A/D CONVERTER CIRCUITS YOU CAN BUILD

NOVEMBER 1996

# Electronics NOW®

## Build a PC Board Assembly System

Our semi-automated system makes project building easier than ever

Keep your telephone conversations interruption-free with the

## Phone Line Sentinel

Build a

## Milliohm Adapter

Measure even the tiniest resistances accurately

Get picture-perfect results with the

## Zonal Enlarging Meter

A GERNSBACK PUBLICATION

$3.99 U.S.
$4.50 CAN.

#BXNBQWF****** 5-DIGIT 95066
#BRK60418090 6#303178 0AP39
JUN 97
CHRIS BARKER 11EN
[redacted]

Electronics NOW®

Vol. 67 No. 11

# CONTENTS

NOVEMBER 1996

## ON THE COVER




## BUILD THIS









ELECTRONICS NOW, (ISSN 1067-9294) November 1996. Published monthly by Gernsback Publications, Inc., 500 Bi-County Boulevard, Farmingdale, NY 11735-3931. Second-Class Postage paid at Farmingdale, NY and additional mailing offices. Canada Post IPM Agreement No. 334103, authorized at Mississauga, Canada. One-year subscription rate U.S.A. and possessions $19.97, Canada $27.79 (includes G.S.T. Canadian Goods and Services Tax, Registration No. R125166280), all other countries $28.97. All subscription orders payable in U.S.A. funds only, via international postal money order or check drawn on a U.S.A. bank. Single copies $3.50. © 1996 by Gernsback Publications, Inc. All rights reserved. Printed in U.S.A.

POSTMASTER: Please send address changes to ELECTRONICS NOW, Subscription Dept., Box 55115, Boulder, CO 80321-5115.

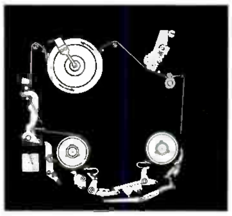
NOVEMBER 1996

