolution of 1024 × 768 in 24-bit color. The camera also has a 512 × 384 pixel mode that allows you to squeeze more images into memory. It even has an automatic lens cover that flips shut when the camera is turned off. The camera is 4 inches wide by 2.7 inches high by 1.3 inches deep and weighs only 8.1 ounces without batteries loaded.

Images are stored on an 8MB industry-standard CompactFlash memory card, one of which is included with the camera. The card can be removed from the camera for connectivity with other computer hardware or to be swapped with additional memory cards like rolls of film. The PowerShot A5 has two JPEG compression levels, fine and normal, for both 1024 × 768 and 512 × 384 modes.

Depending on the resolution selected, and hence the image size, the included 8MB CompactFlash card will hold from 44 to 89 images with low JPEG compression and from 125 to 236 images with high JPEG compression. Pictures taken at 1024 × 768 create file sizes of 85KB or 180KB, while 512 × 384 images are either 30KB or 60KB in size. There's also a CCD-raw mode that stores images with no compression, but only 8 of the 940 KB images will fit in memory. Of course you can always buy higher capacity cards. The camera lets you shoot up to 15 frames at one frame per second in 512 × 384 resolution.

The PowerShot A5 has a low-distortion f/2.5 all-glass lens with a 35mm focal length when compared to a 35mm camera. The TTL autofocus works from 3.5 inches to infinity with a special mode for macro shots. Shutter speeds range from 1/6 to 1/750 of a second. The built-in flash has a range from 8 inches to 11.5 feet and it has four modes: on, off, auto, and red-eye reduction. Exposure compensation can be used for backlit subjects. A full-auto mode sets focus, flash, exposure, and white-balance settings for you. A program mode allows for greater exposure control.

You can compose images using the built-in 2-inch TFT LCD monitor or with the optical viewfinder to save battery power. Of course you have to use the monitor to view stored images. Images are transferred out of the camera via its serial interface, directly from the CompactFlash card, or via a composite-video output. The video output allows image viewing on a TV or recording on videotape. Serial and video output cables are included.

The camera comes with a rechargeable NiMH battery pack, which is good because digital cameras tend to eat batteries. It also comes with an AC adapter to conserve battery power when an electrical outlet is nearby.

All the software you need is included with the A5. It comes with a Photoshop plug-in for Power Mac and a TWAIN driver for Windows 95/98 and NT. The TWAIN driver allows any TWAIN-compatible application to extract images from the camera via the serial port. Bundled applications such as Adobe PhotoDeluxe 2.0 and Ulead PhotoImpact 4.0 lets you adjust color balance, contrast, sharpness, image size, and so on. Canon's PhotoStitch application takes advantage of the A5's stitch assist mode to let you merge images into horizontal or vertical panoramas or in 2 × 2 matrixes. Canon's PowerShot A5 has a suggested retail price of $420; as usual, street prices are usually lower.

### Canon CD-200 Printer

Canon's CD-200 digital printer is an extremely versatile, yet affordable piece of gear that makes high-quality album-sized color prints. It is the perfect accompaniment to the PowerShot A5 digital camera. The CD-200 accepts digital images directly from a CompactFlash card and makes 4 × 6-inch glossy photo prints without connecting to a PC—it has a video output to view images on a TV. The memory cards pop into a slot on the printer. The CD-200 is also Windows and Macintosh compatible with its Centronics and RS-422 connectors. What's really neat about the CD-200 is that a video input lets you capture and print still images from TV programs, camcorders, and other video sources.

The CD-200 is a dye sublimation printer with a resolution of up to 288 dots-per-inch with 256-step gradation. Prints are 4 × 6 inches with an image area of 3.2 × 4.2 inches. It takes about 95 seconds to print an image. Image quality can rival that of 35mm prints depending on the quality of the source image. The CD-200 is only 9.8 inches wide by 10.2 inches deep by 3.3 inches high and weighs only 5 pounds.

JPEG images stored on Compact-Flash cards are displayed on a TV as thumbnails. You can select individual images for previewing at full-screen resolution before printing them. Not having to connect the camera to the printer lets you continue to use the camera while printing images as long as you have another memory card.

The CD-200 costs $409. Refills for the CD-200 containing a new print ribbon and 50 sheets of glossy photo paper cost about $30. That puts the price of prints at 60 cents each, which is cheaper than Polaroid images, and the CD-200's print quality is better. Adhesive-backed sticker media is also available.

The PowerShot A5 is a high-quality digital camera that comes in a small package. It's perfect for creating web content and saving memories in digital form. And the CD-200 digital photo printer gives you hard copy for the photo album. With them you have a complete digital-photography solution that solves all of your home-video/digital-still-camera printing needs at the same time. You'll never have to wait 60 minutes for conventional photography ever again, and reprints are just 95 seconds away.

For more information on the Canon A5 digital camera and/or the CD-200 digital printer, contact the manufacturer directly (Canon Computer Systems, Inc., 2995 Redhill Avenue, Costa Mesa, CA 92626; Tel: 800-385-2155; Web: www.ccsi.canon.com). **EN**

BY KONSTANTINOS KARAGIANNIS
COMPUTER EDITOR

# Lightning-Fast Online Access

I'VE YET TO FIND A COMPUTER USER WHO IS COMPLETELY HAPPY WITH HIS OR HER MODEM. EVEN UNDER IDEAL CONDITIONS, ANALOG MODEMS ALLOW DOWNLOADS AT 53 KBPS—NOT ALL THAT THRILLING.

Considering how cluttered modern Web pages are becoming and how large files of all types are growing, an analog phone line and modem just don't make for satisfactory online conditions.

So how else can you get on the fast lane of the Information Traffic-Congested County Road? (It's anything but a "superhighway" most days.) Just a couple of years ago the only options a home computer user had were modems and ISDN. The former are cheap and slow, the latter is a little faster (64 or 128 kbps, depending on whether you use one or two channels), but hopelessly expensive.

Are we forever doomed to seeing File Download dialogue boxes with messages like "3 hours 45 minutes remaining" in them?

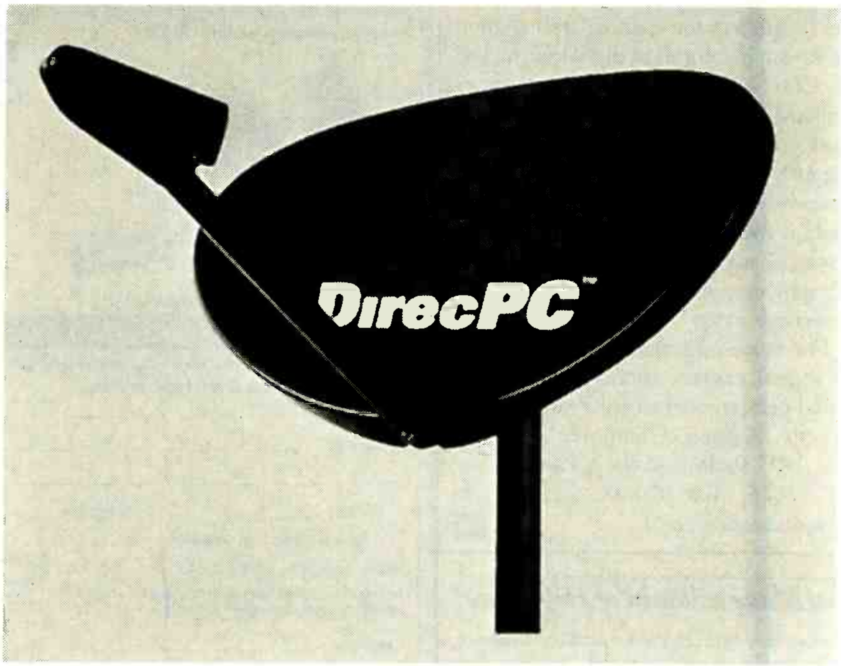
Have no fear. Now there are much faster ways to get data in and out of your computer, without spending a grand a month on a leased pipe to the Net (this is no joke—some companies pay even more). While the high-speed-access technologies we're about to examine are not available in all areas, they will eventually have versions available in every part of the country.

For the time being, many of the solutions we're about to look at are provided by regional providers, instead of nationwide ISPs. That means that except for our first entry I can't really recommend a good company to check out in your area. I apologize in advance for any New York-area price examples I might use in these pages. They're only included to give an idea of the types of service you might be able to find now or soon in your area.

## Almost Wireless, Almost Usable Anywhere

A nationwide provider offers the first technology we'll examine. It's a decent choice for just about anyone. We're talking about DirecPC, from Hughes Electronics. Like its brother, DIRECTV, DirecPC uses an 18-inch satellite dish that you'll have to install on your roof (this excludes many renters, obviously). While it's not as peppy as some of the choices we'll deal with later on, it can be installed in almost any town, making it attractive to those living in more rural areas.

How fast is DirecPC? Compared to a modem, plenty fast. Downloads using DirecPC achieve nice 400-kbps speeds, more than three times peppier than ISDN at its best. However, DirecPC can only be used for downloads—don't go yanking that modem out of your PC just yet (though you will need an extra open PCI slot for the dish's interface card).




NO MATTER WHERE YOU LIVE in the country, a DirecPC dish can get you much-faster-than-modem downloads from the Net. While you'll still need a phone line for upstream data, files will come to your PC at 400 kbps.

As you likely know, surfing the Web is bi-directional. Sending e-mail, typing in URLs, clicking links—all these require a way for your PC to send data, too. To accomplish those tasks, you'll need a standard modem and phone line. For most users, though, this isn't a problem; you all just want a faster way to get things *in*to your computer. However, those of you who do a lot of file uploading....

We started our roundup with DirecPC, because it's available everywhere. Yet while it is cheaper than ISDN, DirecPC is still not affordable for everyone. In addition to your phone-line charges, keep the following in mind: You need to buy and install a dish, which could cost anywhere from $300 (if you install it yourself) to about $500 (if you don't lift a finger after you place the order).

Then comes the monthly fee. Remember how everyone complained about digital satellite TV when it first came out? You know, they'd say lines like "I bought the dish, now I have to pay what?" Those with satellite TV have it better than DirecPC users, though—they don't have time restraints on when they can watch the tube. DirecPC's monthly service costs $30 for 25 hours of downloads or $40 for 100 hours (ISP account included), with each additional hour costing $1.99.

While the preceding prices aren't exactly exorbitant when viewed alone, they do seem high to someone who just paid up to $500 for a dish and still has to either tie up a phone line or add one. As much of an improvement as DirecPC is to just a modem alone, a cheaper and still faster option is available in many areas.

## Finally, Something Good on Cable

Next time you're flipping through your 70 or so channels of cable TV, unable to find a single thing to watch, remember that the very same coax coming into your home could be connecting you to the rest of the computing world at a whopping 10 Mbps! That's the amount of speed available to most small networks, and is about 188 times faster than what you can get out of a 56-kbps modem, which due to telephone-line restrictions usually tops out at 52 or 53 kbps.

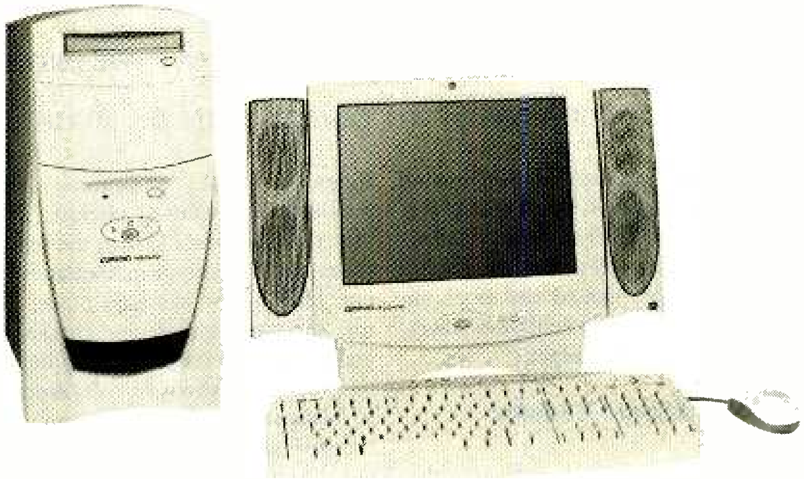
How is this possible? As it turns out, those new lines cable companies have been installing for years to prepare for interactive-television features can carry a lot more than pay-per-view request signals. Downstream data (*i.e.* to your home) comes from a channel in the 5- to 750-MHz range; upstream data is carried on a channel in the 5- to 42-MHz band. This infrastructure provides for up to 10-Mbps data transfer, and is now in place in most areas—but whether your cable company provides Net access is another matter.

Before we toast to the speeds of cable, it's important to note that the medium's bandwidth is shared by each neighborhood, which means at best you'll probably only connect at a maximum of about 5 or 6 Mbps—which is *only* 100 times faster than your analog modem—and sometimes as slow as 1 Mbps. Still, at these speeds it will appear to you like your machine's accessing data off a hard drive or, at the worst, a floppy disk, rather than the Internet. Cable companies are promising to limit the number of subscribers they connect to each sector area of bandwidth, ensuring that your shared access won't end up back in the analog-modem range some day.

In the NY metro area, cable Internet access costs $35 a month if you agree to have the service for a year (you don't need to pay it all up front, though). Five bucks of that fee is to cover the rental of a cable modem—an external device that connects to your computer via an Ethernet port. You have to have at least a 10BaseT (10-Mbps Ethernet) Network Interface Card (NIC) in your computer. Many cable companies give NICs away as incentives, but they are very affordable (I've seen many in the $50 range, some for less).

If you order cable Net access, your cable company will add another line to your room of choice and actually set up the hardware and software on your computer (usually an additional $50). However, don't let these initial fees deter you; cable is no more expensive than analog access. Adding a phone line to a house can cost more than twice as much as the install fee of cable. Furthermore, cable has no per-minute charges, and you don't need to pay an ISP any longer.

Besides the speed that will have you downloading 1.5MB files in about 7 seconds, cable has another nice benefit. It's always online, so when you start up your computer, you're connected to the Net. Live demos I've seen have convinced me how amazing the service is. I might be moving soon, but as soon as the boxes are unpacked, cable Internet is one of the first things I'm having installed.



THE COMPAQ PRESARIO 5600 line features xDSL-capable modems.

## xDSL—Some Four-Letter Solutions

Another promising technology is also only available in select areas right now. The final versions of this speedy service will go by different names, but the core system is called xDSL, with the "x" standing for one of several types of Digital Subscriber Lines.

Similar to ISDN—though faster and cheaper—xDSL is a system that requires an area to be equipped with special digital lines. Note that these lines are installed in your area, not just to your home. Once the modifications are made by the phone company, both asynchronous and synchronous forms of xDSL, or ADSL and SDSL, respectively, can

*(Continued on page 87)*

BY MARC ELLIS

# Evolution of the AC/DC Set

WE BEGAN DISCUSSING SCALED-DOWN-FOR-THE DEPRESSION "MIDGET" RADIOS IN THE APRIL, 1999 ISSUE OF **POPULAR ELECTRONICS**. THEN, IN THE MAY ISSUE, WE DROPPED THE SUBJECT TEMPORARILY TO DISCUSS PHILCO'S MUCH LESS drastic approach to depression downsizing, which led to the development of the very popular (and far from small) "cathedral" radios. Now it's time to return to the original story thread and trace an important line of radio evolution which began with the first "midgets."

## The International Kadette Universal

Back in that April column, the "International Kadette Universal" (definitely a midget) was presented as what was probably the first of a very influential design that became known as "AC/DC" Let's review the meaning of that term.

The Kadette used only three tubes (excluding rectifier). The reason it could get by with so few was that the tubes (types 39, 36, and 38) were from a newly-introduced (in 1931 and 1932) high-performance series designed for auto radio service. Two of those (the 39 and 38) were of the new "pentode" design that offered greatly enhanced performance with little or no increase in parts count. See the April, 1999 **Popular Electronics** "Antique Radio" column for a schematic of the Kadette.

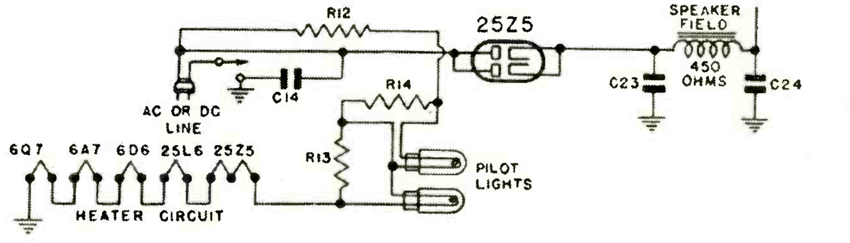
As part of the strategy for eliminating the large and expensive power transformer, the heaters of the three tubes were made to operate directly from the AC line. This was done by putting the three 6.3-volt heaters in series, like an old-fashioned set of Christmas-tree lights. In that configuration, they required 18.9 volts to operate. Placed directly across the AC line, the string of tubes would of course immediately burn out. However, a 310-ohm power resistor, mounted under the chassis, was included in the series string to drop the line voltage by about 93 volts more.

Because there was now no power transformer (a device that could operate only on alternating current), the Kadette could operate from DC as well as the AC line. In those days, the downtown sections of many large cities were still supplied with DC current, which had to be converted to AC by various means to operate common appliances and motors. While this wasn't really a very big market, AC/DC operation was still a useful selling point and radios with series string heaters became known universally as "AC/DC sets."

This system probably wouldn't have even been considered had the auto tubes with their 6.3-volt, 0.3 amp heaters (designed to operate with minimal drain from the storage batteries of the day) not been available. The 2.5-volt 1.75-amp range of tubes then common in home radios would have required a much heavier series resistor to drop the larger voltage at heavier current. As it was, several watts of power had to be dissipated in the resistor. Power dissipation means heat dissipation, and things get hot enough under the chassis to shorten the life of capacitors and other components.

## Cooling-Down Strategies

The heat problem was minimized through innovations on several different fronts. First, the "below decks" power resistor was very soon replaced by one of two devices: (1) the "ballast resistor," which looked like a metal tube (sometimes with heat-releasing perforations in its metal shell), plugged in atop the chassis like any other tube or (2) the line-cord resistor, which was an extra conductor—made of resistance wire—built into the line cord. In both cases, the heat generated by the resistance element was prevented from overheating the space beneath the chassis. However, it's not unusual to find ballast sets with cabinets discolored (or even charred) by heat




A TYPICAL AC/DC power-supply circuit. The heaters of the five tubes are in series; R12 is a ballast resistor; pilot lights operate from a separate tapped resistor. The speaker field coil doubles as filter choke.

generated above the "tube."

The line cord resistor has often confused new hobbyists who may replace it, when frayed, with an ordinary two-wire cord. The result is a dead radio and (depending on which two of the three connection points in the set is used for the new cord) possibly a set of tubes with blown heaters. In attempting to replace the plug on such a cord, neophytes may also either ignore the fine and easily broken resistance wire or tie it to the wrong side of the line. In either case, though no damage will be done, the tubes will not light.

Cords with line cord resistors can be recognized by their fatter-than-usual cross section and (usually) cloth outer covering. Often this covering is frayed in places, exposing the asbestos insulation underneath. If a frayed cord is in working order, don't be tempted to replace it. Resistor cords are hard to come by—though there are alternatives that can be discussed in future articles.

## Tube Evolution in AC/DC Sets

Another innovation was the introduction of tubes with higher heater voltages. The first ones to appear were audio-output tubes such as the 25L6 and rectifiers such as the 25Z5. Tubes in those categories, because of the greater power that they handle, could especially benefit from the greater heater output made possible by the higher operating voltages.

It's not uncommon to find early AC/DC sets with a 25-volt rectifier tube and three 6-volt tubes or with 25-volt rectifier and audio-output tubes and two 6-volt tubes. In either case, significantly less power needed to be dissipated in the ballast or line-cord resistor to drop the remaining voltage.

Among the six-volt tubes providing the detector, RF-amplifier, and AF-amplifier functions in sets with line-cord or ballast resistors and two 25-volt tubes as described are the types 39 and 36, the later types 78 and 77, or the still later 6C6, 6D6 and 6Q7. Six-volt power output tubes in sets not equipped with a 25-volt version are typically type 38 or the later type 43. When five-tube superheterodyne circuits began to replace the four-tube tuned radio-frequency designs, the 6A7 pentagrid converter (also six-volts) began to appear.

As the five-tube superhet circuit became standard in the late 1930s, a whole new series of tubes, all with high-voltage heaters for series heater-string operation, emerged. One configuration was so commonly used that it became known as the "All-American Five." That set was made up of a 12SA7 pentagrid converter, 12SK7 RF/IF amplifier, 12SQ7 detector/amplifier, 35L6 power output, and 35Z5 rectifier. Note that the heater voltages (first two digits of the type number) add up to 106, which was close enough to the nominal 115-volt line voltage so that no ballast or line-cord resistor was needed.

## Other AC/DC Design Features

As has been mentioned in some of the earlier articles on this subject, other changes were also made in the power-supply circuitry in order to reduce size, weight, and cost. Among the earliest simplifications was to substitute the field coil of the dynamic speaker then in common use for the power-supply filter choke. The coil substituted for the choke while at the same time receiving the energizing voltage required for the speaker to operate.

Still later, the development of efficient permanent-magnet speakers rendered dynamic speakers obsolete and field windings disappeared. By that time, however, inexpensive high-capacity electrolytic filter capacitors were available. Using them, filtering action became so much more efficient that a power resistor of a few hundred ohms could be substituted for the choke.

By now, improved tubes and circuitry had made sets so sensitive that the traditional hank of antenna wire, unrolled under a rug or tossed out the window, became unnecessary. A neat, self-contained loop antenna, usually mounted inside the back of the cabinet, was enough to do the trick.

Changes in cabinet design also rate at least a brief mention. The original midget sets were housed in compact wooden cabinets. Made to sell as cheaply as possible while yielding a profit for the manufacturer and dealer, very little thought or money was expended on the radio's looks. Nevertheless, many of these wood cabinets had a kind of naive charm that I, personally, enjoy.

By the early 1940s, more and more cabinets were being made of plastic. This material (usually Bakelite either left in its natural brown color or with a painted finish applied) was easy both to mass produce and to mold into the "streamlined" rounded shapes favored during that era. Also, the newer generation of tubes were about half as high as the types used in the original AC/DC sets, allowing for the cabinet to have a lower, sleeker profile. More attention began to be paid to the aesthetics of the cabinet, and the inexpensive sets began to have a more sophisticated look.

Catalin plastics, which could be produced in a variety of glowing colors, were also sometimes used. Catalin cabinets are fragile and become more so with age, often cracking spontaneously because of internal stresses in the material. Catalin cabinets are rare, especially in flawless condition. They are much prized by some collectors today and a Catalin radio that sold for $19.50 in 1940 might well change hands at $1000 today!

BY THE 1940s, inexpensive plastic-molding techniques were making it possible to mass produce cabinets with a sleeker, more sophisticated look.

## Military Radio Collectors Take Note!

I recently received a query from Major (Ret.) Richard J. Blondis, 291 East Calle Herboso, Green Valley, AZ 85614; Tel: 520-393-0922. The Major has a World War II German military shortwave radio gathering dust in his storage area. He'd like help valuing the set and figuring out how to market it. The markings on the set are: *Telegrafen Werkstatte, Musterr RV 14, Serie II Number 151*. Contact Major Blondis directly if you can assist him or if you are personally interested in the radio.

That's it for this month! We'll see you in July. In the meantime, send your comments and suggestions to me at "Antique Radio", c/o **Electronics Now**, 500 Bi-County Blvd., Farmingdale, NY 11735-3931. Or use my personal e-mail address: ellis@interaccess.com. Regretfully time limitations do not always permit me to respond individually. But all correspondence will be read with interest and acknowledged in the column. EN

# NEW PRODUCTS

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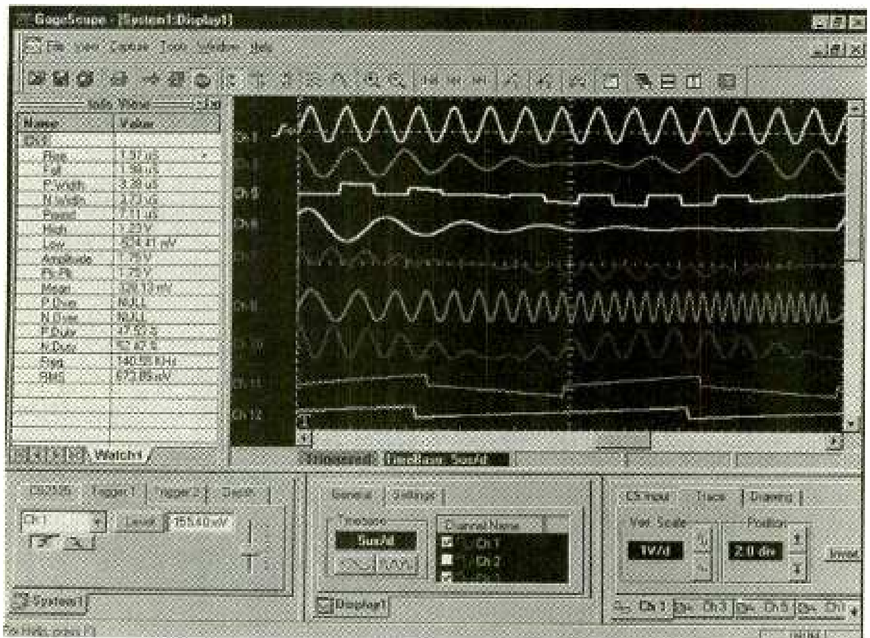
## Oscilloscope Software

GAGESCOPE FOR WINDOWS IS oscilloscope emulation software for controlling the CompuScope family of PC-based oscilloscope and data-acquisition cards. It supports up to 32-channel oscilloscope systems and gives the user complete control of the CompuScope card. The stand-alone software includes waveform cursors, multiple windows with different timebases, the ability to save and load signals, compatibility with SIG files used with the CompuGen arbitrary waveform generator, and more. Settings are located in convenient on-screen controls. All settings are separated into three different controls—System, Display, and Channel—depending on their function.

In combination with a CompuScope data-acquisition card, GageScope for Windows can be used for applications such as disk-drive testing, cellular communications, RF receivers, radar, lidar, imaging, non-destructive testing, ultrasonic testing, laser Doppler anemometry, high-end video, CCD testing, vibration



CIRCLE 20 ON FREE INFORMATION CARD

GageScope for Windows is a powerful and easy-to-use FFT package. Not only can it do multiple channel spectral analysis, it allows for simultaneous viewing of time and frequency domain data. The software features the ability to change most settings with the click of the mouse.

Available settings include sample rate, channel mode, pre- and post-trigger depth, trigger level, trigger slope, timeout, multiple record, timebase, channel visibility, input range, input coupling, vertical scaling, drawing method, polarization, interpolation, and anlaysis, laser diode characterization, and impact testing. GageScope for Windows has a suggested retail price of $495.

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*S. Burlington, VT 05043*
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*Fax: 800-780-8411 or 514-633-7447*
*Web: www.gage-applied.com*

## LCR Meter

EASY TO USE AND CALIBRATE, the Protek Z9216 is an advanced design LCR meter that measures resistors, inductors, and capacitors at 20X per second rate, with 0.5% accuracy, simplifying automated testing and sorting. Component "Q" values and dissipation factors are also displayed via front-panel LCD readouts. For remote operation, the instrument is equipped with RS-232, GPIB, and Handler Port Interfaces. The

CIRCLE 21 ON FREE INFORMATION CARD

unit accepts optional SMD tweezers, BNC fixture adapters, and Kelvin Clips.

It stores and recalls nine instrument setups and has five test frequencies from 100 Hz to 100 kHz and measurement averaging from 2 to 10. Other important features include open- and short-circuit compensation, accurate zeroing, built-in calibration procedures, and binding capabilities. Compact in size, it measures approximately 4 by 14 by 14 inches and weighs almost 13 pounds. The Z9216 sells for $1750.

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*Web: www.hcprotek.com*

## Robotic Video Camera Controller

A NETWORKABLE ROBOTIC video camera controller, the Transit RCM (Robotic Camera Mount) is a computerized positioning control for network video cameras. It adds intelli-

*(Continued on page 84)*

# Prototype

## Counting The Particles On The Head Of A Pin

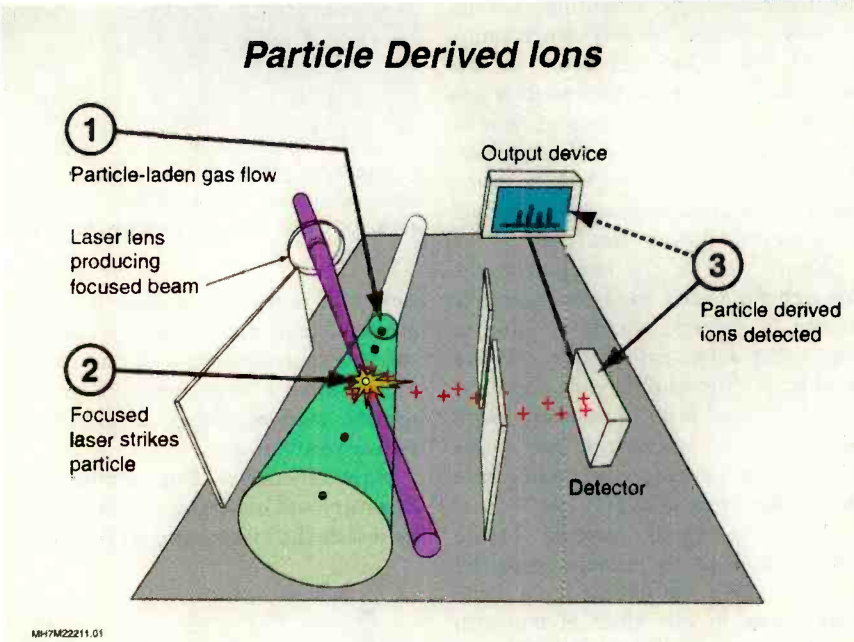
The bar has been lowered in particle-detection technology. A chemist at Bell Labs, William Reents, has designed a novel instrument that detects particles 100,000 times smaller than a pin head, or about one-thousandth of a micron—a development that could have a major impact on semiconductor manufacturing.

Today's transistors, for instance, are roughly one-quarter of a micron wide and as thin as one-hundredth of a micron. As a result, they are subject to short-circuiting by minuscule particles that escape detection during manufacture.

Current particle-detection techniques, which involve spot-checking the surfaces of silicon wafers by observing whether light is reflected by particle deposits, detect particles only as small as two-tenths of a micron. This method requires the entire manufacturing process to be halted for inspection, and it is unable to determine size or composition of the particles found.

The new instrument, whose capability has been demonstrated only in Reents' laboratory, detects particles between one-thousandth of a micron and nine-tenths of a micron (the average dust particle is 50 microns) during the process of semiconductor manufacturing and analyzes the particles in a gaseous phase. While transmission electron microscopes can see much smaller particles (as small as an atom, or one ten-thousandth of a micron), those instruments can only analyze particles stationary on a surface.

The Bell Labs instrument pulls gas particles out of the vacuum chamber individually, detecting up to 10 particles per second. "What we do is, we pull a little bit of the gas stream with particles from the chamber and bring them into our 'particle blaster'," said Reents. A high-intensity pulse laser hits each particle, breaking it up into charged ions and molecules. These then accelerate at various velocities, depending on their weight, and strike a detector. Based on the weights and velocities recorded, the instrument determines the particle's composition and size.




BELL LABS' PARTICLE DETECTOR extracts gas particles out of the vacuum chamber individually, detecting up to 10 particles per second. A laser strikes each particle, shattering it into charged atoms and molecules, which accelerate at various velocities toward a detector. Based on the weights and charges recorded, the instrument instantaneously determines the particle's quantity, composition, and size.

This ability to analyze particle composition is also of interest in circles outside semiconductor manufacturing. Reents is at work adapting the instrument to detect and analyze ambient particles in the surrounding atmosphere. While other sensor methods can detect particles as small as a micron, they cannot determine the complete composition of those particles. Atmospheric analysis, Reents said, has become increasingly important in recent years as government regulators have voiced concern about the health effects of submicron-sized airborne pollutants, both indoors and out. Another possible application for the detector is in performing trace analysis of particles in ultra-pure liquids, which are commonly used in pharmaceuticals and semiconductor manufacturing.

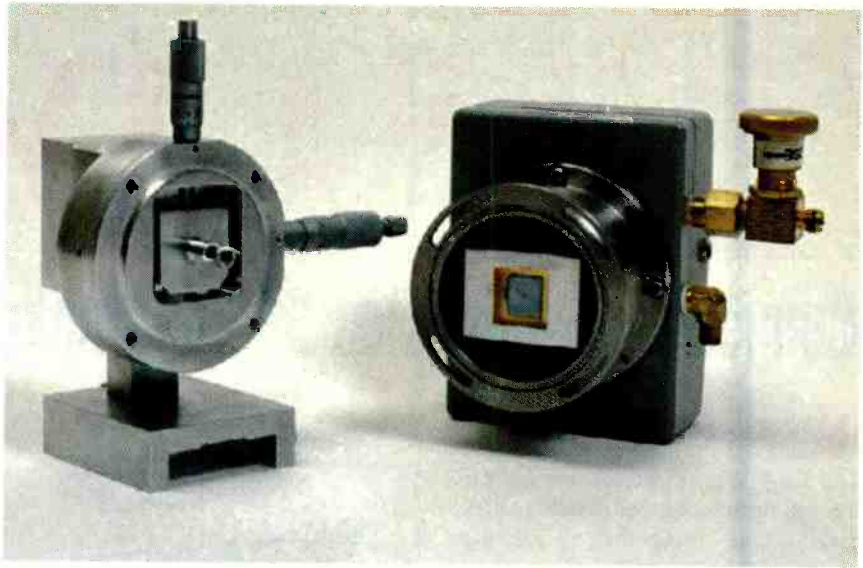
Still, the Bell Labs device, which has the ability to detect particles in real time in a vacuum chamber, will likely find its first application in semiconductor manufacturing. Better particle detection is important because transistors will approach the one-tenth-of-a-micron range in the near future. The ability to detect smaller and smaller particles will become even more important because tiny particles will be able to sneak into the increasingly smaller transistor features.

In semiconductor processing, the current particle detection practice is to put a monitor wafer in the semiconductor production chamber, let it sit there for some period of time, pull it out and count particles on it. "You're limited to doing this only when you are not processing, so it doesn't reflect the conditions of the chamber during normal processing," Reents said. "Our instrument, on the other hand, can see particles whether you are processing or not processing, without affecting the process at all. You can have the plasma running, you can be doing chemical vapor deposition, and it should work for any of those cases."

Reents believes the instrument, the research for which has been internally funded by Lucent, should be able to detect just about any particle. "We've tried it on a dozen different things," he said. "We tried it on some really tough ones. Silica, for example, is easy to see with this instrument; some people have trouble detecting silica particles."

More testing is planned before Reents confirms the device's suspected potential. "We are testing it on some instruments in our clean room, with some success so far," he said. "What we need to do is test it on several instruments, show that it's broadly applicable and how good it is—quantify its signal relative to that of a monitor wafer, because when you have one tool that the engineers rely on you have to be benchmarked against that. If you can't duplicate what they're used to, you've got problems. So we're benchmarking now."

After that, Reents hopes to license the technology and make a commercial instrument available. "I think there should be a lot of interest," he said.—**by Douglas Page** PT



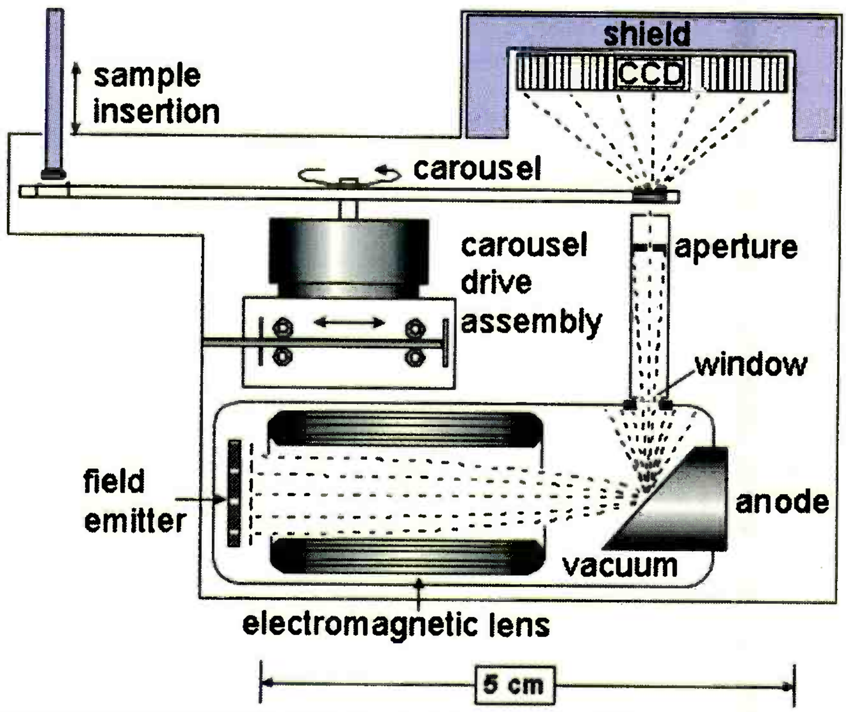
CHEMIN (for CHEmistry and MINeralogy) is a miniaturized XRD/XRF instrument that uses a tiny X-ray tube and a charged-coupled device (CCD) to remotely analyze fine-grained soils, rock, and even ice samples, for chemical and mineralogical information.

# If Rocks Could Talk

The origins and histories of planetary, asteroidal, and cometary bodies are reflected in their building materials. Less than 100 naturally occurring elements combine together to form over 3800 known minerals. This tremendous variety of mineralogy carries stories of pressure, temperature, oxygen fugacity, and solution chemistry—all intertwined with histories of sedimentation, igneous activity, metamorphism, impacts, and surface weathering.

Simultaneously determining the chemistry and mineralogy of these bodies reveals the history of their formation and evolution. In order to do this type of analysis, both X-ray diffraction (XRD) and chemical analysis by X-ray fluorescence (XRF) of minerals that contain water (including ice), sulfur, or halogens are required.

Recent progress in X-ray detector technology paved the way for the development of simultaneous XRD and XRF




THIS SCHEMATIC DIAGRAM shows the components of the CHEMIN instrument.

analysis. CHEMIN (for CHEmistry and MINeralogy) is a miniaturized XRD/XRF instrument that remotely analyzes fine-grained soils, rock, and even ice samples, for chemical and mineralogical information. Using a tiny X-ray tube and a charged-coupled device (CCD), CHEMIN can answer questions about extraterrestrial mineralogy. It also has applications on Earth in situations where a small, low-powered instrument is needed, such as in geological sampling at remote, dangerous sites, or where soil has been contaminated.

A flight-ready version of CHEMIN is the size of a soda can, weighs less than a kilogram, consumes only a few watts of power, and can be mounted on fixed landers, soft penetrators, or small robotic rovers. Small enough to fit onto a planetary rover, like the recent Martian rover, CHEMIN gathers chemical data and crystalline structure information simultaneously from samples. Knowledge of crystalline structure is essential in determining whether a chunk of extraterrestrial carbon is a diamond or a lump of coal.

The quality of CHEMIN XRD data has now progressed to a point where trace mineral occurrences (<1%) can be identified and quantified. Such applications illustrate the high sensitivity of the prototype CHEMIN instrument, currently in use at NASA Ames Laboratory, in detecting very small quantities of diagnostic minerals. In operation since July 1996, this prototype instrument, the collaborative work of Los Alamos and NASA researchers, has verified the principle of CCD-based simultaneous XRD and XRF. However, the instrument is composed of surrogate components that do not illustrate the full capabilities that can be realized with an optimized instrument.

Nevertheless, the data obtained with the CCD-based instrument are sufficient not only to determine the mineral phases present, but also to apply Rietveld analysis in estimating the relative proportions of mineral phases in the sample. Rietveld analysis involves calculating a model diffraction pattern based on the crystal structures of the known phases in a mixture. The quality of fit between the observed and calculated diffraction patterns is then improved via a least-squares process in which relative amounts of each phase and crystal structure parameters are varied. In addition, software is being developed to combine both the chemical XRF data and the XRD result to perform this operation more rigorously. PT

## They Bend, But They Don't Break

Small enough to weigh viruses and other sub-micron scale particles, a "nanobalance" is one application for newly-discovered electronic and micromechanical properties of carbon nanotubes. The use of the tiny tubes in this way depends on the ability to calculate changes in the resonant frequency that occur with placement of an object onto a nanotube.

"This is comparable to putting an object on the end of a spring and oscillating it," said Dr. Walter de Heer, professor in the Georgia Institute of Technology School of Physics. "By knowing the properties of the spring, you can measure the mass of the object. We can use the nanotube like a standard calibrated spring."

Applying this technique, Georgia Tech researchers were able to measure the mass of a 22 femtogram ($10^{-15}$ grams) graphite particle attached to the end of a resonating nanotube. "There is no other way to weigh accurately something that small," de Heer noted.

They studied the behavior of multi-walled nanotubes using a transmission electron microscope with a unique sample holder designed and built by their colleague Dr. Philippe Poncharal. The holder allowed them to rotate specimens, apply electrical voltage, and observe many fundamental effects. The work was sponsored by the U.S. National Science Foundation and the U.S. Army Research Office.

Electrical voltage can be used to induce electrostatic deflection and vibrational resonance in individual carbon nanotubes. This ability to selectively deflect or induce resonance in individual nanotubes opens new potential micromechanical applications for the tiny structures, which are smaller than the finest features on modern microcircuits.

The researchers applied an oscillating voltage to induce resonant vibration in the nanotubes. Resonant nodes appear in the tubes just as they would in a vibrating guitar string. Each nanotube resonates at a specific frequency that depends on its length, diameter, density, and elastic properties.

"You can select which one you want to examine and make it resonate," Poncharal explained. "Then you turn up the frequency and another one will resonate." The resonance occurs in a very narrow range, allowing the researchers to measure the damping properties of the nanotubes.

"This opens a broad new field of study," said de Heer. "To show that we can manipulate individual carbon nanotubes while examining them with an electron microscope is breaking new ground."

By applying a charge to a nanotube placed near an oppositely-charged probe, the researchers were able to severely bend the tiny structures. "We can bend a nanotube almost 90 degrees, and it will still recover and straighten out," said Dr. Z. L. Wang, professor in the School of Materials Science and Engineering. "You can keep on bending them and they will not break. This shows that although nanotubes are very rigid, they have an extremely high elastic limit. Very few materials can do this without damage."

As nanotubes are made thicker and thicker, they enter a new mode of bending. Using high-resolution transmission electron microscopy, Dr. Daniel Ugarte of the Laboratorio National de Luz Sincotron in Brazil observed a rippling on the surface of thick nanotubes as they deflected. This confirms that bending in these tubes is different.

"The elastic constant is varying as a function of its diameter, which is unexpected for a general material. This elastic constant should be an intrinsic property of the tubes, rather than depending on its geometry or size," explained Wang. PT

## The Once and Future Fridge

Developed by Frigidaire Home Products, with technology innovations from ICL's retail systems division, the first online refrigerator recently made its debut. It provides an opportunity for "anything, anytime, anywhere" shopping.

From their kitchens, consumers can access selected retailers, order, scan and purchase goods, pay their bills, and even watch television and send e-mail messages—all from their fridge.

The prototype online refrigerator incorporates a flat-panel touchscreen monitor and bar-code scanner, both located on the door, and has a 233-MHz personal computer installed within the unit. It runs Microsoft Windows 95 using 32 MB of RAM. It also includes an external Ethernet connection.

There are two ways for the refrigerator to be connected to the Net. The refrigerator could be connected to a standard telephone line for dial-up capabilities to an Internet service provider. This requires only that a telephone line, jack, and cable be near the unit. The other method is to connect the refrigerator to an in-home Ethernet network. In that case, an available port on an Ethernet hub is all that's needed to connect the in-refrigerator PC to the hub via an Ethernet cable.

"Internet shopping is taking off, but until recently, it was mostly the sale of books, CDs, and other leisure or entertainment items," says Tony Evans, spokesman for Frigidaire Home Products. "Also it focused on the PC or Web TV, which are not in the right place for people we call Kitchen Managers. This development can bring 'home shopping' directly into the kitchen and thus into the hands of the Kitchen Manager—the person who is responsible for running the heart of the home and who is responsible for most weekly purchasing decisions. With ICL, we've shown it can be done." PT

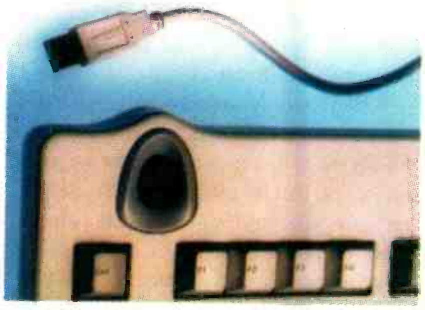

BRINGING THE INTERNET into the kitchen, this refrigerator can even do your shopping for you.

## Your Identity, Please

Designed for Personal Computer and network security, the PFS-100 from Polaroid, a low-cost finger-image scanner, is targeted at users with desktop security concerns and for personal security in e-commerce applications. It will be sold through original equipment manufacturers (OEMs) and integrated into computer systems and keyboards. Key Source International Inc. will be integrating the PFS-100 into their keyboard product line later this year.

The finger scanner is about the size of a pack of gum and can be easily integrated into USB keyboards and other devices in any orientation. The CMOS chip used in the PFS-100 is manufactured for Polaroid by ATMEL Inc. and IBM supplied the advanced finger analysis software.

Philip J. Scarfo, vice president of biometrics for Polaroid, said "We are using the knowledge and experience of more than 50 years in the identification business to create a family of reliable biometrics components that meet the security needs of our customers. PFS-100 combines the best of optical and CMOS sensor technology to create a very durable and low-cost device. The PFS-100 finger-image scanner is a direct result of our experience with finger images and with large-scale identification programs." Polaroid produces some 300-million identification documents worldwide each year.



THIS FINGERTIP SCANNER gives computers and other devices enhanced security while eliminating the need for passwords, PIN numbers, etc.

The new device is a logical extension of the identification tools and identification technology developed by Polaroid's worldwide ID systems business unit. Polaroid ID card and biometric technology already authenticates identification documents and their owners and protects driver's licenses, passports, and other identification documents from tampering and counterfeiting.

"The PFS-100 finger-image scanner is just one of the devices that will be needed to eliminate PINs and passwords, enhance PC and network security and enable e-commerce," said Robert S. Murray, president of Polaroid's Identification and Transaction Systems division. "Identity theft and fraud are serious and growing problems. Annual reported worldwide fraud losses are reported at more than $1 billion."

Polaroid has been producing driver's licenses and identification cards using both photographic and digital systems. The company currently produces driver's licenses in 37 U.S. states including California, Texas, Georgia, Hawaii, and West Virginia. Polaroid's Georgia driver's license solution is the largest civil biometric system in place worldwide with more than 5 million drivers carrying licenses protected with fingerprint verification. PT

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*Below: A lively Trade Show floor is encountered by visitors and exhibitors alike at the 1998 Professional Service Trade Show.*

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NPSC 99

BY SAM GOLDWASSER
SERVICE EDITOR

# Testing Flyback Transformers

WHEN PROBLEMS DEVELOP IN THE HORIZONTAL DEFLECTION/HIGH VOLTAGE SUBSYSTEMS OF TVs OR MONITORS (OR EVEN MODERN OSCILLOSCOPES AND OTHER CRT DISPLAYS), THE FLYBACK TRANSFORMER (OR LINE-OUTPUT TRANSformer for those on the other side of the pond) is often a suspected cause. That is due in part to the fact that the flyback is usually the most expensive and hard-to-find replacement part in the unit and because flybacks are often less well understood than other more common components.

This month, we will look at the flyback in detail. We'll deal with what it is, how it fails, how to test it, and what to do if it is indeed defective. But first, a...

**Warning:** Read, understand, and follow the safety recommendations published in previous "Service Clinic" articles or at my Web site (www.repairfaq.org) before attempting any troubleshooting of a monitor or TV! If you don't know what you are doing, or are careless, both you and your set could suffer irreparable harm.

## What Is The Flyback?

The typical flyback or Line OutPut Transformer (LOPT) consists of two parts:

• A special transformer that, in conjunction with the horizontal-output transistor/deflection circuits, boosts the B+ of the low-voltage power supply to the 20 to 30 kV for the CRT and provides various secondary lower voltages for other circuits.

• A voltage divider that provides the focus and screen supplies. The focus and screen are generally the top and bottom knobs, respectively.

## Why is the Deflection and High Voltage Combined?

One of the main reasons that TVs and many monitors are designed with horizontal-deflection driven flybacks is simply economics—it provides a cheap way to get the high voltage and many or most of the other voltages for the set with minimal hardware. (High quality computer monitors sometimes use a separate high-voltage supply.) The use of the horizontal frequency rather than the AC-line frequency of 50 or 60 Hz allows the power-supply components to be small and light compared to a line-operated power transformer and filter capacitors.

## Flyback Construction

While details can vary somewhat, all flybacks consist of a set of windings on a gapped ferrite core. High-voltage diodes and resistive dividers (often with adjustment pots) for focus and screen (G2) may also be present.

A typical flyback includes the following components:

• Drive winding—for a typical TV or monitor, this may be 100 or so turns of medium gauge (e.g., AWG 26) wire. This is what is connected in series with the B+ to the horizontal output transistor in a TV or monitor.

• High voltage winding—several thousand turns. This winding may be split into several series sections with a high-voltage rectifier for each, or it

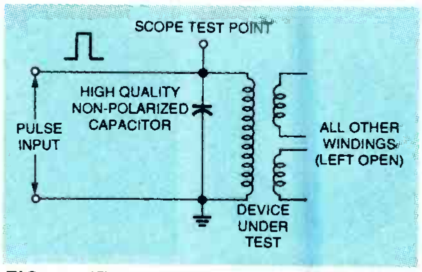


**FIG. 1**—IF YOU HAVE A SCOPE, a ring test using this set up is the easiest way to test a flyback.

could be a single winding. An alternative is to provide a lower-voltage winding and use a voltage multiplier (diode-capacitor ladder) to boost that to what is required by the CRT. Very fine wire (e.g., AWG 40) will be used for the high-voltage winding. The high-voltage lead to the CRT is fed from the highest voltage output of the rectifier or multiplier. (Sometimes the multiplier is external.)

• Resistive divider network for focus and screen (G2)—this will probably be fed from only one of the series connected windings (if used). Often, there are adjustments for focus and screen right on the flyback.

• Auxiliary windings—anywhere from a couple of turns (for the CRT filament) to several hundred turns (for a boost source). Those supply various voltages for the typical TV or monitor: CRT filament, logic power, analog power, boost source (where the flyback does not include its own screen supply), etc.

• Ferrite core—this consists of two C shaped pieces clamped together with either a spring arrangement or studs and nuts. There will be a gap of a fraction of a millimeter provided by a set of spacers between the two C sections.

Most modern flybacks have all the windings on the same leg of the core. The drive winding and auxiliary wind-

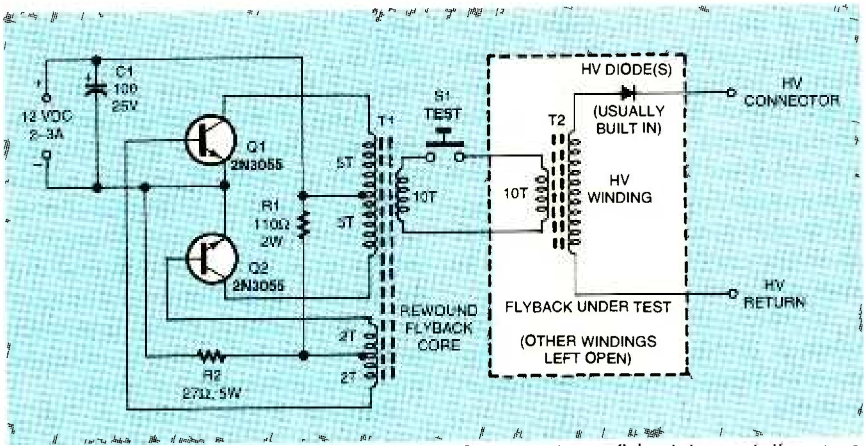


FIG. 2—THE CHOPPER-BASED FLYBACK TESTER excites a flyback in much the same way as would occur in normal operation.

ings will be wound and separately insulated under the high-voltage winding. The high-voltage winding will consist of many layers that have insulating material (i.e., Mylar) between them.

The other components will be mounted in a separate part of the assembly and the entire unit is then potted in an Epoxy-type filler. Part of the core is generally accessible—often one entire leg.

A flyback is not an ordinary transformer. The ferrite core contains a gap. Energy is stored in the magnetic field of the core during scan as the current is ramping up. This was discussed when we dealt with deflection systems in previous Service Clinic articles on deflection systems.

CAUTION: The gap is critical to the proper operation and is usually determined by some plastic spacers. Mark each one and replace them in exactly the same position if you disassemble the core for any reason.

## Why Do Flyback Transformers Fail?

While flyback transformers can on occasion be blown due to a failure elsewhere in the TV or monitor's power supply or deflection circuits, in most cases, they simply expire on their own. Why?

Flybacks are wound with many layers of really, really fine wire with really, really thin insulation. This entire assembly is potted with an Epoxy resin that is poured in and allowed to cure.

In some ways, these are just short circuits waiting to happen. Flybacks get hot during use, and this leads to deterioration of the insulation. Any imperfections, nicks, or scratches in the insulation, or trapped air bubbles and impurities in the Epoxy fill material contribute to failure. Temperature cycles and manufacturing defects result in fine cracks in the Epoxy potting material reducing the insulation breakdown voltage, particularly in the area of the high-voltage windings, rectifiers, and focus/screen divider network. They also physically vibrate to some extent. A whole bunch of other factors are also no doubt important.

Once a breakdown—sparking or arcing—develops, it is usually terminal. Actually, it is amazing that flybacks last as long as they do with the stresses they are under.

## How Do Flyback Transformers Fail?

Flybacks fail in several ways:

1. Overheating leading to cracks in the plastic and external arcing. If there is no major damage to the windings, repair may be possible. However, arcing from the windings punctures their very thin insulation so that shorted windings may already have developed. Even if the windings are currently in good condition, long-term reliability of any such repairs is questionable.

Nonetheless, it doesn't hurt to try cleaning and coating with multiple layers of high voltage sealer, corona dope, or even plastic electrical tape (preferably as a temporary repair, though I have gotten away with leaving this in place permanently). If possible, moving the point to which the flyback is arcing further away (i.e., a piece of metal or another wire) would also help.

2. A cracked or otherwise damaged core will effect the flyback characteristics to the point where it may not work correctly. In some cases that could even blow the horizontal output transistor and other expensive parts, like the low-voltage regulator or switch-mode power supply. If the core can be reconstructed so that no gaps (other than the required ones where the two halves join) are present and clamped and/or glued in place, it should be possible to perform testing without undue risk of circuit damage but consider a replacement flyback as a long-term solution.

3. Internal shorts in the focus/screen divider network, if present. One sign of this may be arc-over of the focus or screen spark gaps on the PC board on the neck of the CRT.

4. Internal shorts in the windings.

5. Open windings.

More than one of these may apply in any given case. As noted, temporary repair at least is sometimes possible for failures 1 and 2. For failures 3 to 5, replacement is usually the only alternative.

## Initial Tests

**Warning:** Before proceeding, make sure you have the TV or monitor unplugged and confirm that the main filter capacitor(s) and CRT have been safely discharged!

For these first tests, you'll only be using your senses and perhaps a multimeter. First, perform a careful visual inspection with power off. Look for cracks, bulging or melted plastic, and discoloration, Look for bad solder connections at the pins of the flyback as well. If the TV or monitor can be powered safely, check for arcing or corona around the flyback and in its vicinity,

Next, perform ohmmeter tests for obvious short circuits between windings; look for greatly reduced winding resistances and open windings. Don't neglect to check between the CRT HV connector (suction cup) and the pins on the base; that should measure infinity.

For the low-voltage windings, service manuals may provide the expected DC resistance (*Sams' Photofact*, for example). Sometimes, that will change enough to be detected—if you have an ohmmeter with a low-enough scale as these are usually a fraction of an ohm. It is difficult or impossible to measure the DC resistance of the HV winding since the rectifiers are usually built in. The value is not published either.

Any measurements that are much less than the published values likely indicate a partially shorted winding. However, a difference of 10% might not be significant at all. Higher than normal readings might simply indicate that a design change was made.

Of course, any continuity between separate windings is definitely a fault.

Partially short-circuited windings (perhaps, just a couple of turns) and sometimes shorts in the focus/screen divider will drastically lower the Q and increase the load the flyback puts on its driving source with no outputs connected. Those types of failures, which are not detectable by simple ohmmeter tests or visual inspection, require the troubleshooting techniques described in the "Advanced Testing" section, a little later in this article.

It is also possible that various types of flyback faults can damage other circuitry (beyond taking out the horizontal-output transistor and its associated parts). Therefore, if shorts are detected in the flyback, it is worth testing some of the components in the vicinity, and *vice-versa*.

## The Process of Elimination

Before attempting the more advanced tests suggested below, there may be ways of being more certain that your flyback is the problem component. The following assumes that running the TV or monitor with the suspect flyback results in an excessive load on the low voltage (B+) power supply, blowing a fuse (or attempting to blow a fuse—excessively bright series light bulb). The B+ likely drops from its normal 65 VDC to 140 VDC or more (depending on the actual TV or monitor and mode) to some low value like 25 VDC when measured on the low-voltage power-supply side of the flyback-drive winding. (Measuring at the HOT can result in all sorts of weird readings due to the pulse nature of the waveform and is not recommended—especially when everything is working properly—since there you will be dealing with 1500 V pulses!)

- Disconnect all the secondary loads from the suspect flyback including the CRT. Connect only the drive (B+ and HOT). Power up the TV or monitor (preferably with a series light bulb or on a Variac). If the B+ now climbs to a more normal value, a problem with the HV (CRT short) or one of the secondary loads is indicated. Connect each of these up one a time (or test individual components) to localize the fault. The flyback is likely good.

- Remove the suspect flyback and connect just the HOT and B+ to the drive winding of a known good flyback for a similar size TV or similar type of monitor (as appropriate). It may be close enough to keep the drive circuitry happy. Power up the TV or monitor (preferably with a series light bulb or on a Variac). If the B+ now climbs to a more normal value, a problem with the original flyback is indicated. However, more thorough testing may be desirable to be absolutely certain.

If you do this regularly, keeping a selection of "flyback simulators"—just the drive windings and cores—might be desirable.

## Advanced Testing

When the basic tests are inconclusive, there are several ways of testing flybacks (assuming you do not actually have special test equipment for this purpose). Here are two possibilities. The first is easier if you have a scope, but the second is more fun.

**Method 1:** The following technique works for flybacks; chopper transformers; motors; mains transformers; deflection-yoke windings; VCR, video, and other magnetic heads; and other transformers, coils, or inductors. It is called a "ring test" and is the method often used by commercial flyback (or other coil/transformer) testers. The theory is that a faulty flyback will have shorted turns in one of the coils. In such a case, the Q of the transformer is greatly reduced. If excited by an impulse, a faulty transformer will resonate with a highly damped oscillation while a good one will decay gradually.

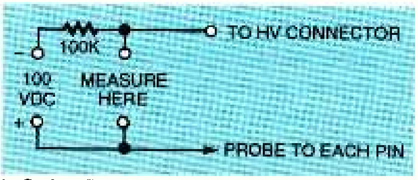


**FIG. 3**—IT IS IMPORTANT TO LOCATE the HV return. This circuit makes that easier to do.

- Connect a high quality capacitor across a larger winding (not the filament) of the suspect device; see Fig. 1. Hope for a resonant frequency of a few kHz. You may need to select the capacitor value for best results. I have found that a capacitor in the 0.001- to 1-µF (non-polarized) range will usually be satisfactory.

- Apply a pulse waveform to the parallel-resonant circuit. In 1960, most scopes had a "sync out" on the time base that provided a few tens of volts at enough current for this. If you don't have one of these, use a simple 555 astable circuit or function generator.

- Look at the waveform across the resonant circuit with a scope. A good unit will give a nicely decaying oscillation, of at least a few cycles, possibly tens of cycles. If there is a shorted turn **anywhere** in the device, the oscillations will be seriously damped, and you'd be lucky to see two complete cycles. Experience and/or comparison with a known good device will tell you what to expect.

**Method 2:** The circuit in Fig. 2 excites the flyback in much the same way as in normal operation; note that none of the component values in the circuit are particularly critical. The only caution is that this tester probably does not put enough stress on the flyback to find an intermittent that fails only under full operating conditions. However, most flyback failures are solid—once a short develops, there is a meltdown of sorts and it is there to stay.

You will need a 12 V power source of at least 2 or 3 amps capacity (regulation is not important—I just use a simple transformer, rectifier, filter capacitor type of power supply). If the circuit does not start oscillating at about 5 volts or less, interchange the two feedback connections to the transistor bases.

The tester is just a chopper feeding the salvaged core from an old flyback (I removed the inductance control spacers for this core). The drive (5T+5T) and feedback (2T+2T) coils can be wound from hookup wire (#14-#20) and well insulated with plastic electrical tape. Connect the center taps directly to the coils—do not bring out a loop of wire. Make sure all the turns of each coil are wound in the same direction. Wind the feedback coil directly on top of the drive coil. The secondary of this core is a 10-turn well-insulated coil similar to the other two wound on the opposite side of the ferrite core.

You will need to remove the suspect flyback from the TV or monitor. Another 10-turn coil is wound on the suspect flyback core anywhere it will fit. Connect one end of this coil to one end of the 10-turn coil on your old flyback core. Use a wire nut or twist together securely. Provide an easy way of connecting the other ends momentarily—a pushbutton comes in handy.

Make sure you locate the HV return lead on the flyback and use that as the return for the arc. Otherwise, you may

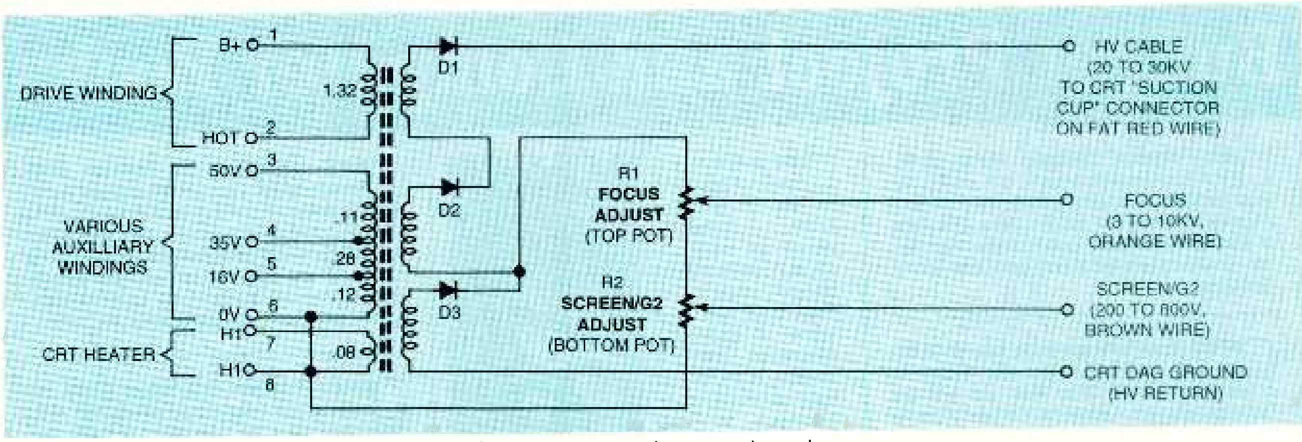


**FIG. 4**—A SCHEMATIC DIAGRAM of a typical flyback. Note the resistance values shown are illustrative and may differ widely from the ones on your unit.

puncture the insulation when the high voltage finds it own path to ground. There are several approaches that can be taken to identify the lead—possibly in combination:

- Process of elimination—the HV return will often be an isolated pin on the flyback not connected to anything else. Check with ohmmeter.
- Check all connections on the circuit board and identify those that go to ground. One of those flyback pins will be the HV return. It will do no harm to connect them all to ground during testing.
- Use a 100-VDC or greater power supply and a high-value resistor, say 100K in the set up shown in Fig. 3. Connect the power supply negative output through this resistor to the HV lead on the flyback (suction cup connector). Check each pin on the base of the flyback with the probe. Touching the return pin will result in the voltage reading dropping to perhaps 50 or 60 volts. This is the forward voltage drop across the high-voltage rectifier stack inside the flyback. All other pins will result in it remaining at the supply voltage.

Once the HV return is found, the circuit in Fig. 2 is wired, and everything is double checked, it is time to "turn on the juice."

- If the flyback is good, then with the coils connected there will be several kV at its output—enough to create a small arc (⅛-inch typical, up to ½-inch for color flybacks).
- The load imposed on the oscillator will be modest (the frequency increases in response to load). If there are any shorted windings, then there will be no significant HV output and the load on the oscillator will increase dramatically.
- If you get arcing or corona from **under** the flyback—at the pins—either you did not locate the correct HV return or there is a short inside resulting in HV arcing internally to the low voltage windings.

I have used this "tester" on a dozen or so flybacks. It has never been wrong (though I have opted not to believe it and gotten in trouble).

## Flyback-Testing Equipment

Sencore and others sell test equipment that includes the "ring test" or similar capabilities built in. For the professional, these are well worth the expense. However, a hobbyist could probably purchase lifetime TV replacements for the cost of one of these fancy gadgets.

Bob Parker has now designed an inexpensive, easy-to-use LOPT/Flyback Tester available through Dick Smith Electronics. Information is available at: www.nlc.net.au/~bobp/fbt.htm (Bob Parker's FBT Page). This (along with his ESR meter) have been highly recommended on the sci.electronics.repair newsgroup.

Other flyback testers are described at: www.usit.com/kephart/flyback.htm (Kephart's FBT Page) and www.vaag.es/produc/art/hr-stvdst-01/index_en.htm (VAAG FBT Page). Various electronics magazines have published construction articles for various types of simplified versions of these devices as well.

## Testing for Bad High-Voltage Diodes

A single diode failure would be tough to find if it is in series with other diodes (as is typical on larger flybacks) as it would only be a problem when run near full output. However, this sort of failure is unlikely.

General diode failure (shorts) would probably not be detected with the sorts of tests described above or with typical flyback-testing equipment. Actually, a simple ohmmeter test between the HV output and return might suffice! If this doesn't reveal anything, I suggest the following:

One possible way to test for this would be to attach a high-voltage capacitor between the HV output and return of the flyback. If the diodes are good, the tester's excitation should then charge this cap up (watch out—the voltage might get to be quite high!). While charging, this load will make the flyback fail any ring test. Once charged, it should pass. However, if the diodes are shorted, I would expect the flyback to test bad as the cap will continue to present an AC load on the output and never charge properly.

## Typical Flyback Schematic

The diagram in Fig. 4 shows a typical flyback that might be found in a direct-view color television or computer monitor. Resistances are included for illustrative purposes only and may be quite different on your flyback.

The high-voltage section on the right might actually be constructed as a voltage multiplier rather than a single winding with multiple HV diodes. The rectifiers or multiplier, and/or focus/screen divider might be external to the flyback transformer in some models.

Flyback transformers used in black-and-white TVs and monochrome computer monitors do not have a focus and screen divider network. Older ones do not include a high-voltage rectifier

*(Continued on page 87)*

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☐ **BP136—25 Simple Indoor and Window Aerials $2.99.** Many people live in flats and apartments where outdoor antennas are prohibited. This does not mean you have to forgo shortwave listening, for even a 20-foot length of wire stretched out under a rug in a room can produce acceptable results. However, with experimentation and some tips, you may well be able to improve further your radio's reception. Included are 25 indoor and window antennas that are proven performers. Much information is also given on shortwave bands, antenna directivity, time zones, dimensions, etc. A must book for all amateur radio enthusiasts.

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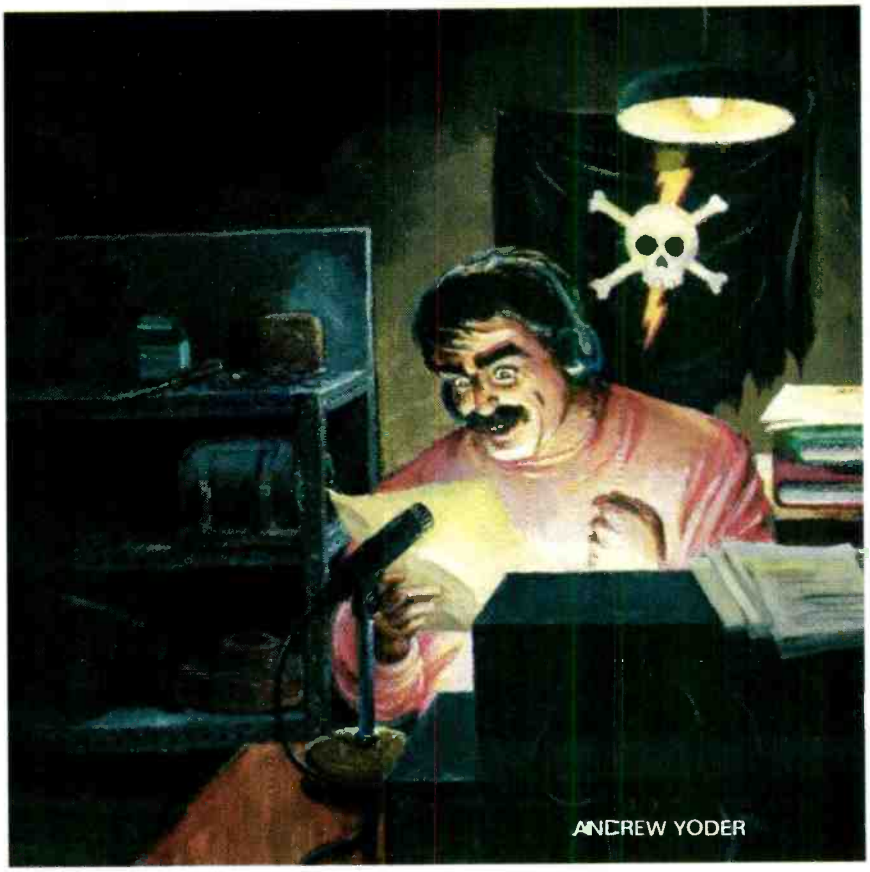
# Pirate Radio

*Shiver me timbers, here's a look inside the never boring world of clandestine broadcasting, more colorfully known as "Pirate Radio."*



ANDREW YODER

Radio tubes are glowing in the dim, electronics-equipment-strewn room. The aroma of incense laces the air. Steve Mann tunes around the shortwave frequency of 6955 kHz one last time to check for other stations using the channel. The radio emits only the light crackle of atmospheric noise. He leans over, flicks a switch on an aging amateur radio transmitter, and punches the play button on his cassette deck. Radio Eclipse is on the air.

As the opening "signature" (interval signal) is playing, shortwave listeners from Ontario to Texas begin tuning in. Others dial up the Internet to let friends know that Radio Eclipse is broadcasting a new program.

Meanwhile, back at the clandestine studio of Radio Eclipse, the strains of "Everybody Wants You" by Billy Squire die down. Steve Mann begins the much-anticipated "News of the Week" segment. As usual, Steve mixes factual news with shortwave culture and complete nonsense...producing often-hilarious results. In the past, Mann had aired everything from barbs at sportscaster Marv Albert to announcing a "list" of Andrew Cunanan's potential victims that the station "discovered." This week, however, Mann sticks with safer targets, namely those involved with the goings-on in Washington.

After a few more songs, fake ads, station-address announcements, and more of the interval signal, Mann turns off the tube finals and puts the transmitter in standby mode to cool off. Just after turning the receiver back on, the static is broken by the words "Good show, Steve." Mann flicks off the standby switch. So ends the broadcast day of Radio Eclipse.

As you might have guessed, Radio Eclipse is a pirate station—one of those almost-mythical phenomena that have been quietly making the headlines for the past decade, but that few people seem to have heard or really know anything about. Sure, many have seen articles about Stephen Dunifer of Free Radio Berkeley, who has tied the FCC up in court for several years or about Radio Newyork International or Radio Caroline (from England), both of which broadcast from large vessels in international waters. But how many have actually heard a pirate?

Stations have been pouring on to the airwaves over the past five years in the United States and Canada. By the FCC's estimates, 300 pirate stations were broadcasting from the U.S. going in to 1998, but these numbers are certainly conservative. Miami, Florida alone has boasted approximately 20 stations in 1998! A radio pirate in your hometown might even have escaped your attention. So, then, who are these pirates and what is the hoopla all about?

**FM Pirates.** Free Radio Berkeley

**ABOUT THE AUTHOR**

Andrew Yoder publishes *Hobby Broadcasting* magazine. He has also written the following books about pirate radio: Pirate Radio Stations, Pirate Radio, and Pirate Radio Operations. He can be contacted at: ayoder@cvn.net or P.O. Box 642, Mont Alto, PA 17237.


*A business card from Steve Mann's Radio Eclipse pirate radio station.*

has been in court with the FCC for several years over their right to broadcast. But the group has done much more than just create legal hassles for the FCC. FRB has also worked hard to spread pirate radio (called "microradio" or "microcasting" by those devoted to the cause) to the masses. Stephen Dunifer has sent out regular press releases, newsletters, and comments concerning Free Radio Berkeley in particular, and the unlicensed radio scene in general, to the FCC and major mass-media outlets across the country.

The press releases and newsletters helped keep Free Radio Berkeley and other unlicensed broadcasters in the news in the San Francisco Bay area, and as a hot feature across the country. But Free Radio Berkeley did more than just inspire others to broadcast. They actually helped put other stations on the air by producing transmitter kits so that other like-minded people could have their own piece of the airwaves.

As a result, stations began popping up across the FM band around the United States, many using the FRB transmitters. The motivation was simple; most radio enthusiasts seem to believe that licensed radio has abandoned community and niche programming. Before long, companies such as Veronica, Broadcast Warehouse, and others were manufacturing higher-powered FM transmitters and marketing them in the United States. The competition lowered the transmitter prices, and even more stations began broadcasting.

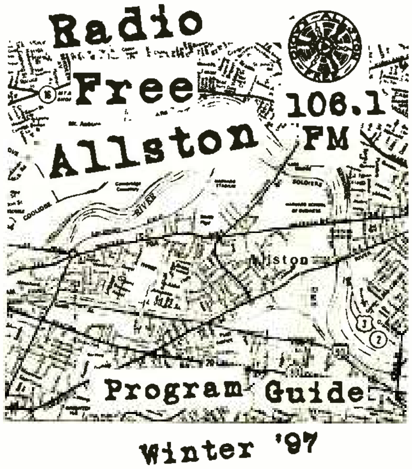
Now it seems that in any city of 100,000 or greater, at least a few FM pirates are broadcasting, either on a set schedule or irregularly. The larger cities have literally dozens of pirates, some of which are broadcasting on a 24-hour-per-day/7-days-a-week basis. For example, when the FCC swept into Miami, Florida in the summer of 1998, it raided 15 different FM pirates that were broadcasting on a regular basis. Within a month of the enforcement actions at least five new pirate broadcasters, all operating on regular schedules, could be heard.

The same story is being repeated across the country. Stations begin broadcasting, the FCC closes some of them down, and more operations come to life. As the FCC raids more stations, the pirates become more resourceful and more determined. It appears that some huge events are on the horizon for unlicensed FM broadcasting.

**AM Pirates.** For decades, AM pirate radio mostly occurred at the top end of the AM-broadcast band. The earliest well-known AM pirates began broadcasting there in the 1960s and 1970s. From that point on, the 1615- to 1635-kHz range was pirate territory. In the late 1970s and early 1980s, pirates such as WFAT, Pirate Radio New England, WART, WDX, WENJ, KPRC, KW Radio, Free Radio 1615, and many others would have hundreds of listeners, often receiving dozens of calls during every broadcast.

Much has changed, however, since the AM "expanded band" opened in the U.S. Long-distance U.S.-based radio pirates have largely disappeared because any such stations appearing within the band are for the most part crowded out by much more powerful signals from commercial stations at night. But AM pirating lives on in other countries. Dozens of stations from the Netherlands crowd the area from 1580 to 1630 kHz, and pirates from Greece and Yugoslavia often can be heard there as well. These days, if any North American pirate would like to broadcast on a clear nighttime channel, it would be necessary to move to 1710 or 1720 kHz. But will anyone be listening?

**Shortwave Pirates.** For decades, the shortwave frequencies have been a favorite pirate hangout. Those on the outside might wonder why anyone would waste their time broadcasting on frequencies that many can not receive. But upon further inspection, you can see that the shortwave bands and pirate radio seem almost made for each other.




*Some pirate stations broadcast on a fixed schedule and even provided a program guide such as this one from a suburban Boston operation.*

The greatest advantage of shortwave is its ratio of signal coverage to power. The typical 10-watt FM station will only cover anywhere from a few blocks to a few miles, depending on the height of the antenna and the obstacles in its path. However, with a decent antenna, 10 watts on shortwave can easily cover several hundred miles during the daytime or 1000 miles at night.

Obviously, if shortwave signals can cover such a huge territory, these stations are much more difficult to locate using direction-finding (DFing) equipment. The pirate could be anywhere! Also, shortwave signals can reflect off large buildings, hills and mountains, water towers, etc. and provide false signals for those who are attempting to locate the station.

*A QSL card from 1970s pirate WFAT in New York City.*

The vast distances and many borders traversed by shortwave signals give those frequencies the final advantage. Who wouldn't feel compelled to tune in mysterious broadcasts from great distances? For example, in the 1970s and 1980s, Russian pirates, called "radio hooligans" by Soviet officials, often broadcast in the 2000- to 4000-kHz region. After the fall of communism in the Soviet Union, the Russian pirate Radio Without Borders International was heard all over Europe (and even in Canada) with its pro-Western pop music format.

**Recent Enforcement Actions.** Until relatively recently, pirate stations, both on shortwave and FM, have been broadcasting with reckless abandon, sometimes for several years. Many of those FM stations bluntly challenged the FCC's rules and their right to enforce them. These stations, particularly the ones that operated on a regular schedule, were staffed by volunteers from the community and often operated from a fixed location. For the most part, the shortwave stations were more careful and operated only a few hours per month, but still mostly from homes or other permanent locations.

But in November 1997, the FCC began to put the squeeze on much of the carefree broadcasting. The first action was an attack on a trio of FM stations (87X, Lutz Community Radio, and The Party Pirate) in the Tampa, Florida area. Those raids were notable because the FCC exercised considerable force to close down the community stations. Those who owned the stations were awakened in the early morning hours, with SWAT teams aiming automatic weapons at them. While the station owners were cuffed, face down on the floor, agents from numerous government agencies rifled through personal possessions, confiscating radio equipment, audio equipment, and music collections.

The enforcement activities continued throughout 1998. Outspoken opponents of the FCC, such as Radio Mutiny (Philadelphia), Free Radio Berkeley, and others were all closed down. The FCC claimed more than 200 raids against pirates in 1998.

But the stations haven't disappeared; if anything, they've become more resourceful. Radio Mutiny was perhaps the master of strategic publicity. After a publicity campaign, the station broadcast from the site of the Liberty Bell. They stated that if their voice of liberty was wrong, then the FCC was justified in raiding the station there, in front of our nation's symbol of liberty and the TV cameras. The FCC was apparently camera shy and the broadcast was a success. Armed with the promise of a media blitz, a female announcer broadcast from their studios completely naked that night, daring the FCC to close the station. Again, another success. When Radio Mutiny was eventually raided, the FCC waited until no one was around and the station was off the air.

At a low-power FM conference in Washington, DC in October 1998, attendees marched to the buildings of the FCC and the National Association of Broadcasters (NAB). As the parade reached the front of

**Some Active North American Shortwave Pirates**

| | |
|---|---|
| Blind Faith Radio | Testing and 1960s/1970s album rock. |
| Free Hope Experience | A weird mixture of UFOs, free speech, and comedy skits. |
| Mystery Radio | All-instrumental synthesized music—very mysterious! |
| Radio Azteca | Homebrew comedy all related to shortwave listening. |
| Radio Eclipse | A wide variety of music and elaborate parodies. |
| Radio Free Speech | Professional mix of novelty music, fake ads, and free speech editorials. |
| Radio Metallica Worldwide | Rock and metal music, plenty of R-rated discussions. |
| WACK | Rock music and telephone call-ins. |
| WEED | Collage-style mixes of rock and punk music, with snips of audio from speeches and movies. |
| WLIQ | Mostly rockabilly music. |
| WLIS | "We Love Interval Signals"—interval signals from stations around the world and some rock music. |
| WMPR | Techno music and brief IDs. |
| WSRR | "Solid Rock Radio" Rock, rap, and soul music, with some Christian sermons. |

the FCC building, a 10-watt FM transmitter was turned on and Radio Mutiny began broadcasting, speaking out against FCC control of the airwaves. The FCC again took no action.

In late November, two radio activists in Berkeley, California broadcast for days, 50 feet up in a redwood tree as "Tree Radio Berkeley." According to several reports, the pair had received considerable media attention and vocal support


*Mystery radio is one of a number of active (as of this writing) North American shortwave pirates. See the sidebar for others.*

from people in the community. It was also reported that the FCC's first attempt to serve the pair a Notice of Apparent Liability failed because they couldn't find a way to get the papers up the tree!

On shortwave, activity in the United States has decreased significantly following raids on four different pirates around the country this past October. Unlike the direct-confrontation approach taken by many FM stations, the shortwave pirates have simply disappeared, apparently awaiting the time that "the coast is clear."

**Tuning In To Pirate Radio Stations.** If you live in a city or in the suburb of a major city, you have the opportunity to hear FM pirates. But they can be difficult to locate. In many large cities, the radio spectrum is nearly full. The best way to look for FM pirates is to get to know the broadcast spectrum and frequently tune the clear channels. Otherwise, it's a good idea to regularly read the alt.radio.pirate newsgroup on the Internet, check the local record shops and alternative weekly papers, and read *Hobby Broadcasting* magazine (see the "About the Author" box). Once you know that a station is active on a given frequency, then you can tune in whenever you have a chance and see if anything turns up.

Shortwave is very different. You don't need to really know a huge variety of frequencies. Instead, most pirates congregate around several well-known, clear frequencies. The current prime frequency area is plus or minus several kilohertz of 6955 kHz, just below the 40-meter amateur band. Also, one of the best-heard pirates of recent years is Radio Metallica Worldwide, which has been using 7415 kHz when a licensed station (WBCQ) that also uses that frequency is off the air. Most pirates broadcast during the weekend afternoons and evenings, although when activity was peaking in 1997 and 1998 (before the FCC raids), weekday-evening broadcasts were not uncommon.

The European pirates typically use the frequencies between 3900 and 3950 and also 6200 to 6300 kHz. The former range is used primarily at night and the latter is used during Sunday mornings. Often, more than one and sometimes two dozen stations broadcast every weekend, but these are very difficult to hear in North America because 3900-3950 kHz is part of the North American 80-meter ham band and signals in the 6200- to 6300-kHz range don't travel far in the daytime.

*(Continued on page 44)*

**The History Of Unlicensed Radio**

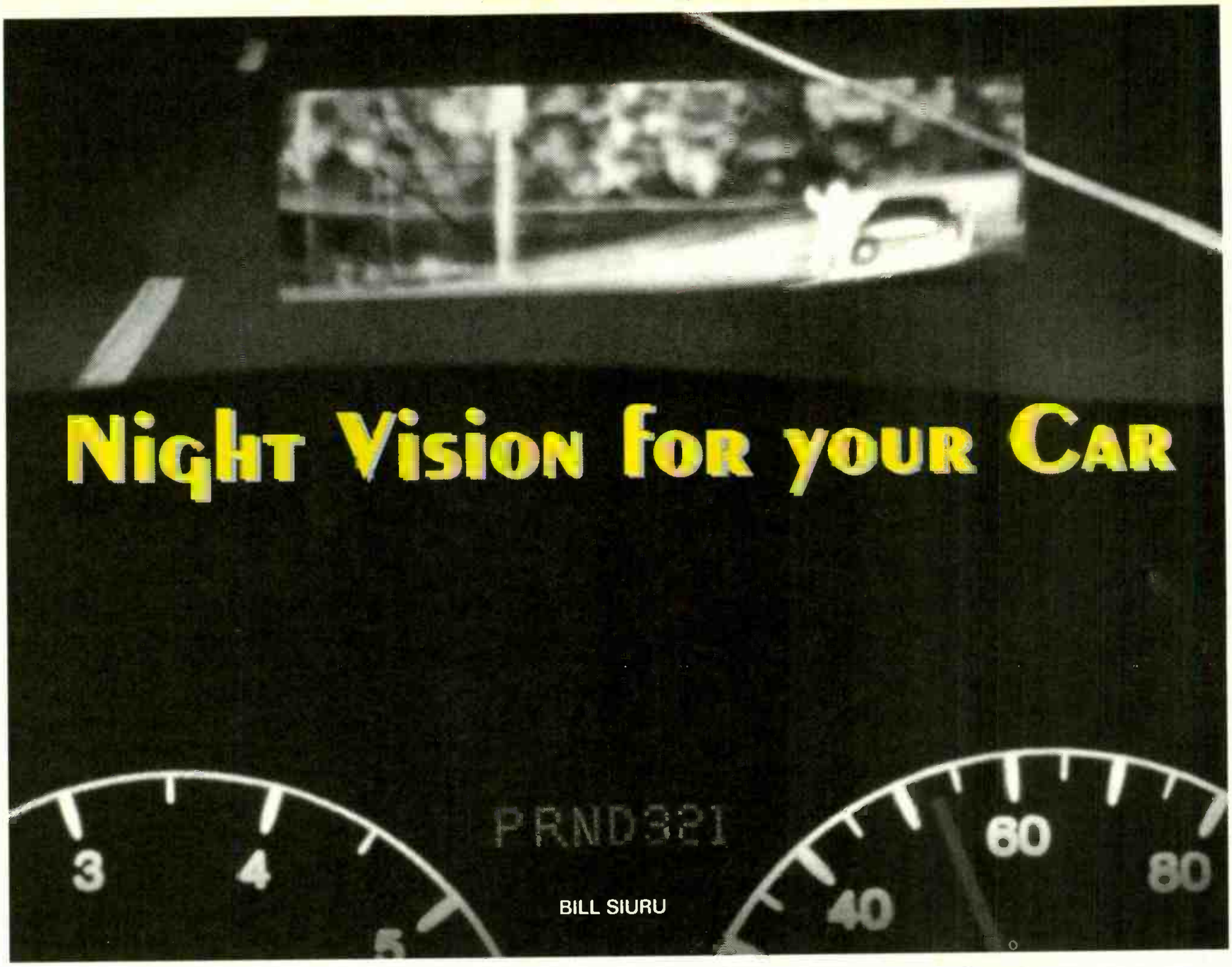
Without a doubt, pirate radio goes back to the earliest days of broadcasting. The first broadcasts ever were made by Reginald Fessenden on Christmas Eve 1906. Just like the pirate broadcasts that would appear nearly a century later, Fessenden's program appeared on a holiday without a schedule; was relatively short; featured variety show music, talk, and readings; and it surprised those who tuned in. Of course, Fessenden's broadcasts were also unlicensed. According to many accounts, these types of unlicensed, hobby broadcasts occurred through the teens, up through the early 1920s when the Federal Radio Commission (predecessor of the FCC) banned unlicensed broadcasting and broadcasting by amateur-radio operators.

It wasn't long until pirates began actively challenging the authority of the FRC. The first-known "true" pirate was WUMS ("We're Unknown Mysterious Station"), which operated irregularly from the banks of the Ohio River from 1924 until 1948. Station operator David Thomas even built a secret transmitter into a table and managed to foil the FCC in court in 1938 and 1948—even though he had been sentenced to four years in prison and an $8000 fine. The real end for WUMS came not from the FCC, but from the operator himself. Thomas died of cancer in 1983, soon after testing a new transmitter that would have put WUMS back on the air.

Other early mentions of pirate radio are difficult to find, but are recorded, nonetheless. For example, *Zenith Radio: The Early Years* by John Bryant and Harold Cones features a photo from when the Zenith flagship radio station decided to defy the FRC's ruling concerning their frequency in 1927. The station staff all donned pirate costumes for the broadcast! And a 1930s issue of *RADEX*, a radio-listening magazine, mentions one listener who received QSL cards from several different Ohio AM pirates.

Pirate radio slowed down for World War II, replaced instead by clandestine radio and espionage. The Cold War of the 1950s also was tough on the independent broadcasters. But as the commercial pirates (such as Radio Caroline, Radio London, Radio Mercur, Radio City, and others) began to take to the airwaves off the coast of Northern Europe in the late 1950s and early 1960s, pirate radio suddenly caught the interest of a new generation. In addition to inspiration from the Europeans, American enthusiasts were aided by then-inexpensive World War II surplus equipment, Lafayette phono oscillators, and such underground works as *The Anarchist Cookbook.*

By the 1970s, pirate radio was a fully established niche and some radio hobbyists even labeled themselves as "pirate radio listeners." The situation was especially well entrenched in Europe, where some shortwave pirates were receiving literally hundreds of letters for just a Sunday morning broadcast. Activity was not nearly as organized in North America during the 1970s, but still numerous stations were active during the decade.




# Night Vision for your Car

BILL SIURU

*Night driving just got much safer thanks to this new system from Cadillac*

Night vision technology is now routinely used by the military, law enforcement, fire departments, TV-news cameramen, and others who have to "see" in darkness. Starting in the year 2000, it will also be used by drivers of the new DeVilles as Cadillac is set to be the first automaker to offer night vision on a production vehicle.

Cadillac's Night Vision will make nighttime driving safer by helping drivers see objects that would otherwise remain in the dark. While nighttime driving represents only about a quarter of total miles driven, according to data from the National Highway Traffic Safety Administration (NHTSA), it accounts for more than half of all traffic fatalities. While many other factors, such as fatigue, contribute to this increase in nighttime crashes, decreased visibility certainly plays a significant role.

Cadillac Night Vision will help drivers see beyond the range of their head lamps. However, it is not intended to be a "drive-by" system or to replace a driver's view out of the windshield. What it will do is give drivers additional visual information beyond what their unaided eyes are capable of seeing. Depending on conditions, with Night Vision drivers will see three to five times farther down the road than with just low-beam headlamps. Night Vision can also help drivers see beyond the blinding headlamp glare from oncoming vehicles or spot a deer amongst the dried brush at the edge of the road.

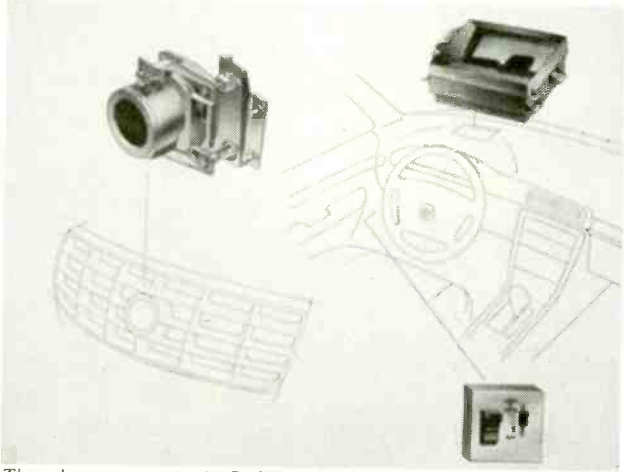
**How It Works.** Technically, the title "Night Vision" is a bit of a misnomer since that term is usually associated with image intensification (II) technology used commonly in night-vision goggles. Instead, the Cadillac system uses thermal imaging (TI), or infrared (IR) detection. Thermal imaging is based on the differences in heat energy emitted by all objects in a scene being viewed. Everything emits heat to some degree, but humans, animals, and moving vehicles are more visible in the TI image because of their high thermal contrast compared to the background. Drivers view the TI scene on a heads-up display (HUD) developed by Delphi-Delco Electronics.

**FOR MORE INFORMATION**

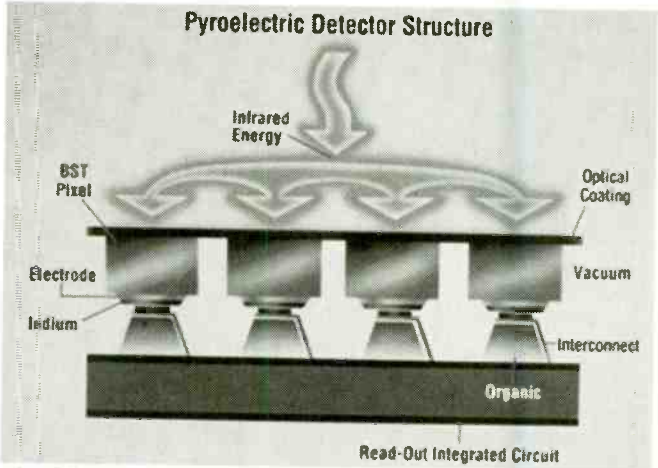
**Cadillac Communications**
100 Renaissance Center
Detroit, MI 48265-1000
Tel: 800 760-4078

The IR detector on Cadillac's Night Vision system (developed by Raytheon Systems Co.) uses an uncooled focal plane array (UFPA) made of barium-strontium-titanate (BST), a ferroelectric material. One important property of that sensor is that it operates at room temperature to measure the thermal energy of objects that are invisible to the human eye; while detector temperatures are stabilized with thermoelectric coolers, there is no attempt, nor need, to achieve the cryogenic temperatures used in similar detectors.

No mechanical scanner is required to serially trace out object space to produce an image. Instead, each pixel of the one-inch UFPA detector "stares" out into space continuously, the scene energy is modulated, and the image is then produced by electronically scanning or reading out the detector array. The



*Three key components in Cadillac's Night Vision system include the IR detector (behind the grille), the HUD, and the controls.*




*The IR detector consists of a barium strontium titanate reticulate structure bonded to a readout integrated circuit.*

UFPA has 320 horizontal IR sensing elements and 240 vertical elements. Thermal energy is focused on the detector, using optics designed to pass infrared wavelengths. Each element is a temperature-dependent capacitor that changes capacitance depending on how much IR energy is received. A chopper disc rotates in front of the detector to modulate the scene's energy by allowing the pixels to view the scene and then an absence of scene. It rotates in phase with the detector read-out circuitry timing. The circuit under each element samples capacitance on a regular basis, and those readings are converted into a monochromatic video signal in which hotter objects in the scene appear white.

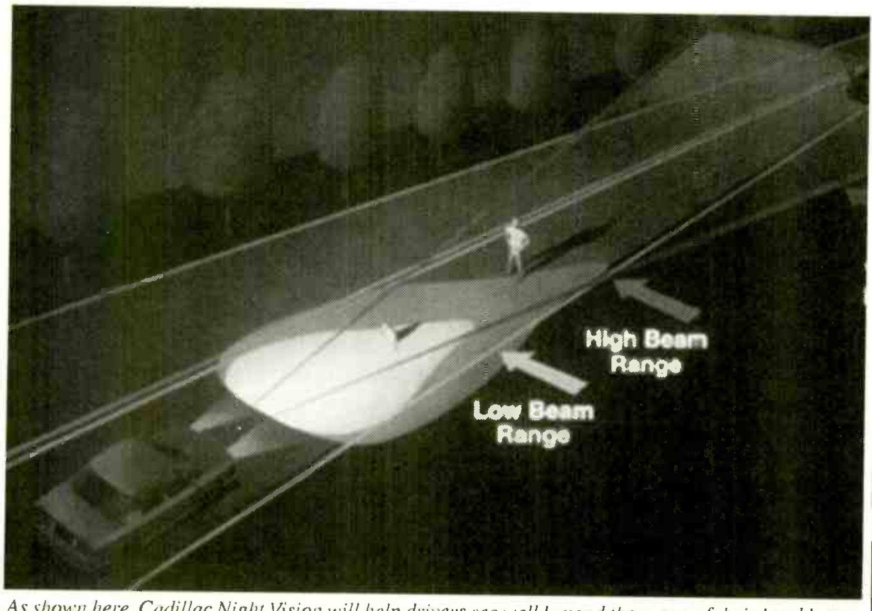
Refractive optics, chosen because of their smaller package, are mechanically controlled internally to keep the system in focus over the anticipated temperature range. The optics, similar to those used in visible-light cameras, refract the IR rays from the object to the detector.

After considering factors like sensor size, vibration, dirt, damage from stones, and weather and temperatures, Cadillac located the sensor behind the center of 2000 DeVille's grille. There it has an unobstructed view of the road and can be kept reasonably clean by just washing the car. It is equipped with a window to protect the optics as well as to provide a durable surface to clean. An internal heater prevents snow and ice build-up on the window.

The HUD is integrated into the dash in front of the driver and projects a virtual image that appears in the driver's peripheral vision above the instrument pod, where it does not obstruct the view of the road. Drivers can glance at the virtual image without refocusing or removing their eyes from the road, much like they use rear-view mirrors. The image has a horizontal field of view of 11 degrees and a vertical field of view of 4 degrees. Objects in the image are the same size as the objects in the road scene helping drivers better judge the distance to an object. The virtual image looks somewhat like a black and white photographic negative with hotter objects the driver cares about most—*i.e.* people, animals, and moving vehicles—standing out from the black background of the cooler objects. Having the HUD image projected below the driver's line of sight also helps the driver handle headlamp glare from oncoming vehicles. The image location is ideal since the drivers tend to naturally look downward to avoid the glare.

The system operates only at night, when the head lamps are on and the "Twilight Sentinel" photo cell indicates it is dark. A switch controls image position and intensity. The image position is adjusted by moving a mirror in the HUD so the virtual image is moved up and down to the desired position.

Night Vision can help even when you are not driving down the road. For example, it can enhance personal safety by detecting a person hiding in the dark near homes, offices, and parking lots. It can also help drivers see someone changing a tire on the side of the road where they might not be visible with the naked eye until it's too late. Ω




*As shown here, Cadillac Night Vision will help drivers see well beyond the range of their head lamps*

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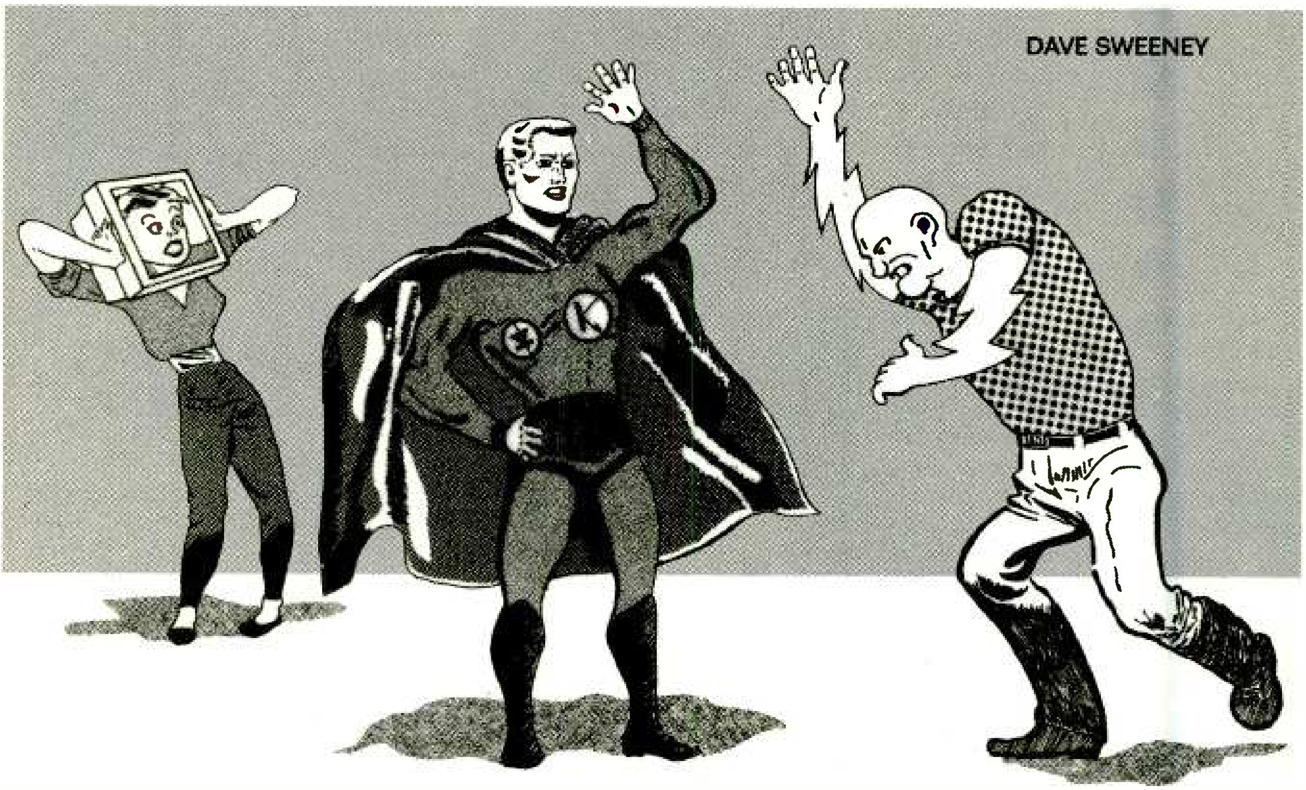
# Protect Your Computer's Parallel Port With This Optical Isolator



DAVE SWEENEY

*Accidentally burning out a computer's internal circuitry is a thing of the past with this simple device.*

There are an ever-increasing quantity of projects and devices that are controlled by the output signals available from a computer's printer port. Examples of those devices include relays, stepper motors, lights, and even electric trains. There have also been several projects that have appeared in both **Electronics Now** and our sister magazine, **Popular Electronics.** In fact, if a way can be found to use a 5-volt digital signal to control some device, it can be hooked up to a printer port and controlled by some simple software commands. With that ability at your fingertips, you could (dare we say it)...run the world!

Seriously, though, interfacing a computer to a piece of hardware and having the software react to feedback from external signals has opened up a new level of control and sophistication in electronics. The problem many times has become one of taking proper safety steps to safeguard your computer from any errors that you might have made in assembling your latest experimental project. The days where you could build a new project and "watch for smoke" are sadly (or thankfully) gone. An ungrounded soldering iron, voltage on a ground return, or a short at the wrong moment could zap a computer's internal circuits. Even an inductive pulse on the computer's output could cause a smokeless tragedy.

What is needed then is a way to electrically isolate the printer port's signals yet let them pass through to the device that they are to control. The ideal solution is optical isolation. That way the parallel port's pins are disconnected electrically from the outside world, but signals can flow back and forth on a beam of light. Combining the Parallel-Port Optical Isolator presented here with software that controls the separate pins on the parallel port results in a system that's safe

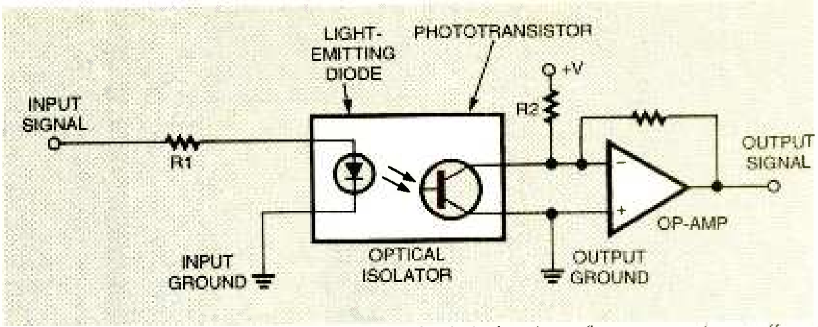



*Fig. 1. A simple opto-isolator circuit can completely isolate input from output electrically without impeding the signal itself; the signal travels on a beam of light.*

for computer control of your experimental devices.

**Light Signals.** By using light to conduct a signal, optical isolators interrupt the electrical connection between their input pin and output pin. A typical arrangement, shown in Fig. 1, demonstrates the concept. Inside the optical isolator are a light-emitting diode and a phototransistor. When a positive voltage is applied to the LED through current-limiting resistor R1, the LED shines. The light from the LED falls on the phototransistor, causing it to conduct as if a current were applied to its (non-connected) base lead. Note that on some real-world optical isolators, the phototransistor's base lead is brought out to an additional pin.

Normally, the collector lead of the phototransistor is at a positive voltage supplied through R2. When the phototransistor conducts, the current through R2 is shunted to the output ground through the phototransistor's emitter. Because of the voltage drop inherent in all semiconductors, the voltage on the phototransistor's collector will generally be below one volt—it will never reach a zero-volt potential unless the emitter is connected to a negative voltage that is equal to the phototransistor's voltage drop.

At this point, the output signal is an inverted version of the input signal; if that is fine for your application, no further conditioning to the signal is needed. However, it is usually best to keep the polarity of the output and input signals matched. In the Fig. 1 example, the inverted and isolated signal is buffered and re-inverted by an op-amp. An additional advantage of using an op-amp is having a low-impedance output.

It is very important to note that the input and output grounds are not connected together in any way; the purpose of optical isolation would be defeated if they were. To further enhance electrical isolation, a separate power supply should be used for the output portion of the circuit; that is, the phototransistor and op-amp.

**Circuit Design.** The full schematic diagram for the Parallel-Port Optical Isolator is shown in Fig. 2. Note that it is very similar to the single isolation circuit of Fig. 1. While any opto-isolator chip that has a similar pinout can be used in place of the devices specified, keep in mind that the suggested units have an isolation rating of 5000 volts—much higher than most other units that are commonly available.

In our discussion of the basic circuit, we did not mention any detailed description of the op-amp. Traditionally, an op-amp in its linear mode always tries to keep its two input lines at the same voltage level. By feeding back the op-amp's output voltage to one of the inputs, the output can be made to follow an input signal at whatever ratio and pattern set by external components. While that explanation is very simplistic, it is sufficient for our purposes here; a detailed discussion can fill a book.

When used in a non-linear mode (linear mode with "infinite" gain), an op-amp compares the voltage levels of the inputs. If the non-inverting input is higher than the inverting input, the output will go high. A reference voltage is needed to set the point at which the output will change state. A reference voltage of one-half the power supply voltage is created by R41 and R42; that reference voltage is applied to all of the non-inverting inputs. As long as the voltage from the phototransistors does not fluctuate beyond that level, the output of the op-amps will remain stable.

An additional opto-isolator, IC3, lets the Parallel-Port Optical Isolator send isolated feedback signals to the computer. Note that op-amp buffers are not used. Since the parallel-port input circuit is a known load that does not change, buffering is not necessary. However, note that the phototransistor's load resistor is connected between the emitter and ground, acting as a pull-down resistor when the phototransistor is off; the result is a non-inverting output to the computer. Although there are five input lines in a standard parallel port, only four are implemented; the opto-isolator chip that we are

## LISTING 1

```
                'Continuous pulse output to pin 3
10              'Start
OUT &H3BC,0     'Reset all pins – port 3BC is assumed. Port 278 or 378 possible
D=2             'Value selects pin – 1=pin 2, 2=pin 3, 4=pin 4, 8=pin 5, 16=pin 6,
32=pin 7, 64=pin 8, 128=pin 9
PW=5            'Controls the time the output is high (pulse width)
                'Begin pulse generation
OUT &H3BC, D    'Sets pin 3 high
DO WHILE I,PW
        I=I+1
LOOP
I=0
PI=10           'Controls the interval between pulses
OUT &H3BC,0
DO WHILE I<PI
        I=I+1
LOOP
GOTO 20
```

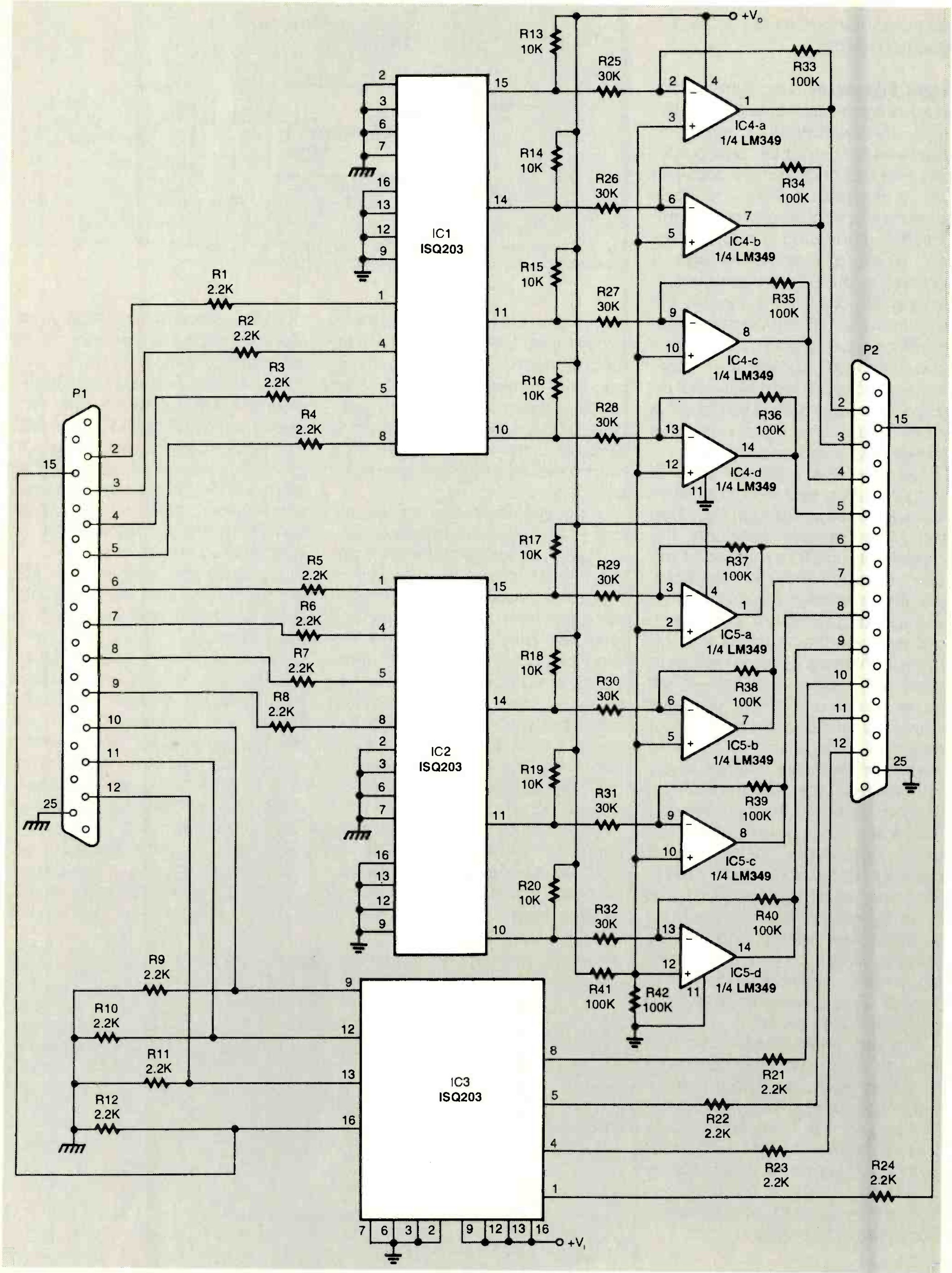



*Fig. 2. The Parallel-Port Optical Isolator uses a series of eight opto-isolator circuits to isolate the port's output lines. An additional set of four circuits lets feedback signals enter the computer. Note that two completely separate grounds are used.*

using has four isolation circuits. With those input signals, the computer software can react to signals from whatever external hardware is plugged into the Parallel-Port Optical Isolator. Similarly, only the eight main data lines are used for output. Since not all of the standard signals are connected, the Parallel-Port Optical Isolator can't be used with traditional computer equipment such as printers or other devices that plug into the parallel port. Those limitations should be kept in mind when you are connecting any type of hardware to the Parallel-Port Optical Isolator.

**Power Supply.** As mentioned above, the Parallel-Port Optical Isolator needs a separate power supply to prevent any possible electrical damage to the computer. The schematic for the power supply is shown in Fig. 3. Each supply voltage is regulated. While IC6, a simple 5-volt regulator supplies power to the input circuit (IC3), a higher voltage is needed for the output (computer-to-hardware) circuit. In order for the op-amps to achieve a 5-volt peak output, their supply voltage must be at about 6.5 volts. An LM317T adjustable regulator is used for IC7. With a 12-volt input, the values shown for R1 and R2 will set the output to 6.5 volts. Variations in the supply voltage might change IC7's output voltage; adjusting the value of R2 will compensate for any supply variations.

**Construction.** The Parallel-Port Optical Isolator is simple enough to be built on a piece of perfboard using standard construction techniques. However, a neater assembly results if a PC board is used. For those that would like to use the printed-circuit approach, foil patterns for the single-sided boards have been provided. Note that the power-supply regulators have been placed on a separate board. Having two smaller boards instead of one large one gives you more flexibility in choosing a suitable enclosure for the unit.

If you decide to etch your own PC boards using the foil patterns, follow the parts-placement diagrams when assembling the boards; Fig. 4 is for the optical-isolator circuit itself while Fig. 5 is for the power-supply regulators.

It is a good idea to use sockets for the integrated circuits. Not only will that make it easier to replace a "zapped" IC when repairing the unit, it will make testing easier. For now, just install the sockets; do not install the ICs at this time. When building the main board, don't forget to install the several jumpers that are indicated; use insulated wire to prevent any accidental shorts.

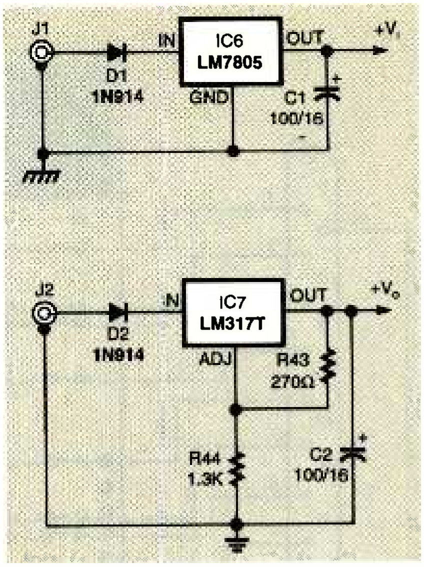
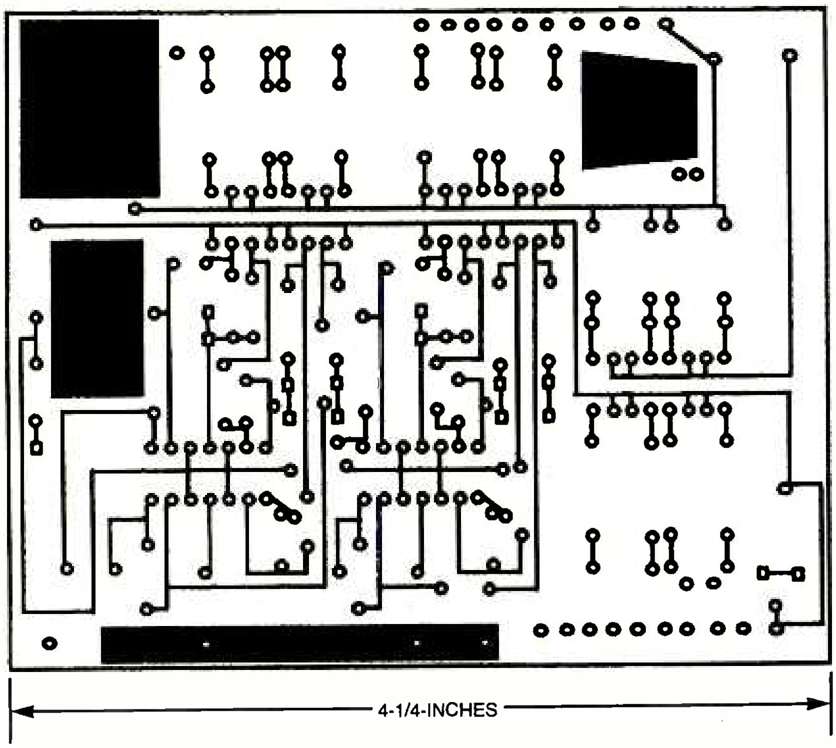



*Fig. 3. A simple pair of power regulators supply the Parallel-Port Optical Isolator. Note that the output supply uses an LM317T to supply 6.5 volts to the op-amps. That way, the output of the op-amps can reach a full five volts for CMOS compatibility.*




*Here's the foil pattern for the Parallel-Port Optical Isolator's main board.*

**A Ready-Made Enclosure.** The Parallel-Port Optical Isolator can be housed in any suitable enclosure. However, cutting the trapezoid-shaped holes for the DB-25 connectors can be difficult. It would also become annoying having to keep plugging and unplugging the Parallel-Port Optical Isolator every time you wanted to use it. The solution to those problems is to install the unit into an existing parallel-port A-B switch. Those devices, available at most computer stores, let you connect two pieces of equipment to a parallel port. By turning the switch on its front panel, you can connect either device to the computer without having to change or move any cables, saving wear and tear on the connectors, pins, cables, wires, and—most importantly—your sanity!

In selecting an A-B switch, it is important to choose a mechanical one. There are "automatic" devices available, but they are completely electrical in nature and sometimes require special software to use.

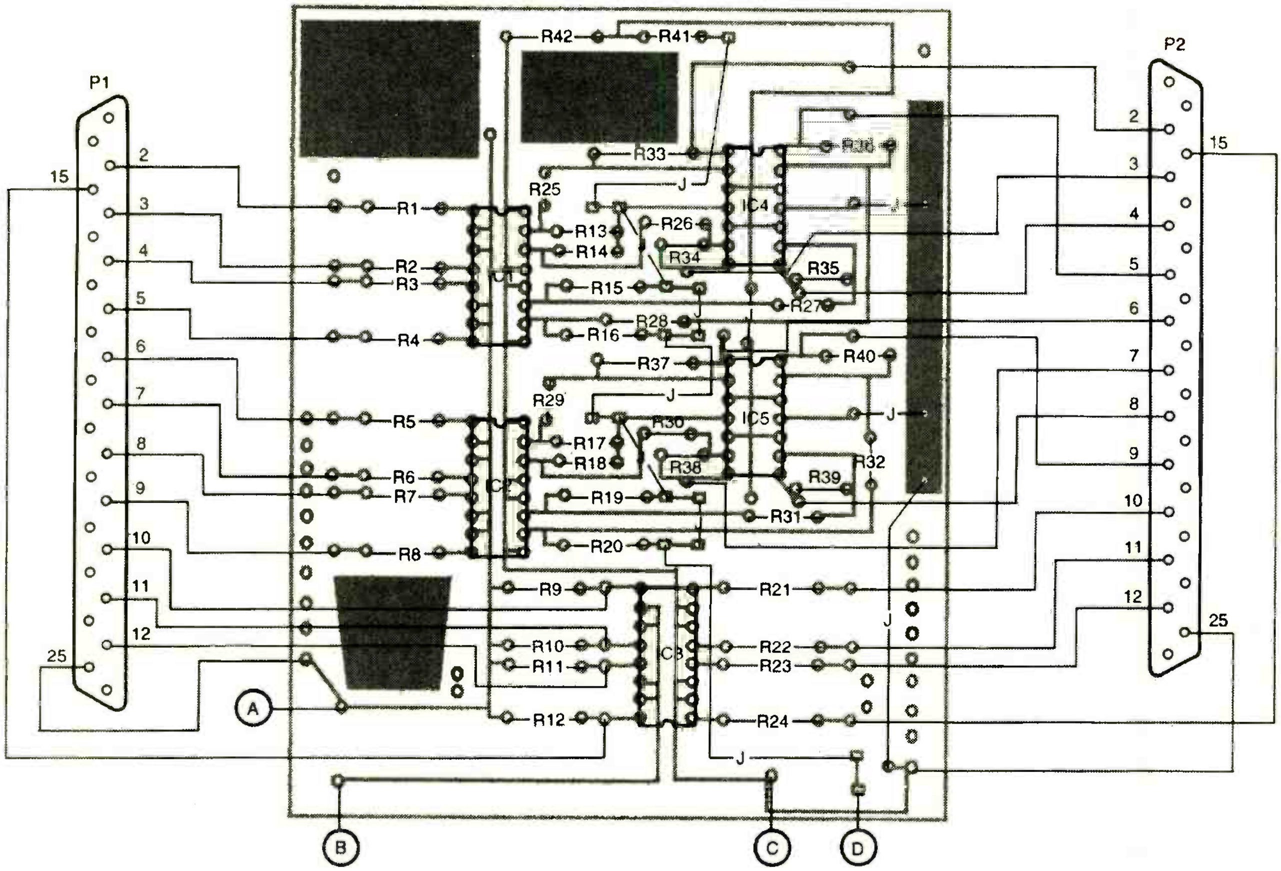



*Fig. 4. The Parallel-Port Optical Isolator uses a single-sided PC board. Note that several jumpers are needed to complete some connections. Some of the resistors might be a tight fit for flat mounting and might have to be mounted vertically.*

Another important feature to look for is that the A-B switch uses individual wires to make the connections between the connectors instead of a PC board. While the PC-board version is considered a "deluxe" model that minimizes crosstalk between the signals, the modification of the wire-type switch is much easier.

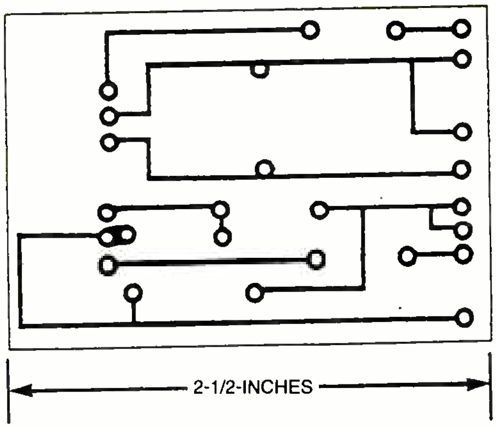
The author's prototype was installed in such a box; it can be seen in Fig. 6. Note how the main PC board sits at the bottom of the case while the power-supply board is tucked against the front panel next to the switch.

Start by removing the switch and the connectors from the case without breaking any of the wires. Select one of the "output" connectors for optical isolation; don't use the "common" connector that will go to the computer. Cut each wire between that connector and the switch, strip the two ends, and install them into the appropriate holes on the main PC board. The wire from the switch goes to the Parallel-Port Optical Isolator's connections for P1, while the wire from the DB-25 socket is wired up as P2. The PC board has extra solder pads for the wires that are not used. Connecting them will prevent any lose wire ends from rattling around in the enclosure. If you don't want to make all of those extra connections, the wires can be simply removed by unsoldering or simply clipping them off.

Note that there are several connections labeled "A" through "D" in Figs. 4 and 5. Those are the connections between the main board and the power-supply board. When making the connections for J1 and J2, the connectors can be substituted with direct connections between the PC board and the transformers. In that case, a suitably sized hole (3/8-inch is a good choice) should be drilled in the back of the case. Mount a rubber grommet in the hole and run the transformer wires through the grommet before soldering them to the power-supply board. Be sure to tie an overhand knot in the wires before soldering them to act as a strain relief. The obvious disadvantage to that arrangement is the heavy transformers that are permanently tethered to the unit, mak-

**LISTING 2**

```
                        'Input sensing
10
DATA%=0                 'Initialize a variable
DATA%=INP(&H3BD)        'Read state of input pins
PRINT DATA%             'Display value of pin reading
GOTO 10
```




*Here's the foil pattern for the Parallel-Port Optical Isolator's power-supply board.*

ing it difficult to move the Parallel-Port Optical Isolator from one location to another.

Install the main PC board in the bottom of the case. Be sure to insulate the bottom of the box to prevent shorts; a piece of heavy gray "fish" paper, electrical tape, or gasket paper will work well. If you don't want to drill holes for screws, nuts, and spacers, you can bond a few pieces of hook-and-loop fastener material to the bottom of the PC boards and to the insulating paper. If

and output connectors: pin 1 to pin 1, pin 1 to pin 2, pin 1 to pin 3, and so on. Once all 25 combinations have been checked, continue with pin 2 to pin 1, pin 2 to pin 2, pin 2 to pin 3, and so on.

On the same connector, pins 2 through 9 should read infinity to ground (pin 25). On the input connector (P1), pins 10–12 and 15 should read 2200 ohms to ground; on the optically-isolated connector, they should all read infinity to ground. Be sure to use pin 25 of the

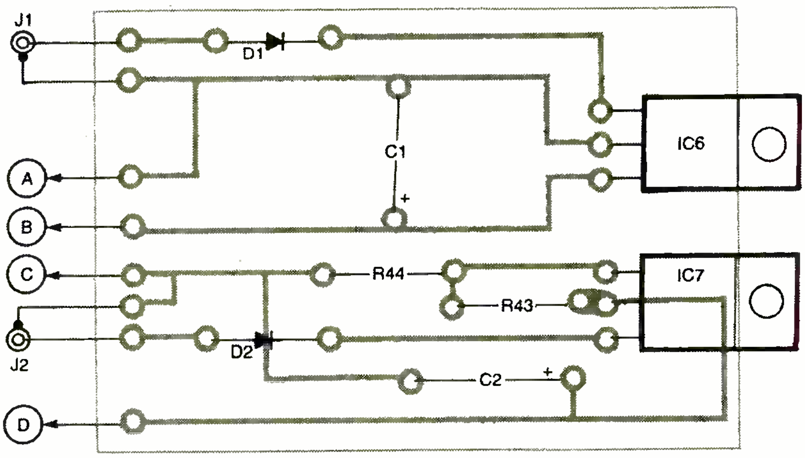



*Fig. 5. The power-supply board is a simple single-sided construction. The four connections labeled "A" through "D" show the connections between the power-supply board and the main board.*

you decide to go that route, be sure to glue the insulator to the case!

**Testing.** With no ICs installed, turn the switch to connect to the optically-isolated connector. Measure for infinite resistance on all combinations of pins between the input

same connector as your ground reference when making those checks. You should also read infinite resistance between the two power supplies and the two grounds.

Plug in the transformers. On IC1–IC3, pins 10, 11, 14, and 15 as well as pin 4 on IC4 and IC5 should

read between 5 and 7 volts. On IC4 and IC5, pins 3, 5, 10, and 12 should read about 2.5 volts.

Unplug the transformers and insert the ICs. With the power turned on, apply pulses from a pulse generator to the input pins and check to see that the pulse appears on the corresponding pin on the other connector. Pins 2–9 pass signals from P1 to P2, while pins 10–12 and 15 go in the opposite direction. If you don't have a pulse generator to test the unit, the QBASIC code shown in Listing 1 can be used for testing the output pins. The comments in the program are self-explanatory. Monitor the pins on P2 with an oscilloscope and verify that the pulse rises to 5 volts and that there is no crosstalk between pins. The program will have to be modified to check each output pin in turn. Don't forget to choose the port address for the parallel port that the Parallel-Port Optical Isolator is plugged into. The example program is set for hexadecimal value 3BC; the other valid combinations on IBM compatible computers are 278 and 378 (again, in hexadecimal values). If you are unsure of the address of your port, you should check you computer's manual. If you have Windows95 or Windows98 installed on your machine, port addresses can be found in Device Manager, which can be found in the System Properties tool in Control Panel. If you are at an MS-DOS prompt, the utility MSD (Microsoft Diagnostics) can tell you the address of the parallel ports that are installed in your machine. Again, consult your computer's documentation if you are unsure how to go about doing that.

The simple program in Listing 2 can be used to check the input pins. As you apply a positive voltage to one input pin at a time, you'll see the value on the screen change. Again, check that there is no crosstalk between pins. Also note that the input port is one value higher than the address used in Listing 1. In the published example, the output port is 3BC; the companion input port is 3BD. If you are using one of the other values, the input address would be x79 depending on which address your computer's parallel port is set for.

Once the Parallel-Port Optical

Isolator is verified as working without errors, it can be closed up and put to use.

**Using the Parallel-Port Optical Isolator.** If you know how to write your own software in your favorite language, you might already be familiar how to send and receive data from the parallel port. If not, QBASIC provides an extensive array of commands for building your own port-control software to switch port connector pins high or low. Keep in mind that since we are not using the Parallel-Port Optical Isolator to control a printer, the published standards that assign specific functions to each of the pins will not apply.

If you are going to be using QBASIC, a modified version of the test programs shown in Listings 1 and 2 can be used as simple subroutines. Those subroutines can be used in any program that you write whenever they are needed. Let's take a closer look at the two statements that the programming examples are built around: the "OUT" and "INP" statements.

### PARTS LIST FOR THE PARALLEL PORT OPTICAL ISOLATOR

**SEMICONDUCTORS**

IC1–IC3—ISQ203 Quad opto-isolator, integrated circuit (Jameco 114083 or similar)
IC4, IC5—LM349 Quad op-amp, integrated circuit
IC6—LM7805 voltage regulator, integrated circuit
IC7—LM317T adjustable voltage regulator, integrated circuit
D1, D2—1N914 silicon diode

**RESISTORS**

(All resistors are ¼-watt, 5% units.)
R1–R12, R21–R24—2200-ohm
R13–R20—10,000-ohm
R25–R32—30,000-ohm
R33–R42—100,000-ohm
R43—270-ohm
R44—1300-ohm

**ADDITIONAL PARTS AND MATERIALS**

C1, C2—100-µF, 16-WVDC, electrolytic capacitor
J1, J2—Co-axial power connector
P1, P2—DB25 subminiature connector
12-volt DC power adapters, case or existing A-B port switch, hardware, wire, etc.

**The "OUT" Statement.** The OUT command sends a byte to a port; The OUT statement has the format

OUT <port>, <data>

where <port> is an address and <data> is a number in the range 0–255. In the Listing 1 test program, note that the address is being specified in hexadecimal rather than plain decimal. The choice is one of personal preference; whatever format you choose should be consistent across all of your software for readability's sake. We've already discussed what address to use to access the parallel port; you should already know that number at this point. The value for <data> can be a variable that is set by some other part of the program, the result of an INPUT statement (that will be discussed later), or even a constant number. Converting a decimal to binary will indicate which pins on the parallel port will be set high. The decimal values of the output pins are listed in the comments of Listing 1. Any output pin that is not addressed will automatically be set low by the OUT statement. The combination of high and low settings on the port pins will remain until another OUT statement addresses the port and changes the values of the port.

If you want to generate a series of timed pulses or a single pulse on the parallel port, consecutive OUT statements must have timing loops between them to set the amount of delay between turning the pins on and off (as was done in the program in Listing 1). Keep in mind that any simple delay loops, especially in QBASIC, will depend on the speed of the computer's central processor. Other solutions are available in more sophisticated programming languages such as Visual Basic, C++, and Turbo Pascal to name just a few. The use of those program-development packages are beyond the scope of this article and is left up to the reader's personal preferences.

**The "INP" Function.** The INP function returns a decimal value between 0 and 255 that is read from a port. The values that are returned from the Parallel-Port Optical Isolator's input pins will have to be determined by simple experimentation. Once they are known, the signals can be read and acted upon at one time or the individual bits can be separated out and examined one at a time.

Since INP is a function and not a command by itself, a destination for the read data must be specified. A variable is the usual way to use the function. Once the data is read in, the variable can be examined and the appropriate action taken. Another technique is to use the INP function as a part of an IF...THEN statement. However, it would become quite cumbersome to mask out the bits that you aren't

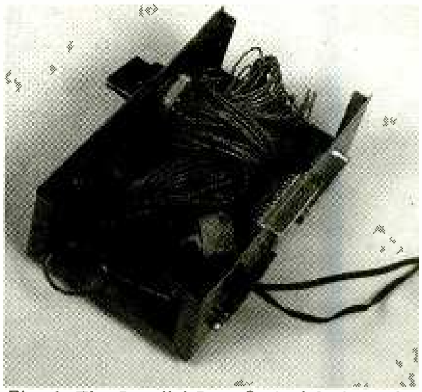
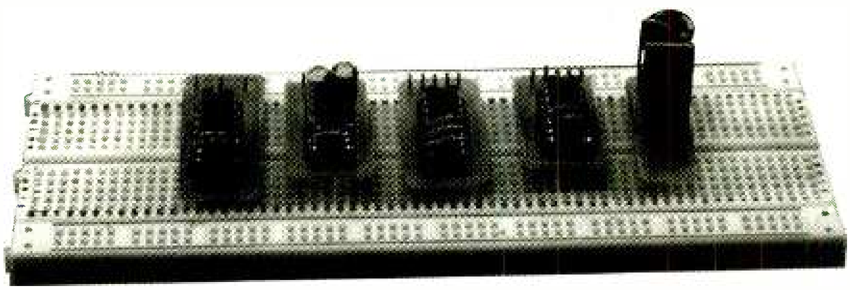


*Fig. 6. The Parallel-Port Optical Isolator fits neatly into the bottom of a computer A-B switch. Note that the author's prototype, shown here, has the power transformers hard-wired to the supply board.*

interested in with a single statement. Additionally, if you want to have several branches depending on the state of the input pins, you'd have to read the input port each time you wanted to test for a possible branch. For example, if you want to have three possible branches in your program, you'd need three IF...THEN statements. There is also the possibility that the port value might change between readings for the various IF...THEN statements. Again, more sophisticated programming languages have many different approaches.

With the Parallel-Port Optical Isolator attached to your computer, you can experiment with controlling hardware without the fear of what a simple error could do to your computer. The worry of an expensive computer going "up in smoke" is a thing of the past! Ω

# The BreadBlox Prototyping System



*Stop "re-inventing the wheel" whenever you breadboard a new circuit with these handy modules!*

JAMES MELTON

The solderless breadboard is without a doubt one of the best ideas that anyone ever had. Simple in concept, as most truly good ideas are, the solderless breadboard lets you try out a new circuit idea or integrated circuit as fast as you can make connections between components.

Of course, not all is perfect. If you have used a breadboard for any length of time, you know that that technique's disadvantages are:

- It is easy to make wiring errors you must make sure each component makes good contact
- You must keep an eye out for loose or 'knocked over' components
- It is boring and tedious to wire the same support circuits again and again

If there were one way that the breadboard could be made even easier to use, it would have to do with that last point. It has been the author's experience that when evaluating a new chip, there are many subassemblies (referred to in the electronics industry as "glue logic") that are needed to connect a circuit to the outside world.

Since many of those basic "glue logic" circuits are used over and over again, doesn't it make sense to build those circuits on small PC boards, then add some pins so that the boards can be plugged into a solderless breadboard? Well, the BreadBlox system presented here does just that.

Whatever you're building, one or more of the five BreadBlox presented here are sure to be handy. They are a clock generator, a tone decoder, an inverting op-amp, a non-inverting op-amp, and a voltage regulator. Let's look at each of them.

**The Clock Generator.** Figure 1 is the schematic diagram for the clock generator. It is built around IC1, an LM555 timer running in its astable mode. The circuit needs only three connections to the breadboard—power (between 5 and 15 volts), ground, and output. The astable mode of a 555 provides a constant-frequency squarewave based on the values of R1, R2, and C1. The formula is:

$$F_{OUT}=((R1+R2) \times C1 \times 1.1)$$

The output of the 555 timer will source or sink up to about 200 mA. While the 555's output is TTL compatible with respect to voltage levels, keep in mind that those levels will change as the current load is increased. For example, with a supply voltage of 15 volts and a 200-mA load, the highest voltage a 555 can put out under those conditions is only 12.5 volts. Be sure to review the specification sheet for the chip before attempting to "push the envelope."

**The Tone Decoder.** The tone decoder (see Fig. 2) uses an LM567 for frequency detection. That chip contains an oscillator and phase detector that together work as a phase-locked loop circuit. The circuit needs four connections to the solderless breadboard—power, ground, the input signal, and "tone detected" output. The LM567 can use a supply voltage between 4.75 and 9 volts. By choosing the values of R3 and the three capacitors, a combination of center frequency and bandwidth can be set.

The center frequency is set with R3 and C2; C4 sets the detection bandwidth. Formulas and detailed information on those calculations, as well as test and application circuits are published in the LM567's data sheet. That information, as well as specifications of their entire

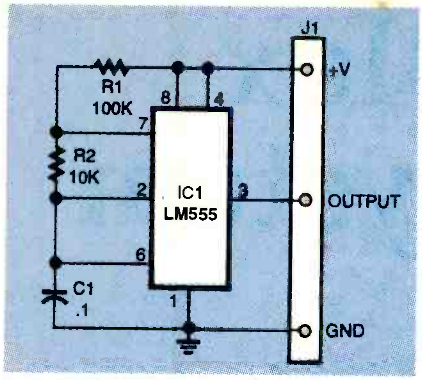


*Fig. 1. A clock generator built around an LM555 is a handy BreadBlox. The frequency can be adjusted to suit, and the output can be both TTL and CMOS compatible.*

product line, is available for download at National Semiconductor's Web site (http://www.national.com/pf/LM/LM567.html).

The output of IC2 is an open-collector arrangement. That means that you need to use a pull-up resistor for a valid voltage to appear. That arrangement makes the output compatible with any type of logic family. Limit the current drawn from the output to about 10 mA. Be ready to have long (greater than several seconds) detect times at lower frequencies.

**The Op-Amps.** The operational amplifier is among the most widely used analog circuits; two versions have been included with the BreadBlox. An inverting op-amp circuit is shown in Fig. 3, while a non-inverting circuit is shown in Fig. 4. Although the two circuits are very similar, there are minor differences between them. Both have a feedback resistor (R4 or R7) plus an input resistor (R5 or R8) on the inverting input. The values of those two resistors set the gain for the op-amp circuit. In the inverting circuit, the gain is given by the formula:

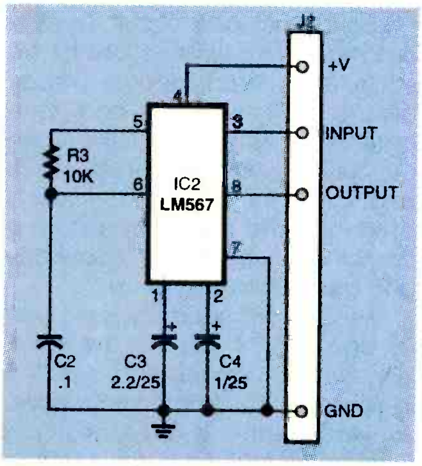


*Fig. 2. A tone-decoder BreadBlox might be useful as a piece of test equipment as well as a part of an experimental circuit.*

$$V_{OUT}=(-V_{IN}(R2/R1))$$

For the non-inverting amplifier, it is:

$$V_{OUT}=V_{IN} \times (1+(R2/R1))$$

Note that an op-amp can lower or raise the input voltage depending on the values of R4/R5 or R7/R8. Many op-amp circuits omit R6 (as we've done on the non-inverting circuit), but if you are dealing with circuits that are intended to pass

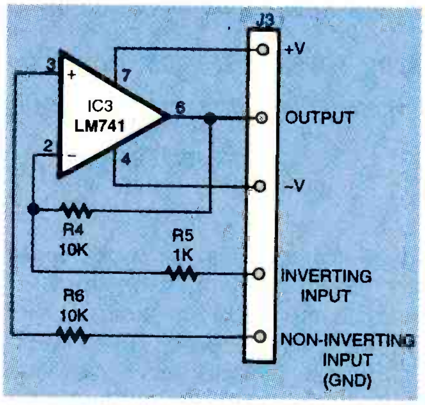


*Fig. 3. An inverting op-amp is one of the staples of analog circuit design.*

DC voltages at very accurate levels, it is best to include that resistor. If you want to simplify your circuit, you can replace R6 with a jumper wire; test your circuit to see if it will perform as needed.

Both op-amp circuits need a bipolar (positive and negative) power supply; the LM741 requires both voltages. A nice feature of op-amps in general is that you can substitute many other types for the LM741—nearly all single op-amps have the same pinouts.

**The Voltage Regulator.** To round out our collection of BreadBlox, we've included a three-terminal regulator; the schematic is shown in Fig. 5. While a standard 7805 5-volt regulator is shown, other types can be substituted for whatever voltage is needed. For example, many of the newer chips require lower voltages than even the 5 volts that is standard on most breadboards; 3.3 volts and even lower voltages are often needed for microprocessor or digital-signal-processing chips. With a BreadBlox voltage regulator, you can use the existing power supply on your breadboard without taking up too much space. The capacitor selection depends somewhat on the input voltage, the load, and the input ripple. If you are reducing a voltage that is already filtered, such as producing a 5-volt output from a 12-volt supply, you might not need C5. Do not eliminate C6. Under most conditions, a high-frequency and high-amplitude noise or ripple will be the result.

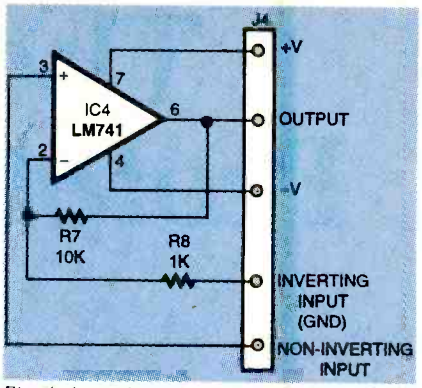


*Fig. 4. A non-inverting op-amp makes a handy impedance-matching circuit. The gain can easily be changed by substituting different resistor values.*

**Construction.** The BreadBlox should be built on a PC board to best stand up to repeated handling and similar "abuse". A foil pattern for a single-sided board has been included here. Note that all five BreadBlox are included on the

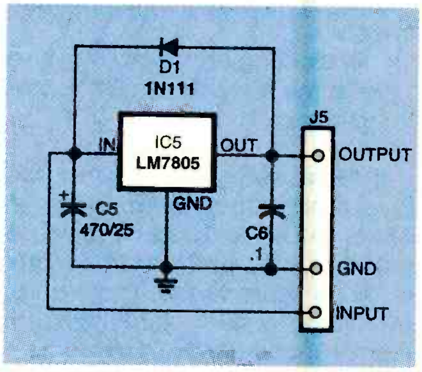


*Fig. 5. While some powered breadboards might have a 5-volt supply, this BreadBlox can be used for any voltage—positive or negative—simply by changing IC5. If you want to make a negative-regulator module, pay attention to the IC pinouts as well as the polarity of C5.*

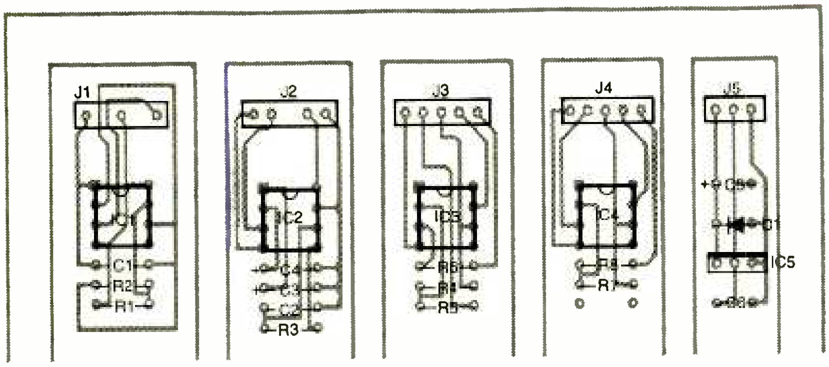



*Fig. 6. With the exception of the voltage regulator, all of the BreadBlox components are inserted into machine-pin IC sockets—making them a miniature breadboard in their own right!*

## PARTS LIST FOR THE BREADBLOX

**SEMICONDUCTORS**

IC1—LM555 timer, integrated circuit
IC2—LM567 tone decoder, integrated circuit
IC3, IC4—LM741 op-amp, integrated circuit
IC5—LM7805 voltage regulator, integrated circuit
D1—1N111 germanium diode (NTE109 or similar)

**RESISTORS**

(All resistors are ¼-watt, 5% units.)
R1—100,000-ohm
R2–R4, R6, R7—10,000-ohm
R5, R8—1000-ohm

**CAPACITORS**

C1, C2, C6—0.1-µF, ceramic-disc
C3—2.2-µF, 25-WVDC, electrolytic
C4—1-µF, 25-WVDC, electrolytic
C5—470-µF, 25-WVDC, electrolytic

**ADDITIONAL PARTS AND MATERIALS**

J1–J5—Wire-wrap pins (Vector T-44 or similar)
Machined-pin IC sockets

**Note:** The following item is available from James Melton, 2747 Wentworth Drive, Grand Prairie, TX 75052: PC board and wire-wrap pins, $16.99 plus $3.00 shipping and handling. Texas residents must add appropriate sales tax. No COD orders will be accepted.

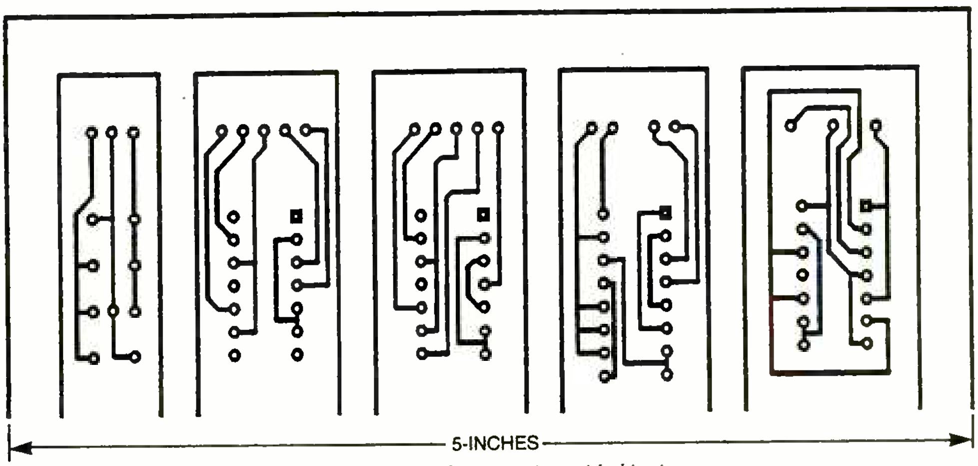
one pattern; it is much easier to etch one large board than five tiny boards. As an alternative, an etched PC board is available from the source given in the Parts List. If you decide to make your own boards, be sure to use a high-quality fiberglass board such as FR-4 for a stronger assembly.

After etching and drilling the boards, use a bandsaw or a pair of heavy tin snips to cut them apart. After the five modules have been separated, use a belt sander, a sheet of emery cloth, or 100-grit sandpaper to sand the boards down as far as possible. The goal is to make the boards as small as possible without damaging any of their copper traces!

Follow the parts-placement diagram in Fig. 6 for locating the various components. A good place to start is with J1–J5. Those connectors, used to make all of the connections between the BreadBlox and the solderless breadboard, are made from wire-wrap pins. The holes in the board should be drilled just undersized for those pins; a special technique is needed to push the pins through the holes. Clamp the PC board in a vise and hold the pin near its top with a pair of needlenose pliers. Heat the tip of the pin with a 50-watt soldering iron and begin pushing it into the board. The PC-board fiberglass will begin to melt and deform. Slowly push the pin into the board while keeping it hot until it is fully seated. Let the pin cool—the melted board material will solidify around the pin. The resulting tight fit will help give the pin a better mechanical connection to the board, so it will hold up while you are inserting and removing the BreadBlox from your breadboard. It is a good idea to put all of the wire-wrap pins into all of the modules at one time while you are set up to do so.

All of the modules, with the exception of the voltage regulator, get an IC socket that has machined or "colletted" pins—do not use the low-cost wiper-contact sockets. The colletted pins will let you use the BreadBlox as miniature breadboards, making it easy to substitute different resistors and capacitors to change the circuit characteristics of the individual modules. A high-quality socket will also withstand repeated insertions and removals of components.

After installing the wire wrap pins




*Here's the foil pattern for the BreadBlox. All of the modules can be made at one time with this single-sided pattern.*

and the IC sockets, you are ready to insert the components and test your BreadBlox.

A 7800-series voltage regulator has leads that are slightly larger than the holes in the board. If you are using that type of regulator on the voltage-regulator module, the leads will have to be cut with a pair of diagonal cutters so that they will fit into the holes in the board. That will give the 7800-series regulator a better mechanical fit to the board. Invariably the regulator will be grabbed when removing the regulator module from the breadboard, so that component can use all the help it can get!

You'll find the BreadBlox are as handy to have in your experimenter's box as they are fun to use. After using them once or twice, you'll probably wonder how you ever got along without them.

The BreadBlox can also be of benefit to instructors in high school vocational programs, trade schools, and college labs. Not only can the BreadBlox be used to teach soldering skills to beginning students, they can then be used while the students begin learning simple circuits.

Note that we've just scratched the surface in this article. Every builder has favorite circuit subassemblies that he or she uses repeatedly. There is no reason that any of them can't be successfully implemented as a BreadBlox module. Please feel free to send any ideas that you might have for future modules to the author; the most popular ideas might be translated into a next-generation BreadBlox. Send your ideas to melton@startext.net. Ω

## PIRATE RADIO

*(continued from page 30)*

However, because of the recent FCC raids, one European pirate, SWRS (Shortwave Relay Service) is currently heard in North America more than most of the stations from this continent. SWRS relays programs from many different pirates on 21,450, 11,470, and 7,490 kHz on most weekends. In the East, 21,450 kHz often fades in for a little while from 1200-1400 UTC. 11470 can be heard for longer amounts of time, but with a weaker signal, and 7490 is rarely heard.

**The Future Of Pirate Radio.** Whether you call it "pirate" radio, "microbroadcasting," or "LPFM," unlicensed broadcasting has existed since the earliest days of radio. For years, people have speculated that the diversity of the commercial stations would eliminate pirate broadcasting. Instead, licensed radio (both public and commercial) has become more homogenized. As more people are compelled to support the pirates, the FCC is stepping up its enforcement. Unless the FCC begins to implement unlicensed broadcasting bands, the pirate radio conflict will continue to make headlines across the country. Stay tuned. Ω

### What Do I Need To Hear Pirates?

Hearing shortwave pirates does require some specialized listening equipment, but you don't need a wall of equipment that could give NASA a run for its money. Of course, the first requirement is a shortwave receiver. The receiver doesn't have to be the latest in Stealth technology, but it must be more sensitive than the "boom boxes" that include shortwave bands. Typically, any receiver that is capable of tuning in SSB (single side-band) signals will tune in at least half of the pirates broadcasting in North America.

SSB reception is important because most pirates from this continent broadcast in the USB mode. Some of the portables that do well for receiving pirates include the Sony 7600 and 2010, Grundig YB-400, Sangean ATS-909, and the Drake SW-8. Also, any tabletop model should do quite well for receiving pirates.

You don't need a massive log-periodic or rhombic antenna on a few acres to hear pirates, but an external antenna certainly will help. On tabletop receivers, the antenna should be at least 20 feet long (although a longer antenna or a dipole will help). Anywhere from 10 to 40 feet of wire stretched out, with one end stripped and wrapped around the whip antenna of portables, will considerably raise the signal levels. Be aware that long antennas could cause damage to portable receivers, such as the Sony 2010.

Finally, a cassette recorder is helpful so that you can record programs for posterity. A notebook will help you to log all of the stations that you hear.

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C-2000, Basic Video Transmitter Cube ............... $89.95
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C-3001, High Power Video & Audio Transmitter Cube ... $229.95

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Top quality Japanese Class 'A' CCD array, over 440 line line resolution, not the off-spec arrays that are found on many other cameras. Don't be fooled by the cheap CMOS single chip cameras which have 1/2 the resolution, 1/4 the light sensitivity and draw over twice the current! The black & white models are also super IR (Infra-Red) sensitive. Add our invisible to the eye, IR-1 illuminator kit to see in the dark! Color camera has Auto gain, white balance, Back Light Compensation and DSP! Available with Wide-angle (80º) or super slim Pin-hole style lens. Run on 9 VDC, standard 1 volt p-p video. Use our transmitters for wireless transmission to TV set, or add our IB-1 Interface board kit for audio sound pick-up and super easy direct wire hook-up to any Video monitor, VCR or TV with A/V input. Fully assembled, with pre-wired connector.

CCDWA-2, B&W CCD Camera, wide-angle lens .......... $69.95
CCDPH-2, B&W CCD Camera, slim fit pin-hole lens ...... $69.95
CCDCC-1, Color CCD Camera, wide-angle lens ......... $129.95
IR-1, IR Illuminator Kit for B&W cameras ............... $24.95
IB-1, Interface Board Kit ............................ $14.95

# Mini Radio Receivers

Imagine the fun of tuning into aircraft a hundred miles away, the local police/fire department, ham operators, or how about Radio Moscow or the BBC in London? Now imagine doing this on a little radio you built yourself - in just an evening! These popular little receivers are the nuts for catching all the action on the local ham, aircraft, standard FM broadcast radio, shortwave or WWV National Time Standard radio bands. Pick the receiver of your choice, each easy to build, sensitive receiver has plenty of crystal clear audio to drive any speaker or earphone. Easy one evening assembly, run on 9 volt battery, all have squelch except for shortwave and FM broadcast which has handy SCA output. Add our snazzy matching case and knob set for that smart finished look.

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HFRC-1, WWV 10 MHz (crystal controlled) Kit .......... $34.95
FR-1, FM Broadcast Band 88-108 MHz Kit .............. $24.95
FR-6, 6 Meter FM Ham Band Kit ...................... $34.95
FR-10, 10 Meter FM Ham Band Kit .................... $34.95
FR-146, 2 Meter FM Ham Band Kit .................... $34.95
FR-220, 220 MHz FM Ham Band Kit ................... $34.95
SR-1, Shortwave 4-11 MHz Band Kit .................. $29.95
Matching Case Set (specify for which kit) ............. $14.95

# Tiny FM Transmitters

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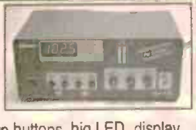
FM-4MC, High Power FM Transmitter Kit ............... $17.95
FM-5, World's Smallest FM Transmitter Kit ............ $19.95
FM-6, Crystal Controlled 2M FM Transmitter Kit ........ $39.95
FM-6, Fully Wired & Tested 2M FM Transmitter .......... $69.95

# Super Pro FM Stereo Transmitter



Professional synthesized FM Stereo station in easy to use, handsome cabinet. Most radio stations require a whole equipment rack to hold all the features we've packed into the FM-100. Set freq with Up/Down buttons, big LED display. Input low pass filter gives great sound (no more squeals or swishing from cheap CD inputs!) Limiters for max 'punch' in audio - without over mod, LED meters to easily set audio levels, built-in mixer with mike, line level inputs. Churches, drive-ins, schools, colleges find the FM-100 the answer to their transmitting needs, you will too. Great features, great price! Kit includes cabinet, whip antenna, 120 VAC supply. *We also offer a high power export version of the FM-100 that's fully assembled with one watt of RF power, for miles of program coverage. The export version can only be shipped outside the USA, or within the US if accompanied by a signed statement that the unit will be exported.*

FM-100, Pro FM Stereo Transmitter Kit ......... $249.95
FM-100WT, Fully Wired High Power FM-100 ..... $399.95

# FM Stereo Radio Transmitters

No drift, microprocessor synthesized! Excellent audio quality, connect to CD player, tape deck or mike mixer and you're on-the-air. Strapable for high or low power! Runs on 12 VDC or 120 VAC. Kit includes case, whip antenna, 120 VAC power adapter - easy one evening assembly.

FM-25, Synthesized FM Stereo Transmitter Kit .... $129.95

Lower cost alternative to our high performance transmitters. Great value, tunable over FM band, plenty of power and manual goes into great detail about antennas, range and FCC rules. Handy kit for sending music thru house and yard, ideal for school projects too - you'll be amazed at the exceptional audio quality! Runs on 9V battery or power from 5 to 15 VDC. Add our matching case and whip antenna set for a nice 'pro' look.

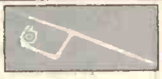
FM-10A, Tunable FM Stereo Transmitter Kit ....... $34.95
CFM, Matching Case and Antenna Set ........... $14.95
FMAC, 12 Volt DC Wall Plug Adapter ............. $9.95

# RF Power Booster

Add muscle to your signal, boost power up to 1 watt over a freq range of 100 KHz to over 1000 MHz! Use as a lab amp for signal generators, plus many foreign users employ the LPA-1 to boost the power of their FM transmitters, providing radio service through an entire town. Runs on 12 VDC. For a neat finished look, add the nice matching case set.

LPA-1, Power Booster Amplifier Kit ............. $39.95
CLPA, Matching Case Set for LPA-1 Kit ......... $14.95
LPA-1WT, Fully Wired LPA-1 with Case .......... $99.95

# FM Station Broadcast Antenna



For maximum performance, a good antenna is needed. Properly tuned and matched antenna is fully PVC enclosed for weather protection and rugged use. Vertical or horizontal mounting, 'F' style connector, 5' long.

TM-100, Tru-Match FM Station Antenna Kit .............. $39.95

# AM Radio Transmitter

Operates in standard AM broadcast band, set to clear channel in your area. AM-25 'pro' version is synthesized for stable, no-drift frequency and is setable for high power output where regulations allow, typical range of 1-2 miles. Entry-level AM-1 has tunable transmit oscillator, runs FCC maximum 100 mw power, expected range 1/4 mile. Both accept line-level inputs from tape decks, CD players or mike mixers, run on 12 volts DC. Pro AM-25 includes AC power adapter, matching case and bottom loaded wire antenna. Entry-level AM-1 has an available matching case and knob set for a finished, professional look. High level modulation for low distortion.

AM-25, Professional AM Transmitter Kit ......... $129.95
AM-1, Entry level AM Radio Transmitter Kit ...... $29.95
CAM, Matching Case Set for AM-1 ............... $14.95

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BNO-1, 10x25 Roof Prism Binoculars ............ $24.95
BNO-1EX, 10x25 Ruby Coated Porro Prism ....... $29.95
BNO-2, 10x25 TacGrip Ruby Coat Porro Prism ..... $59.95
BNO-6, 10x50 Ultra-View Ruby Coat Porro Prism ... $69.95

# World's Smallest FM Radios

Everyone who sees one of these babies says they just gotta have one! Super cute tiny FM radios have automatic scan/search tuning, comfortable ear bud earphones and we even include the battery. The pager style unit looks like a shrunken pager and even has an LCD clock built-in. You will be amazed at the crystal clear amazing sound! That's a quarter in the picture for size comparison - pretty tiny, huh?

MFMT-1, World's Smallest FM Radio ............. $11.95
PFMR-1, Pager Style LCD Clock & FM Radio ...... $12.95

# Speech Descrambler

Decode all that gibberish! This is the popular descrambler / scrambler that you've read about in all the Scanner and Electronic magazines. Speech inversion technology is used, which is compatible with most cordless phones and many police department systems, hook it up to your scanner speaker terminals and you're in business. Easily configured for any use: mike, line level and speaker output/inputs are provided. Also communicate in total privacy over telephone or radio, full duplex operation - scramble and unscramble at the same time. Easy to build, all complex circuitry contained in new custom ASIC chip for clear, clean audio. Runs on 9 to 15VDC. Our matching case set adds a professional look to your kit.

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CSS, Custom Matching Case and Knob Set ...... $14.95
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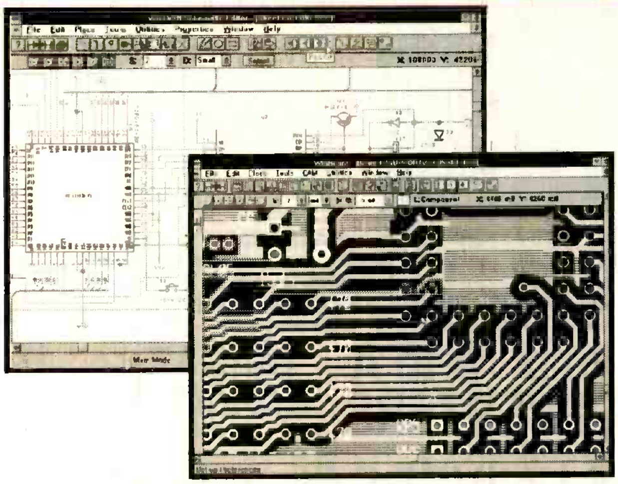

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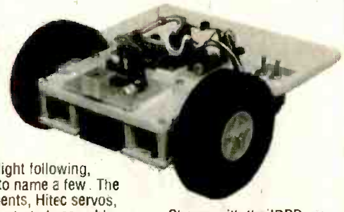

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| EEPROM DATA MEMORY | NONE | 64 |
| PROGRAM MEMORY | 768 OTP | 1K FLASH |
| MATH REGISTERS | 1 | 32 |
| MAX INSTRUCTIONS / SEC | 5M | 20M |
| MAX COUNTER BITS | 16 | 18 |
| INPUT / OUTPUT BITS | 12 | 15 |
| A TO D COMPARATOR | NO | YES |
| HARDWARE INTERRUPTS | NONE | 3 |

PINOUT:

| | | | |
|---|---|---|---|
| RESET | 1 | 20 | VCC |
| PD0 | 2 | 19 | PB7 |
| PD1 | 3 | 18 | PB6 |
| XOUT | 4 | 17 | PB5 |
| XIN | 5 | 16 | PB4 |
| PD2/INT | 6 | 15 | PB3 |
| PD3 | 7 | 14 | PB2 |
| PD4/TMR | 8 | 13 | PB1/AD1 |
| PD5 | 9 | 12 | PB0/AD0 |
| GND | 10 | 11 | PD6 |

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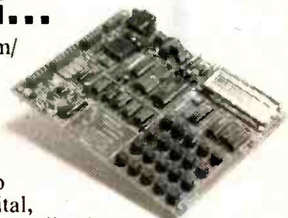

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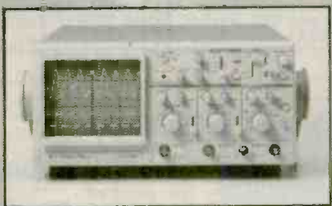

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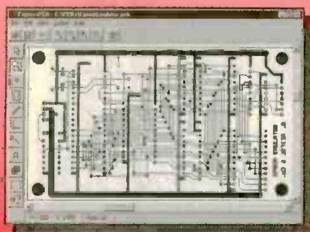

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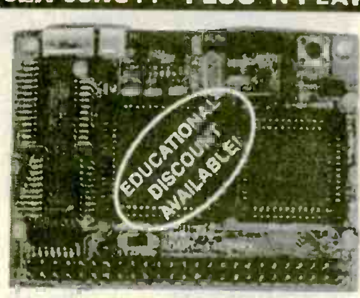


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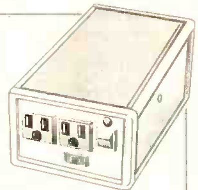

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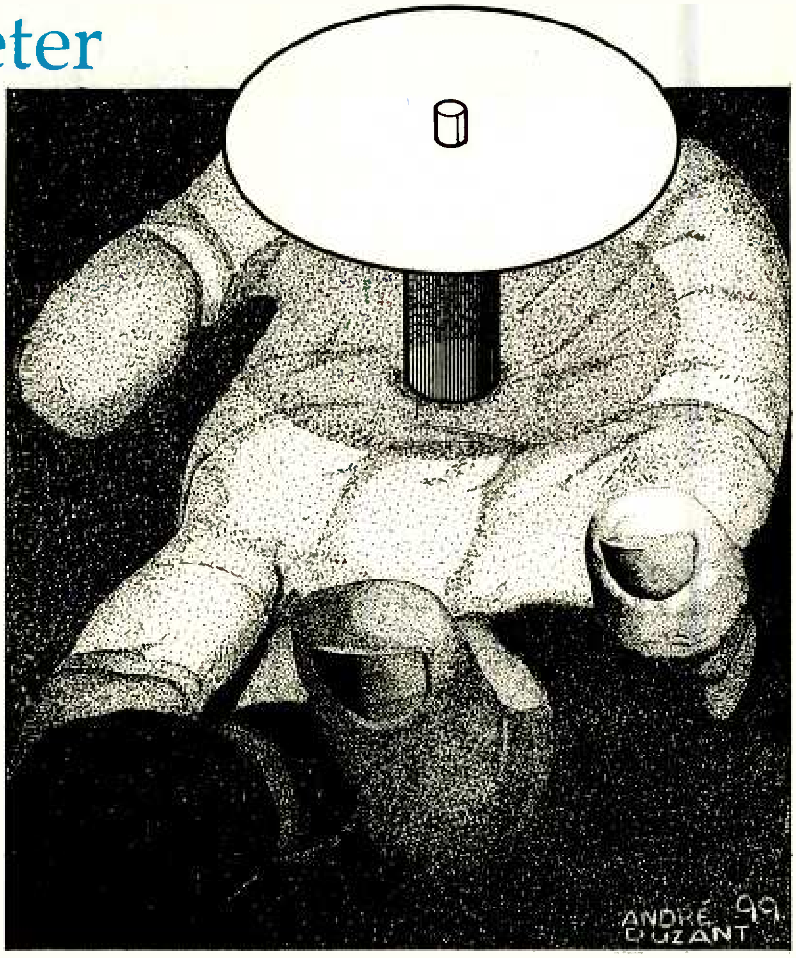
# Measure the Sun's Intensity with a Solar Dosimeter



*You can achieve suprisingly accurate results with this simplest of circuits.*

PAUL NEHER

There are many times where you would want to know how much sunlight a particular location receives—though some of them are not so obvious. Many of us are aware of the health risks that are associated with ultraviolet radiation; recent studies have linked cancer and premature aging of the skin to ultraviolet radiation exposure. Even older people can be at risk of developing cataracts and should be wearing ultraviolet-absorbing sunglasses whenever they are outdoors. If you are looking into setting up photovoltaic or solar-heating panels, the choice of whether to install a tracking mechanism, with its increased cost, depends on the site location and how many hours of direct sunlight the panels will receive. Vegetable and flower gardens are another area of concern—do they receive too little or too much sunlight?

Whether planning a solar installation, measuring how much sunshine a potential garden spot gets, or just curious about how many hours per day you are exposed to the sun, an instrument that can measure the total number of hours of sunlight per day would be a handy tool to have. Of course, such "solar-site analyzers" exist and can be purchased for a couple of hundred dollars, but there is a less-expensive alternative.

In this article, we'll take a look at how solar-radiation monitors, or *dosimeters*, have worked in the past, and how to build a modern version that, while not exactly the most accurate instrument in the world, can't be beat for cost. In fact, you probably have the components needed in your "junk drawer". If, on the other hand, you purchase all of the items needed, you would be hard-pressed to spend much over a dollar.

**Sunshine Recorders.** Meteorological instruments designed to record the duration of sunshine have been used since the mid-nineteenth Century. One particularly clever recorder is the Campbell-Stokes device, dating from about 1880. It uses a glass sphere to focus sunlight onto a strip of paper. Like a magnifying glass, the strip of paper is held at the lens' focal point. The intense heat from the focused spot of light burns the paper. As the sun moves across the sky, a black trace is left on the paper showing how long the sun was unobstructed. It can record the sun's movement from horizon to horizon if it is properly aligned, and it can reveal fixed obstructions, such as buildings and trees, as well as variable amounts of cloud cover if several days worth of readings are taken and compared. Although there is a certain aesthetic quality to a recording instrument that is self-powered, that style of recorder lacks portability.

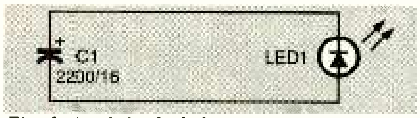



*Fig. 1. Don't be fooled by the simplicity of the solar dosimeter's circuit—it is suprisingly accurate for such a low-cost device.*

**Electronic Dosimeters.** While many different types of electronic dosimeter circuits are available, most of them are based on active components to record the collected data; the elegant simplicity of a self-powered device is not taken into account.

Consider the electrical characteristics of a light-emitting diode. In its usual method of connection, an LED has a constant voltage drop across it, producing light when about 10 mA of current flows through it. When the voltage is reversed, the LED doesn't produce light and the current flowing through it is very small—on the order of nanoamps. On the manufacturer's data sheets, that current is referred to as *leakage current.* However, that is not entirely correct when it comes to LEDs.

Although an LED is designed as a light-producing device, it is also a small-area photovoltaic diode that is capable of passing a current when it is exposed to light. Under normal room lighting, the conductivity of an LED is only in the nanoamp range, but in bright sunlight the photocurrent is about one microamp.

Most low-cost LEDs that are used as panel indicators are only tested for forward operation. The reverse-breakdown voltage is typically specified at five volts. That doesn't mean that the device can't withstand higher reverse voltages; it's just the maximum voltage that the manufacturer tests the LED for. All of the LEDs that the author has tested have shown actual reverse-breakdown voltages of at least 50 volts; most units are greater than 100 volts.

In the region of the LED's reverse-voltage characteristic between the breakdown voltage and zero volts, the device acts like a constant-current element, with the current depending only on the intensity of the light.

Now that we have a light-dependent constant-current source, we need some way to record the overall amount of current that passes through the LED.

A capacitor stores an electric charge in proportion to the voltage across its terminals. The formula for that relationship is

$$Q=CV$$

where the total charge (Q), in coulombs, is a product of the capacitance (C), in farads and the voltage (V), in volts. A constant current flowing into (or out of) a capacitor will change the voltage

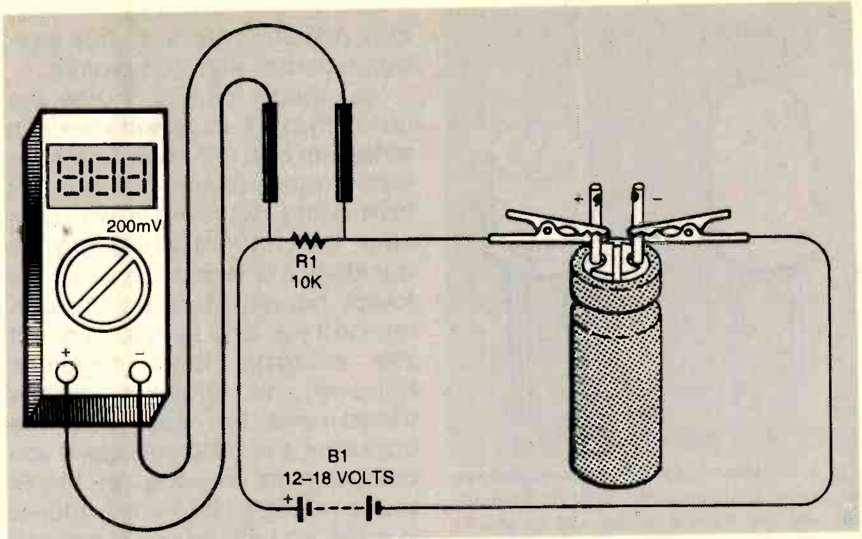



*Fig. 2. Measuring the voltage drop across a resistor in series between the capacitor and a battery is an easy way to measure the capacitor's leakage current.*

across its terminals at a rate that is proportional to the current. For example; a 1-μF capacitor being charged with a constant one-microamp current will increase its voltage by one volt per second.

The capacitor's voltage is also proportional to the amount of current that has been accumulated over a period of time; that function is a near-perfect integrator. The same one microamp current in the above example, applied for 100 seconds, will change the voltage on the capacitor by 100 volts.

Based on that knowledge, let's put an LED in parallel with a capacitor. There are few electronic circuits that can match the simplicity of Fig. 1, but that's all that it takes to build a simple, self-powered solar dosimeter that can be used to measure the amount of sunlight that falls on a given area over a period of time.

If you charge up C1 in a dark room, very little current will flow through LED1; C1 will stay charged up for a long time. Place the unit in bright sunlight and a larger constant current will flow through LED1, discharging C1 at a rate that is proportional to the intensity of the light. For example, if C1 discharges at a rate of 1.25 volts per hour in bright sunlight, the voltage should change by 5 volts if it is exposed to the same intensity of light for 4 hours.

Typically, you would charge up C1 to about 15 volts; that voltage and the values shown will let the solar dosimeter be used for over a day before needing a recharge. In bright sunlight, such as the southwestern

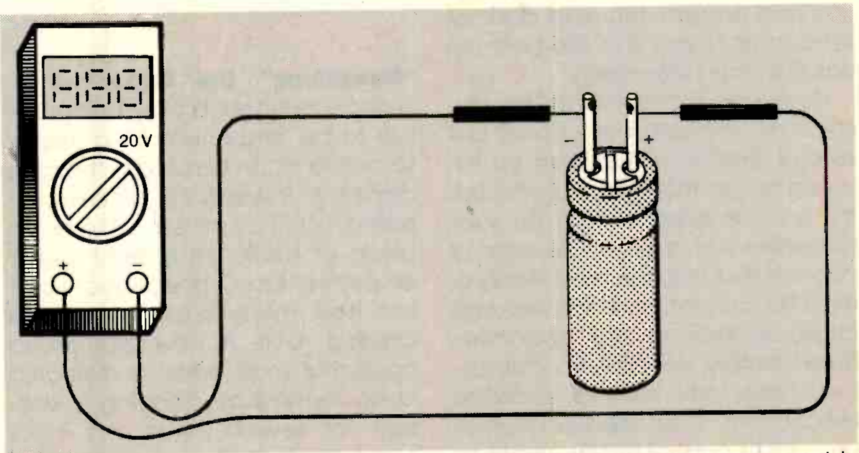



*Fig. 3. When measuring how much voltage the capacitor has lost, make your measurement as quickly as possible—even the most sophisticated digital voltmeter consumes some of the capacitor's charge when taking a reading.*

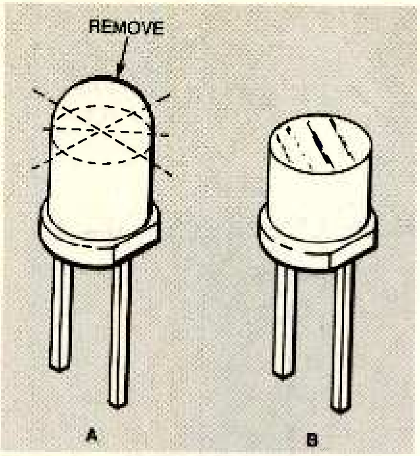



*Fig. 4. A standard LED has a lens molded into its case to concentrate the light. By flattening the lens, the solar dosimeter will be able to sense sunlight from almost any angle.*

US, the capacitor discharges at a rate of about one volt per hour.

Another advantage of the solar dosimeter is that it directly simulates the performance of a solar panel or photovoltaic array—the change in capacitor voltage is directly proportional to the amount of ampere-hours that the array would produce for that day. If you would like to investigate whether a tracking array would be worth the extra money, simply compare the results from first leaving the solar dosimeter pointed in one direction, and from pointing it at the sun by changing its position about once every hour. Many locations, such as southern California, have morning fog and hazy skies until mid-morning. Mountains and other obstructions can reduce the amount of direct sun that your location receives. With a little data collection and analysis, the solar dosimeter can help you find the best orientation for a solar array.

Of course, a circuit that is this simple is not a perfect one. There are several restrictions that must be followed to get the most out of it. The first is to understand that the solar dosimeter has a probable error of about 10% due to the nonlinearity of the LED current and the leakage characteristics of the capacitor. Unfortunately, electrolytic capacitors have an internal leakage mechanism that allows a small amount of current to flow between its "insulated" plates. You can think of that leakage as a resistor across the capacitor's terminals. That leakage increases with temperature.

You should always charge the unit from a 12- to 18-volt source in series with a 10,000-ohm resistor. The resistor prevents the components from being destroyed if you connect the battery backward by accident; it also protects you if the source happens to be a car battery and you accidentally connect the charging leads together. However, the charging voltage should never be higher than the capacitor's working voltage. If you are going to be using an 18-volt source, such as two 9-volt batteries in series, you should use a capacitor that is rated higher than the 16-volt rating that is specified here—25 or 35 volts would be better.

That being said, let's see what we need to do to build our solar dosimeter.

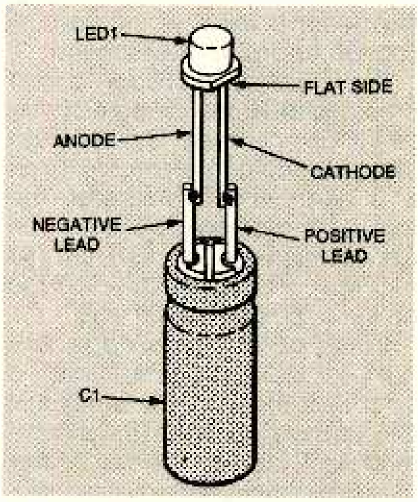



*Fig. 5. To build the solar dosimeter, simply solder an LED onto a capacitor. Be careful of polarities or the unit won't work.*

**"Seasoning" the Capacitor.** To reduce leakage, a new capacitor has to be "seasoned" for a day or so before it can be used in the solar dosimeter. Interestingly, a capacitor pulled out of a junk car radio or old piece of audio equipment would be perfect for our needs because it has had many hours of voltage applied to it. A new electrolytic capacitor must have its dielectric layers formed by applying a voltage for several hours. An ideal place to do that is inside a warm parked car using the 12-volt lighter jack as the voltage source. Alternatively, you can charge the capacitor from a pair of nine-volt batteries and leave it connected for a day inside your home, perhaps on a sunny windowsill.

Once a capacitor is "aged", its internal leakage needs to be tested; there is always the possibility that a particular unit might not be suitable. After charging the capacitor for several minutes, connect a digital voltmeter across the resistor. Do not use an older style "moving-needle" meter. Those instruments draw a bit of current from the circuit being measured and will introduce errors in your readings. The voltage drop across the resistor will show the capacitor's leakage current; a reading of 10 mV indicates a leakage of 1 microamp. At first the leakage might be quite large, perhaps a few microamps. After several hours, the meter should read zero mV, indicating an internal leakage of less than $1/10$ microamp. That is a good indication that the capacitor is forming well. The general arrangement for that test is shown in Fig. 2

Next, disconnect the capacitor from the charging source and voltmeter, and let it sit for an hour in its charged condition. Measure its voltage by connecting the meter only long enough to get a reading as shown in Fig. 3, and again at least 12 hours later. If the capacitor is a "good one", it will have lost only a few tenths of a volt between readings. A capacitor that loses more than about one volt will be marginal for use in the solar dosimeter because of the error it introduces.

**Construction.** The first step in building the solar dosimeter is to modify

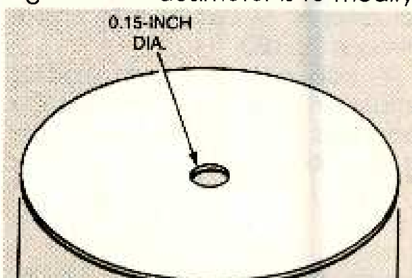



*Fig. 6. To increase accuracy of the solar dosimeter, the capacitor must be kept cool. This disc, cut from an index card, will act as an umbrella, shielding the capacitor from the sun.*

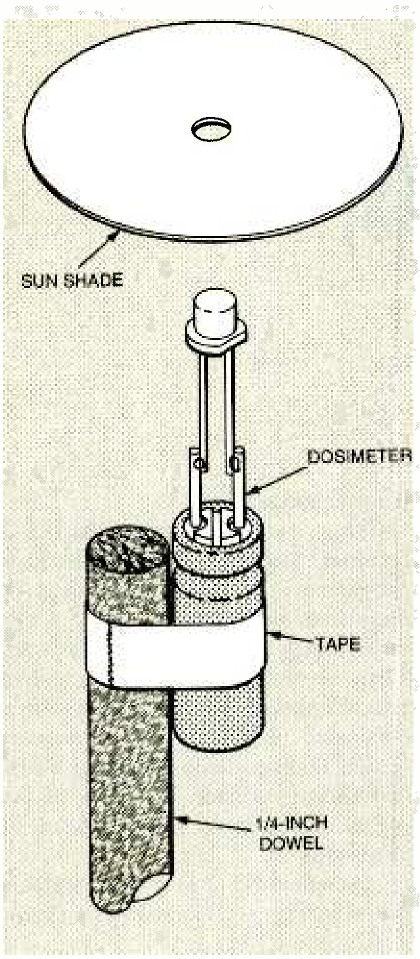



*Fig. 7. With the solar dosimeter mounted on a dowel and wearing its "hat", it's ready to measure the amount of sunlight anywhere that you want it to.*

the LED by filing or sanding off its top. Most LEDs have a rounded lens as shown in Fig. 4A. By removing the lens, you will have an angular sensitivity of almost 180 degrees. The LED should look like Fig. 4B.

The two components are soldered together as shown in Fig. 5. Obviously, there is a right way and a wrong way to connect the two polarized components together. The positive lead of C1 should be connected to the cathode of LED1; the cathode lead of LEDs is usually physically longer in length and a flat spot is molded into the case. If you get the connections backwards, the LED will glow when you try to charge the unit and you won't be able to go above about two volts.

Cut a 3-inch-diameter disc out of a piece of index card. Punch a hole in the center of the disc the same diameter as LED1. Dimensions for the disc are shown in Fig. 6. The disc will act as a sunshade to keep C1 from becoming too warm. Remember, the capacitor's leakage current will rise with temperature.

Mount the dosimeter on a stick such as a ¼-inch wood dowel that is about a foot long, using white masking tape to hold the capacitor in place. That way, the dosimeter can be "planted" in the ground and away from the heat of the soil. The sunshade is placed over LED1 so that C1 is always shaded. The final assembly is shown in Fig. 7.

**Calibration.** Pick a bright, sunny day to calibrate the dosimeter, preferably at noon when the sun is directly overhead; intense sunlight is needed. Charge the dosimeter for at least an hour before measuring its voltage. Charging the dosimeter is done in the same way that the capacitor was tested for leakage: a 10,000-ohm resistor in series with a 12- to 18-volt battery. Place the dosimeter in the sun with the flat surface (cathode) of LED1 facing the sun's direction of travel and note the time. After one hour or more, measure the voltage across C1, recording that along with the time. The difference in voltage divided by the difference in time will tell you how many volts per hour the dosimeter registers in bright sunlight. We'll call that ratio the *exposure constant*. To measure the number of hours of sunlight that a spot receives in a day, measure the change in voltage and dividing it by the exposure constant.

**Troubleshooting.** The solar dosimeter is based on commonly-available parts and some basic physics. What if it doesn't work as advertised? The green LED is inexpensive; if one doesn't work satisfactorily, try another one. Some LEDs might be more efficient photodiodes than others, causing the capacitor to run out of charge before the day is over. Some capacitors have less actual capacitance than marked on the can, causing the same problem. In either case, you can reduce the rate at which the voltage drops by either using two capacitors in parallel or putting a neutral filter over the LED. Such a filter can be made from a few layers of clear tape, a thin layer of white nail polish, or placing the dosimeter into a white plastic film canister.

If you've used a capacitor with a higher voltage rating, you can charge the capacitor up to a higher voltage to start off with. If you've been using a 12-volt source, try seasoning the capacitor at 18 volts.

If the capacitor has too much leakage, that is, it self-discharges by more than a volt in twelve hours, try charging it to a lower voltage initially, or season it longer at about 100 degrees F.

Do not let moisture get between the capacitor terminals. Dew or rain will cause the capacitor to discharge rapidly. Place the dosimeter in a watertight enclosure, such as the 35-mm film canister mentioned earlier, if that is a problem.

### PARTS LIST FOR THE SOLAR DOSIMETER

LED1—Light-emitting diode, green, T-1¾ size, diffused lens, (Mouser 351-5023, RadioShack 276-022 or similar)
C1—2200-µF, 16-WVDC, electrolytic capacitor, low-leakage, radial leads
R1—10,000-ohm, ¼-watt, 5% carbon resistor
B1—12-volt battery
Wooden dowel, tape, etc.

**Sample Applications.** Suppose you have a southeast-facing sloped roof on your house, and you are wondering how well a photovoltaic array would work, mounted in that same orientation. Simply orient the solar dosimeter with its flat surface parallel to the roof and expose it for a full day. Measure the change in voltage and you have a number equivalent to the amount of ampere-hours a photovoltaic array will put out. Compare that with how much the dosimeter registers with different orientations and angles, and you'll know if odd-angle mounting or tracking mechanisms are worth the extra complexity and expense.

An unusual location to mount the solar dosimeter is inside a hat. The LED could be mounted on a small hole punched in the brim with C1 taped underneath with the leads bent at a right angle.

A final note on sun exposure:

*(Continued on page 83)*

BY DON LANCASTER

# Twinkle, Twinkle, Little Lights, and More

LET'S TAKE A LOOK AT SOMETHING SO OLD AND SO SIMPLE THAT IT JUST MIGHT BE NEW FOR YOU. AT ANY RATE, THIS IDEA STILL MAKES A SELDOM-SEEN AND A REALLY FINE LITTLE HOMEBREW PROJECT...

## Twinkle Lights

In my opinion, the NE-2 neon lamp is by far the number-one electronic component of all time. Yes, the device is more or less way into retirement due to the high voltages needed and its restricted light output. But you can still get them for a dime or so each at RadioShack and elsewhere, and nothing else even comes remotely close to its versatility or its elegant simplicity.

In its prime, that good old NE-2 served as everything from...

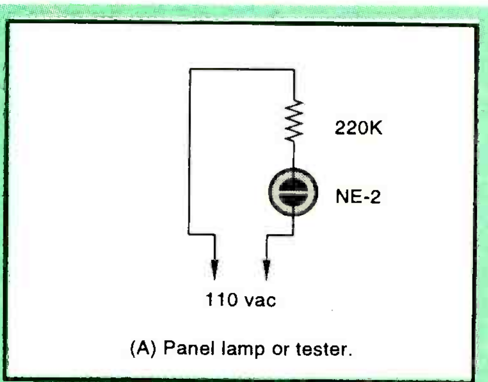
- panel lamps
- electronic organs
- surge protectors
- voltage regulators
- polarity finders
- AC-DC voltmeters
- display decorations
- proximity devices
- AND-OR logic
- flash triggers
- strobe lights
- computer memories
- flame monitors
- lamp dimmers
- touch sensors
- signal sources
- flip-flop latches
- frequency dividers
- "hot chassis" checkers
- audio oscillators
- vacuum tube testers
- radiation detectors

...and an awful lot more.

The NE-2 is just a small glass tube with a tiny amount of low-pressure neon gas in it. Two simple pins act as terminals. At voltages below 55 volts or so, the neon lamp is more or less an open circuit. Above that value, the tube "turns on" and starts to conduct, emitting a distinctive orange light.

When conduction starts, the NE-2 becomes a negative resistance. This happens as more current ionizes more gas in the plasma and lowers the drop across the terminals to (typically) 45 volts or so. That destructive behavior requires external current limiting, usually with a high-value resistor of 100K or more. Conduction continues as long as a current source remains. When and if the current drops down to zero, the neon lamp turns off.

A standard NE-2 pilot light circuit is shown in Fig. 1A. Connect that circuit to



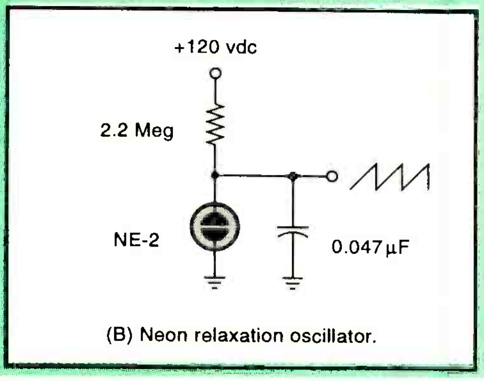




FIG. 1—TWO NEON LAMP CIRCUITS: The one in A is a simple lamp tester; the one in B is a relaxation oscillator.

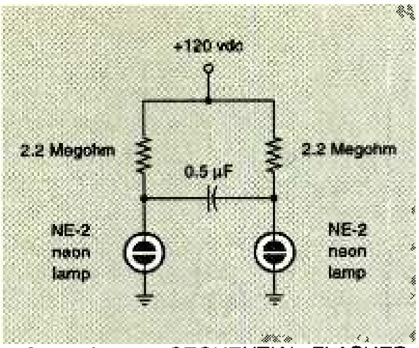



**FIG. 2—A NE-2 SEQUENTIAL FLASHER,** otherwise known as an astable multivibrator.

110-volts AC and both pins will light up to that characteristic neon orange. Once again, external current limiting must be provided, or a NE-2 will self-destruct. A variation on the circuit is the standard hardware store "circuit tester." Both lamp pins light on AC, but only the positive one does on DC. Thus, you have a simple AC-DC and polarity detector.

Another long-forgotten trick with the circuit checker is to use it as a hot-chassis detector. In some consumer-electronics equipment, one side of the line cord is connected to an internal chassis. Supposedly, the polarized prongs of the power cord prevent the wrong side from being connected, but mistakes do happen.

A severe shock hazard can exist when you try to service hot-chassis gear. To find out if what you are working on is of that type just hold one terminal of a neon tester in your hand and then touch the other to the chassis. If the lamp weakly lights, reverse the power cord or take other suitable precautions. No shock should be felt.

A simple neon-lamp relaxation oscillator is shown in Fig. 1B. That two megohm resistor by itself cannot provide enough current to light the neon lamp in this circuit. So, the lamp remains off, and the capacitor starts charging. When the capacitor charges up to 55 volts, the neon lamp turns on and flashes brightly.

The capacitor is then discharged to the lamp's turnoff point, and the cycle repeats. The lamp flashes at a frequency determined by the RC time constant and the thresholds involved. A sawtooth-like exponential wave will appear across the capacitor; it can be sensed and used as an audio or other signal source.

Neon circuits are also micropower because only a very few microamps are needed from your DC supply.

In Fig. 2, a pair of neon lamps is used as an alternating flasher. This was once known as an astable multivibrator. The capacitor first charges right-to-left and then left-to-right as the alternate lamps conduct. The secret to startup involves the small stray capacitances that are inherently around each bulb.

Figure 3 gives you a cute neon twinkle light effect. Long ago and far away, I used this many times for dance decorations.

Due to the differences in lamp thresholds, the sequence ends up pretty much random—hence your twinkle lights or "little stars." At any given time, one (or rarely two) lamps are lit and provide capacitor charging paths. As the capacitors charge, the threshold for another lamp is exceeded and it fires. Because of a commutation effect, any other lamp turning on should turn off any already lit ones.

For relaxation oscillators to work, the resistors and supply voltage must all be chosen to lie on the negative resistance portion of the NE-2 curve. This usually happens over a rather wide value range. Some cut-and-try may be needed for anything fancy. Resistors in the one to four megohm range are usually a good starting point.

What is really mind-blowing is that I still know of no way to do the same thing using LEDs that can end up being remotely as simple, as cheap, or as low in power. Much more on elegant simplicity appears in ELESIMP.PDF on my www.tinaja.com Web site.

## Tachometer Fundamentals

A tachometer is an instrument to measure the speed of a rotating shaft. The results are often shown in rpm, short for Revolutions per Minute.

Tachometers, or tachs, could be digital or analog. Generally, digital ones are more accurate but can be much harder to read and interpret, especially during changes. Since there are lots of subtle

**NEED HELP?**

Phone or write all your US Tech Musings questions to:

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Box 809-EN
Thatcher AZ. 85552
Tel: 520-428-4073

US email: don@tinaja.com
Web page: http://www.tinaja.com

## NAMES & NUMBERS

**Hitachi**
2000 Sierra Point Pkwy.
Brisbane, CA 94005
(415) 589-8300

**Home Automation Systems**
17171 Daimler Street
Irvine, CA 92614
(800) 367-9836

**Home Automator**
2258 Sandy Lane
Mebane, NC 27302
(910) 578-9519

**Live Wire Enterprises**
PO Box 670081
Flushing, NY 11367
(718) 544-4400

**Maxim**
120 San Gabriel Dr.
Sunnyvale, CA 94086
(800) 998-8800

**P-O-P & Sign Design**
7400 Skokie Blvd.
Skokie, IL 60077
(708) 675-7400

**Point of Purchase**
6225 Barfield Rd. #200
Atlanta, GA 30328
(404) 252-8831

**Sign Business**
1008 Depot Hill Office Pk.
Broomfield, CO 80020
(303) 469-0424

**SignCraft**
PO Box 06031
Ft. Myers, FL 33906
(813) 939-4644

**Synergetics**
Box 809
Thatcher, AZ 85552
(520) 428-4073

**Technical Works**
PO Box 3692
Albany, GA 31706
(912) 787-3000

**Texas Instruments**
PO Box 655303
Dallas, TX 75380
(800) 336-5236

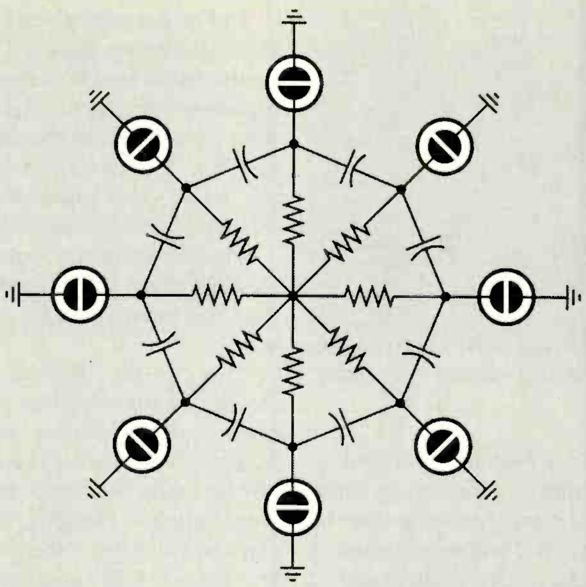


**FIG.3**—"TWINKLE LIGHTS" for a dance, show, or display.

"gotchas" to tach design, I thought we might go over some fundamentals. Digital tach design can often be split into sensing, conditioning, algorithmic conversion, and display:

**Sensing**—Sensing involves generating one or more pulses per revolution. In "sensorless" sensing, speed signals are extracted and conditioned directly from the motor's back emf. This has to be tightly integrated into the exact motor and controller in use.

In "sensored" sensing, a device is placed on or near the motor shaft to generate one or more electric pulses per shaft revolution. Sensored sensing most often is done magnetically or optically.

Magnetic sensing is usually done with magnets and Hall Effect devices, or alternately by using ferrous gear teeth and variable reluctance coils. With infrared optics, a bladed vane could interrupt a LED/photodetector pair, or IR light could be bounced off reflective shaft portions.

A third route of very questionable reliability is to use direct mechanical contacts in a commutator setup or a physical gear or roller.

Note that speed can be determined using a single sensor. But when both speed and direction are needed, then a pair of quadrature sensors must be used. These are arranged so that one is in the middle of its sensing activity while the other is at its edge. A dual flip-flop or a computer-logic circuit can extract both speed and direction, as could a somewhat trivial software algorithm. Actual position could be found by adding up or integrating all your speed pulses.

Honeywell and Allegro Electronics are major suppliers for low cost Hall sensors. Optoelectronic providers include Hewlett-Packard, Texas Instruments, Toshiba, Siemens, and QT Optoelectronics.

**Conditioning**—This just consists of making sure that each sensed pulse ends up as a single clean event. It can be done using hardware, software, or a mixture of both.

**Algorithmic conversion**—This step usually has to solve several interface problems. It might include numeric translations and reaching acceptable measurement speeds.

At 600 rpm with a single pulse per revolution, you'll have 10 pulses per second. The "10" result from a direct one second measurement must be multiplied by "60" to provide a "600" display. Other scaling factors need to be considered when more than one pulse per revolution is involved, or in automotive applications where each cylinder fires only once for every two revolutions. Note that certain newer cars may fire their cylinders twice to eliminate a distributor—once for real and once at a uselessly wrong time, so watch that detail.

Scaling can be done with hardware or software. These days, software scaling

## TACHOMETER RESOURCES

**Abbeon Cal**
123 Gray Ave.
Santa Barbara, CA 93101
(805) 966-0810

**Allegro Microsystems**
Box 15036
Worcester, MA 01605
(508) 853-5000

**Asian Sources**
1020 Church St.
Evanston, IL 60201
(847) 475-1900

**Barbara Arnold Sales**
3704 Carlisle Ct.
Modesto, CA 95356
(800) 335-4852

**Circuit Cellar Ink**
4 Park St. #20
Vernon, CT 06066
(203) 875-2751

**Scott Edwards**
964 Cactus Wren Lane
Sierra Vista, AZ 85635
(520) 459-4802

**Electromatic Equipment**
600 Oakland Avenue
Cedarhurst, NY 11516
(800) 645-4330

**Hewlett-Packard**
PO Box 10301
Palo Alto, CA 94303
(415) 857-1501

**Honeywell Microswitch**
3660 Technology Dr.
Minneapolis, MN 55418
(800) 345-6770

**Measurement & Control**
2994 W Liberty Ave.
Pittsburgh, PA 15216
(412) 343-9666

**Microchip Technology**
2355 W Chandler Blvd.
Chandler, AZ 85224
(602) 786-7200

**Frank Murphy Mfg.**
PO Box 470248
Tulsa, OK 74147
(918) 627-3550

**Omega Engineering**
One Omega Dr.
Stamford, CT 06907
(800) 826-6342

**Parallax**
3805 Atherton Rd. #102
Rocklin, CA 95765
(916) 624-8333

**QT Optoelectronics**
610 N Mary Ave.
Sunnyvale, CA 94086
(408) 720-1440

**Red Lion Controls**
20 Willow Springs Circle
York, PA 17402
(717) 767-6511

**Reddington Counters**
130 Addison Rd.
Windsor, CT 06095
(860) 688-6205

**Sensors**
174 Concord St.
Peterborough, NH 03458
(603) 924-9631

**Siemens Components**
2191 Laurelwood Rd.
Santa Clara, CA 95054
(408) 980-4500

**Sunshine Instruments**
1810 Grant Avenue
Philadelphia, PA 19115
(800) 343-1199

**TES Electronics**
57 Jen-Ai Road SEc 2
Taipei, TAIWAN
886-2-2393-9142

**Texas Instruments**
PO Box 655303
Dallas, TX 75380
(800) 336-5236

**Toshiba**
1220 Midas Way
Sunnyvale, CA 94086
(800) 321-1718

**Veeder Root**
125 Powder Forest Dr.
Simsbury, CT 06070
(860) 651-2700

using a PIC or other micro is the preferred choice.

Again, at 600 rpm using a single pulse per revolution, you'll have 10 pulses per second. Six seconds would be required to achieve a ten percent accurate measurement. Much longer times would be required for higher accuracy, especially at lower speeds.

One obvious solution to response times is to have more sensed pulses per revolution. A second solution is to use a phase-locked loop (such as a CMOS 4046) to "multiply" the input-pulse repetition rates by a reasonable selected numeric value. Such a multiplication might also perform the required scaling as well. However, there is an inherent lag in any PLL circuit, which might cause the display to unacceptably fall behind real-time speed changes.

An often optimum workaround is to measure the time period between the sensed pulses instead of counting their frequency. This is known as the EPUT method, as in Events Per Unit Time. The once-horrendous nasty involved here is that a 1/x calculation is required. If your chosen micro has no division instructions, alternates such as a table lookup or a repeated subtraction can be used. Scaling can also be provided internal to your 1/x calculation process.

Another algorithmic consideration is the update time as continuous updates tend to jump around and can be incredibly difficult to interpret or follow. Something near two to four updates per second is often a good choice that optimizes human factors. It's also a very good idea to take the average of as many measurements as practical before displaying them. It is sometimes optimum to round all the display values off to the nearest 100 revolutions per minute.

In certain circumstances, it is best to provide for both an analog and a digital speed display. Use digital for accuracy and analog to interpret any sudden changes.

**Display**—A PIC or other micro can be used for input conditioning, scaling, and algorithmic conversion. This will often drive an LCD or LED display. An LCD display might typically carry its own very specialized controller chip strapped onto its back.

## Some Resources

I've gathered together some tachometer information for you as this month's resource sidebar. Your best starting points are usually the *Sensors* or *Measurements & Control* trade journals. Lab tachs are resold by Omega Engineering, Abbeon Cal, and others.

Three examples of handheld tachs include the TouchTach by Barbara Arnold Sales, the Shimpo DT-105 from Sunshine Instruments, and the RM-1500 from TES Electronics.

Ready-to-use digital-tach panel instruments are widely available. A pair of useful sources includes Red Lion and Reddington. Check out the latter's Eagle

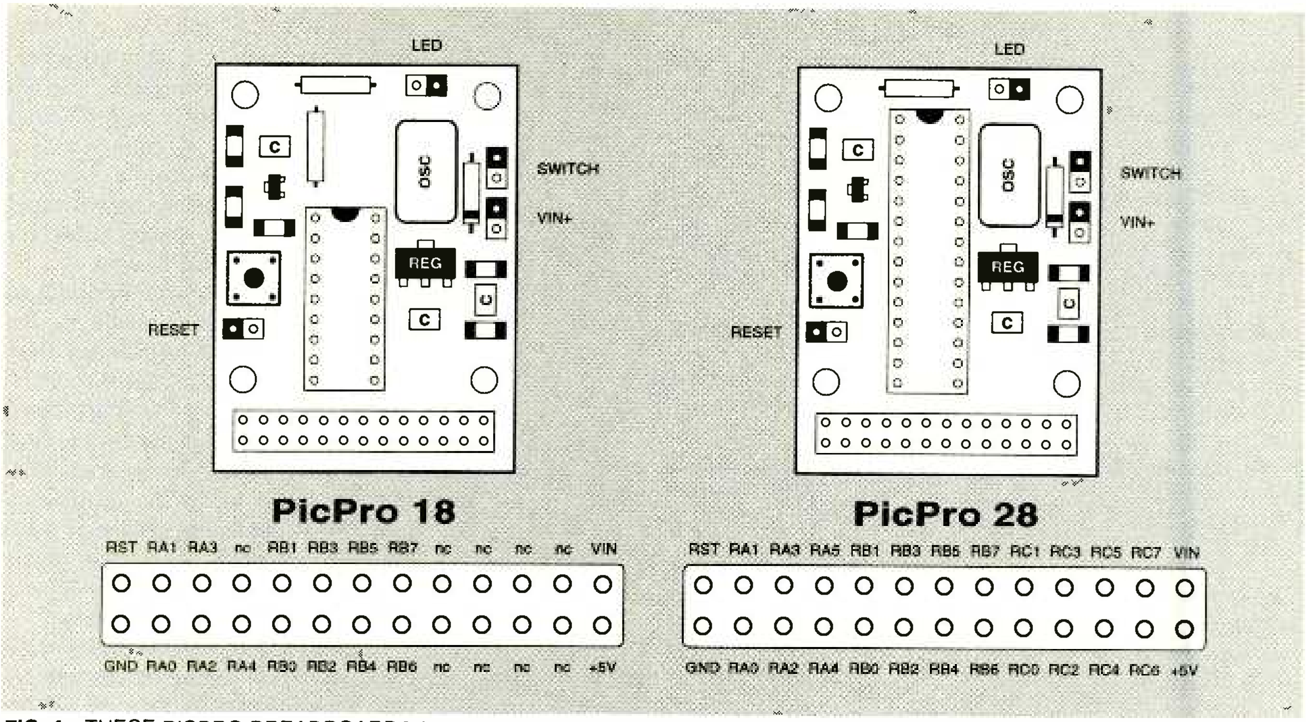


**FIG. 4**—THESE PICPRO BREADBOARDS from Technical Works simplify PIC design and interface.

Model 53.

One obvious starting point for any custom tachometer is to use the Basic Stamp from Parallax combined with an LCD display module from Scott Edwards Electronics. Later these can be replaced with a custom PIC or a baby PIC design and cheaper display. Microchip Technology is your main PIC supplier. Alternate solutions are offered by Circuit Cellar, as well as in most of the "hobby projects" kit-product lines. But unless you are up to something special, the commercial high volume modules are likely to be a better and cheaper solution than homebrew.

## PIC Development Boards

Speaking of PICs, Brad Mock of Technical Works has just come up with something that has long been needed—some small printed circuit breadboards that hold your choice of popular PIC chips, along with all the necessary regulator, oscillator, reset circuitry, and related goodies. Unlike the Basic Stamp from Parallax, these conveniently let you work directly in ultra fast PIC machine language. Two current models are for the 18- and 28-pin PIC chips; other sizes are in the works.

The list prices will be $17.95. His special introductory price of $14.95 is available for readers of this column. Several more details on these PicPro devices are shown in Fig. 4. Lots more PIC information can be downloaded at www.tinaja.com/picup01.html.

## New Tech Lit

From Texas Instruments there's Radio Frequency Solutions and Video Solutions for PC Platforms mailers. From Maxim comes the latest release of a Data Catalog CD. The new reference library CD from Hitachi is about their SuperH RISC Engines

There is a new freebie catalog out from Home Automation Systems. And *Home Automator* magazine remains your first choice for useful help in this field. A home-automation tutorial is at www.tinaja.com/resbn01.html.

I came across two interesting new books this month. First, be sure to check out *When Things Start to Think* by Neil Gershenfeld. This text is mostly on ongoing projects by the MIT Media Lab. Neil makes heavy predictions for the widespread use of low-cost distributed intelligence: everything from erasable digital paper to smart shoes. This title meshes nicely with *The Age of Intelligent Machines*, which we looked at last month.

There is also a superb *Planetary Astronomy* text by a Ronald Schorn. This appears to be a highly readable and a definitive history of our solar system discoveries as written by a NASA insider. Lots of references and a detailed and annotated bibliography are nicely included.

More on these titles can be found at www.tinaja.com/amlik01.html. A very useful database for astronomy teaching materials can be obtained from www.aas.org/~education/index1.html.

An intriguing "Knotty Neon" lighting and display material is now available. These are basically knottable "ropes" of electroluminescent light.. There's ten colors with lengths up to 600 feet. The colors are somewhat adjustable by changing the applied frequency from a 12-volt AC control unit driven by a wall wart supply. The supplier is Live Wire Enterprises. I was unable to locate their Web site (if one exists). They are mentioned at www.led.com and at www.lightsearch. com. Trade journals that target this sort of neat stuff include *Signcraft*, *Sign Business*, *POP and Sign Design*, and *Point of Purchase*.

There sure is a bunch of interest in boat anchors—pieces of ancient military surplus communications or test gear that are outrageously huge and heavy—these days. They sure don't make them like this any more. I will try to do an in-depth survey sometime, but for now, check into the link farm at nashville.net/~badger/millist. Or to find "straight from the horse's whatever" information, try out FM 24-24 at www.gordon.army.mil/doctrine/2424, plus, of course, good old Surplus Al at mh105.infi.net/~surplsal/.

Speaking of boat anchors, I just happen to have a stunning buy on a neat 60-kilowatt load bank. AC or DC, single or three phase, 12 to 440 volts. You use this one for generator testing, student power-lab loads, or wind energy research. It also makes toast. And, no, there is no way you can call this one a white elephant—it is a perfectly normal gray elephant in color and size. Contact me via e-mail at don@tinaja.com or see www.tinaja.com/bargte01.html.

For all the fundamentals of digital integrated circuits, be sure to check into my *TTL* and *CMOS Cookbooks*, either by themselves or as part of my bargain priced *Lancaster Classics Library*. See my nearby Synergetics ad for full details. And for all your other book needs, see www.tinaja.com/amlink01.html.

The latest Web-site additions to my Guru's Lair found at www.tinaja.com include a tutorial on Supraluminal Dowsing for Brown's Gas in Roswell. Your key secret, of course, is to be sure to use an overunity water-fueled black helicopter.

Our Consultant's Network is newly expanded and greatly improved at www.tinaja.com/consul01.html. And lots of surplus bargains are found at www.tinaja.com/barg01.html.

As usual, most of these mentioned items should show up in our Names & Numbers or Tachometer Resources sidebars. Check here before calling our no-charge US technical helpline shown in the nearby box.

Let's hear from you.

EN

## SOLAR DOSIMETER

*(continued from page 77)*

Note that the solar dosimeter responds only to the blue-green portion of the visible spectrum; it does not directly measure ultraviolet radiation. You can use it, however, to estimate your UV exposure in the six hours around noon when UV intensity is proportional to visible radiation. Also note that due to the nature of the Earth's atmosphere, the amount of visible light is not necessarily an accurate indicator of the amount of UV radiation. Ω

# NEW PRODUCTS

*continued from page 16*

gence and mobility to new and existing network video cameras by providing pan/tilt/zoom position control and viewing access from anywhere in the world. Easy to use and set up, the Transit RCM is connected into the camera with a tripod mount and then plugged into a PC serial port. Control of that camera can then be accessed from any PC connected to the digital network being used.

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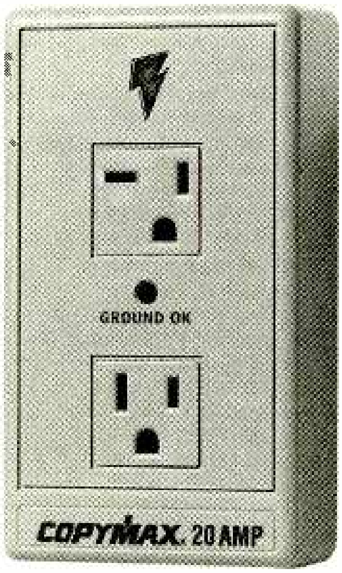
The camera mount provides accurate remote positioning control for new or existing CCD/CMOS video camera systems connected via digital networks. This controller increases the field-of-view of existing stationary video cameras (analog or digital) up to 270 degrees, depending on the camera used, and eliminates the need for low resolution "fisheye" lenses. The compact Transit RCM features control for motorized zoom, focus, and iris, and self-calibration upon reset. The Transit RCM has a suggested retail price of $295.

**SURVEYOR CORP.**
*4501 Orcutt Road*
*San Luis Obispo, CA 93401*
*Tel: 805-784-9000*
*Fax: 805-784-0925*
*e-mail: mfj@surveyorcorp.com*
*Web: www.surveyorcorp.com*

## Power Filter

DESIGNED TO PROTECT DIGITAL multi-functional equipment, the COPYMAX 20 AMP power filter ensures a much greater degree of product safety. As well as meeting UL 1449 standards, the unit provides thermal fusing, which protects against fire in case of extended overvoltage. The unit includes surge protection circuitry with an enhanced power line filter design.

It uses both common and normal mode coils, adding suppression of noise

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from connected equipment and provides noise filtration and increased noise and spike attenuation. The COPYMAX 20 AMP has two 20-amp outlets and plugs directly into the AC wall outlet. Diagnostic lights continuously monitor the status of the power being supplied, as well as the operation of the circuitry. The COPYMAX 20 AMP has a suggested list price of $99.

**PANAMAX**
*150 Mitchell Blvd.*
*San Rafael, CA 94903*
*Tel: 800-472-5555 or 415-499-3900*
*Fax: 415-472-5540*
*Web: www.panamax.com*

## Air Cleaner Test Probe

THE FLUKE 80K-15 ELECTRONIC Air Cleaner Test Probe is an accessory that extends the voltage measurement capability of most digital multimeters up to 15kV. It is intended for measuring the output voltage in low energy environments such as electronic air cleaners. The 80K-15 probe provides high accuracy (± 2%) when used with a voltmeter having an input impedance of 10 megohms.

Plastic body construction provides the user with isolation and protection from the voltage being measured. A heavy-duty grounding clip offers a secure connection to earth ground. The

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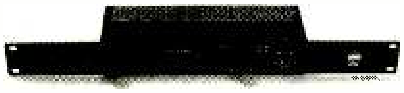
80K-15 probe has a suggested retail price of $149.

**FLUKE CORP.**
*P.O. Box 9090*
*Everett, WA 98206*
*Tel: 800-44FLUKE*
*Fax: 800-FLUKE-FAX*
*e-mail: fluke-info@tc.fluke.com*
*Web: www.fluke.com/handheld/access*

## Recorder/Equalizer Interconnect Device

USEFUL FOR SERIOUS RECORD collectors, sound restorers, and home studios, the SuperConnector is an easy-to-use, audiophile-quality device. It permits connection of up to five audio recorders and various equalizers to your main audio system. It can also connect



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between your recorders for dubbing onto any or all of them.

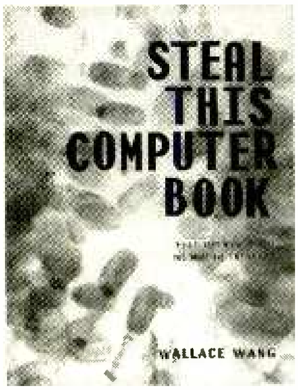
The unit adds a mono mode control to facilitate recording mono sources, or to accommodate mono equalizers, or single channels of a source. External recorders can be conveniently connected via front-panel ¼-inch stereo plugs. Made of high-quality, double-sided, fiber glass epoxy PCB, the equalizer features 34 gold-plated RCA connectors and is rack mountable. The SuperConnector sells for $299.

**ESOTERIC SOUND**
*4813 Wallbank Ave.*
*Downers Grove, IL 60515*
*Tel: 630-960-9137*
*e-mail: esoterictt@aol.com*

EN

## Steal This Computer Book: What They Won't Tell You About the Internet

*by Wallace Wang*
*No Starch Press*
*555 De Haro Street, Suite 250*
*San Francisco, CA 94107*
*Tel: 415-863-9900*
*Fax: 415-863-9950*
*Web: www.nostarch.com*
**$19.95**
Computer viruses, hacking, phone phreaking, e-mail bombs—how do they work, who are the perpetrators, and how can you protect yourself from them? These issues, among others, are explored in this book. The author provides objective information that enables readers to become active, involved, educated Netheads as opposed to passive victims.

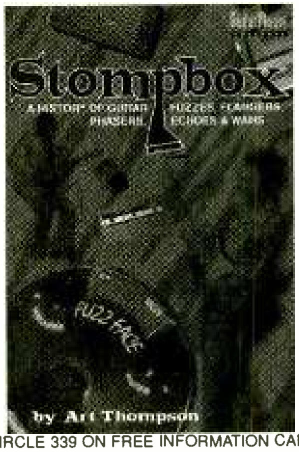



CIRCLE 338 ON FREE INFORMATION CARD

In exposing the dangers of computer technology, this book reminds us that sometimes the best defense is a good offense. To help you protect yourself and your computer, the author takes a tour of the Internet and explains the secrets necessary for survival.

## Stompbox: A History of Guitar Fuzzes, Flangers, Phasers, Echoes & Wahs

*by Art Thompson*
*Miller Freeman Books*
*6600 Silacci Way*
*Gilroy, CA 95020*
*Tel: 800-848-5594 or*
*408-848-5296*
*Fax: 800-437-3299 or 408-848-5784*
*Web: www.books.mfi.com*
**$24.95**
This book tells the story of the electric guitar devices that rendered some of the most famous music of the 60s and beyond, such as the Stones' "(I Can't Get No) Satisfaction." Thousands of songs owe a huge debt to the small unit that distorts and sculpts guitar sound, creating outrageous effects.




CIRCLE 339 ON FREE INFORMATION CARD

The author portrays the stompbox in all its incarnations: fuzz boxes, wah-wah pedals, reverb and tremolo bars, talk boxes, echo units, and other guitar add-ons—mostly with crazy names like Fuzz Wah Diddy and Orange Squeezer—and accompanies the text with over 200 photos. He traces its roots back to the transistor and discusses how many of the old units have become very popular with today's guitarists.

## 1999 Master Catalog

*from Jensen Tools, Inc.*
*7815 S. 46th Street*
*Phoenix, AZ 85044-5399*
*Tel: 800-426-1194 or 602-968-6231*
*Fax: 600-366-9662 or 602-438-1690*
*e-mail: jensen@stanleyworks.com*
*Web: www.jensentools.com*
**Free**
This 308-page, full-color catalog contains many new products including the recently introduced line of Jensen brand handheld meters. Among other new products are the TX Series DMMs from Tektronix, Fluke's i2000flex current probes, and Leatherman's Wave multipurpose tool.


CIRCLE 340 ON FREE INFORMATION CARD

In addition to 50 pages of Jensen original tool kits, the new catalog features products from all major manufacturers, including test equipment, power and specialty tools, wire and cable, equipment for soldering, telecommunications, and much more. A complete alphabetical index is provided, listing products by manufacturer and type.

## Caller ID & ANI Security

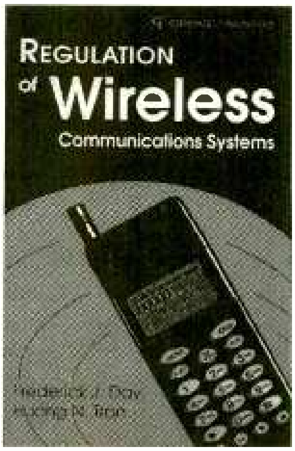
*by John J. Williams*
*Consumertronics*
*P.O. Box 23097*
*Albuquerque, NM 87192*
*Tel: 505-237-2073*
*Fax: 505-292-4078*
*Web: www.tsc-global.com.*
**$29**
Want to keep your ID secret when calling? This manual details how Caller ID works and discusses the vulnerability of

Caller ID, ANI, *69, *57, *67, and Call Blocking. Other topics covered are Class Per-Call Services, Advantages and Disadvantages of Caller ID, Phone Privacy, and Technical Details.

## Regulation of Wireless Communication Systems

*by Frederic J. Day and Huong N. Tram*
*Government Institutes*
*4 Research Place, Suite 200*
*Rockville, MD 20850*
*Tel: 301-921-2355*
*Fax: 301-925-0373*
*e-mail: giinfo@govinst.com*
*Web: www.govinst.com*
**$89**

A valuable reference tool for researching FCC policies and regulations, this book provides an in-depth understanding of the regulations of wireless systems. Readers will get a critical analysis of the history and current status of FCC regulations, including the Telecommunications Act of 1996—an understanding of which is essential to successfully navigating your wireless communications business.

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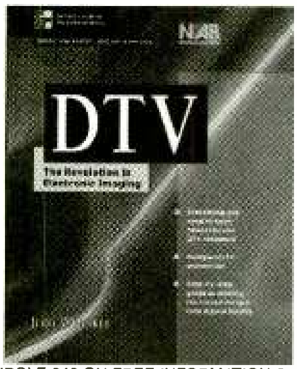
Easy-to-read, this sourcebook takes a comprehensive look at FCC regulations affecting wireless communications, such as private land mobile and microwave communication systems, and common carrier communication systems. Numerous charts, tables, and diagrams help explain complex concepts, including the fundamentals of radio communications, frequency allocations, and "reframing the spectrum."



## DTV: The Revolution in Electronic Imaging

*by Jerry Whitaker*
*McGraw-Hill*
*1221 Avenue of the Americas*
*New York, NY 10020*
*Tel: 800-2MCGRAW*
*Web: www.ee.mcgraw-hill.com*
**$55**

DTV combines the best available digital technologies for video and harnesses them for new uses in broadcast communications. This book provides complete background for every important innovation in this field.



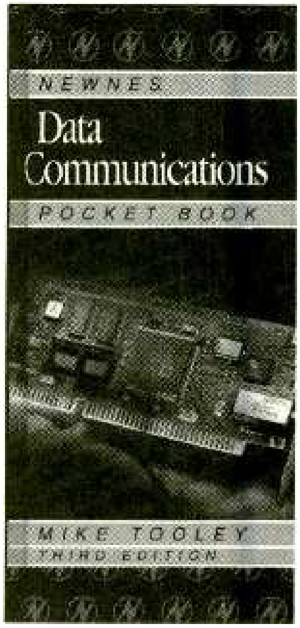

CIRCLE 342 ON FREE INFORMATION CARD

Using explicit examples, schematics, and mathematics, the author creates a primer of DTV standardization—a blending of telecommunications, broadcasting, and computer technologies into one tool. The book also reports on video transmission issues and interchange formats. Other topics covered include video compression, convergence issues, and transmission and reception hardware.

## Newnes Data Communication Pocket Book, 3rd Edition

*by Mike Tooley*
*Newnes, Butterworth Heinemann*
*225 Wildwood Avenue*
*Woburn, MA 01801-2041*
*Tel: 800-366-2665 or 781-904-2500*
*Fax: 800-446-6250*
*e-mail: orders@bhusa.com*
*Web: www.bh.com/newnes*
**$28.95**

This edition has been substantially updated and expanded to keep up with the latest deveolopments in data communications technology. Among the topics covered are data compression, the Internet and the Web, and HyperText Mark-up Language (HTML).




CIRCLE 343 ON FREE INFORMATION CARD

Despite the complexity of the material, this information is presented clearly and concisely. Tables and diagrams help readers locate information quickly and easily.

## 1999 Catalog

*from CAIG Laboratories, Inc.*
*12200 Thatcher Court*
*Poway, CA 92064-6876*
*Tel: 800-CAIG-123 or 619-486-8388*
*Fax; 619-486-8398*
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This catalog features a variety of environmentally safe products to improve conductivity and maintain optimum signal quality on connectors, probes, switches, and other electrical contacts and connectors. CAIG offers a complete line of non-aerosol applicators for aerosol-sensitive customers.

Products include lubricants, deoxidizers, solvents, pastes, anti-static and shielding compounds, lint-free accessories, solder pots, plastic cutting and welding tools, heat-shrink ovens, process conveyor ovens, and more. EN

## SERVICE CLINIC

*continued from page 25*

either—it is external.

As stated early in this article, the ferrite core of a flyback transformer is constructed with a precision gap usually formed by some plastic spacers or pieces of tape—don't lose them if you need to disassemble the core. The ferrite core is also relatively fragile, so take care.

The focus and screen divider network uses potentiometers and resistors (not shown) with values in the tens to hundreds of megohms, so they may not register at all on your multimeter. The high voltage rectifiers (D1 to D3 on this diagram) are composed of many silicon diodes in series and will read open on a typical VOM or DMM.

Note that there is no standardization to the color code. However, the fat wire to the CRT is most often red, though it could also be black. Of course, you cannot miss it with the suction cup-like insulator at the CRT-anode end. The focus and/or screen connections may also be to pins rather than flying leads.

### Replacement Flyback Transformers

Unfortunately, you cannot walk into RadioShack and expect to locate a flyback for your TV or monitor. However, there are other options:

• Original manufacturer—most reliable source but most expensive. Older models may not be available. This may be the only option for many TVs and monitors—particularly expensive or less-popular models.

• Electronics distributors—a number of distributors sell replacement flybacks. However, there may be no way of knowing if what you are getting is an original replacement or a generic equivalent, and you could end up with something that isn't quite compatible (see below). Thus, unless the catalog listing says "original part," these may be no better than ones from the generic sources we'll detail shortly.

In your search for flybacks, here are some places to try:

Component Technologies, Tel: 888-FLYBACK or 800-878-0540; e-mail: fbtxformer@aol.com

CRC Components, Tel: 800-822-1272

EDI (Electro Dynamics, Inc.) NY, Tel: 800-426-6423

Data Display Ltd, Canadian sub of CCS, Tel: 800-561-9903

Global Semiconductors (Toronto, Canada), Tel: 800-668-8776, Web: www.globalsemi.com

• Generic replacements—ECG, NTE, ASTI, HR Diemen, for example, offer lines of replacement flybacks. These companies have sites on the Internet that include a cross reference to their replacement based on TV or monitor model and/or the part or house number on the flyback:

NTE Electronics: www.nteinc.com
ECG Philips: www.ecgproducts.com
HR Diemen: www.hrdiemen.es
ASTI Magnetics: www.astimagnetics.com
Flybacktransformer: www.flybacktransformer.com
Cactus Technology Corp.: www.flyback-transformer.com.

Note, however, that generic replacements might be of lower quality or be not quite compatible with your original. In an effort to minimize the number of distinct flyback models, some corners may be cut and one-size-fits-many may be the rule resulting in all sorts of problems that could even further complicate your troubleshooting. In short, turn to these only if availability or economics leave you with no other choice.

### Wrap Up

That's it for now. Next time we will continue our discussion of monitor troubleshooting and repair. Until then, check out my Web site, www.repairfaq.org. I welcome comments (via e-mail only please at sam@stdavids.picker.com) of all types and will reply promptly to requests for information. See you next time! EN

## COMPUTER CONNECTIONS

*continued from page 13*

work with your standard phone lines.

To take advantage of xDSL, you'll need to equip your computer with an appropriate modem—usually ADSL or SDSL. The difference between these two is that ADSL is designed to have more bandwidth for downloads, making it perfect for Web use, while SDSL has synchronized speeds in both directions, making it a great solution for videoconferencing and file uploads. Maximum speeds for xDSL are expected to be about 2 Mbps; this seems slower than cable at first glance, but what you should know is that you'll get this speed on a regular basis and don't have to worry about bandwidth being used up by others someday (it's hard to say if cable companies will keep their promise of speed and bandwidth control).

**VENDOR INFORMATION**

**Compaq**
20555 State 249
Houston, TX 77070
Tel: 800-345-1518
Web: www.compaq.com

**Hughes Network Systems (DirecPC)**
11717 Exploration Lane
Germantown, MD 20876
Tel: 800-DirecPC
Web: www.direcpc.com

**DSL Communications**
4675 Stevens Creek Blvd.
Suite 241
Santa Clara, CA 95051
Tel: 408-249-6400
Web: www.dsl-com.com

As only a few areas are currently operating with the technology, xDSL's pricing is difficult to determine right now. From what we've seen, at its cheapest it's about $60 a month—almost double the cost of cable. Keep a look out for xDSL announcements in your area in the coming months. Computer vendors like Compaq are already shipping machines with modems that can handle both xDSL and standard analog lines (check out their Presario 5600 line), and companies like DSL Communications are already shipping add-on modems for use with any computer.

That's all for now. Until next time, here's hoping you have a viable high-speed way to get on the Net. If you'd like to get in touch, you can send e-mail to connections@gernsback.com, or snail-mail to *Computer Connections*, **Electronics Now**, 500 Bi-County Blvd., Farmingdale, NY 11735. EN

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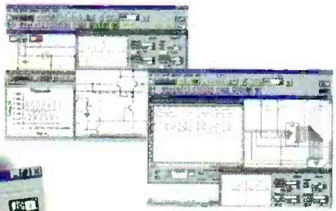

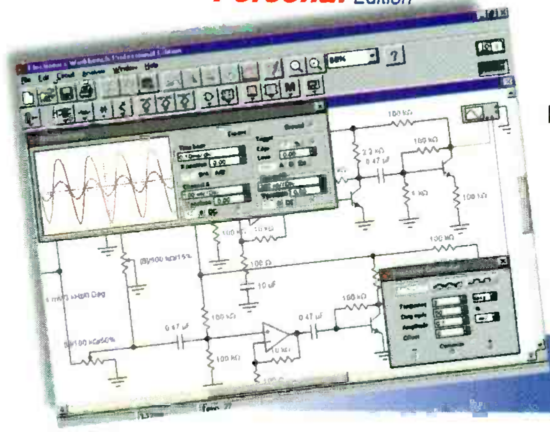

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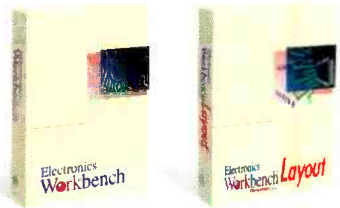


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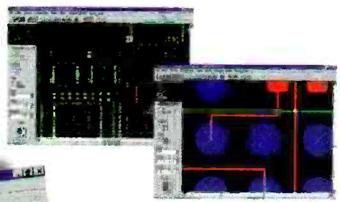

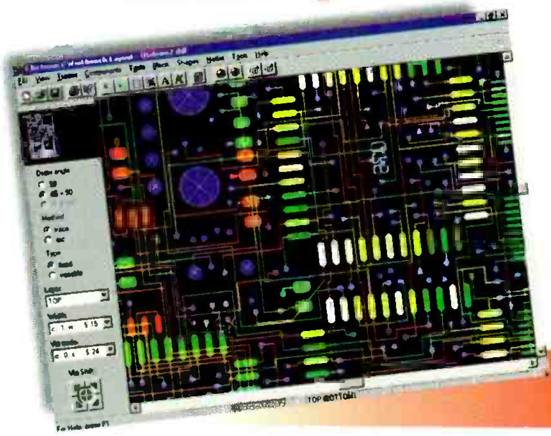

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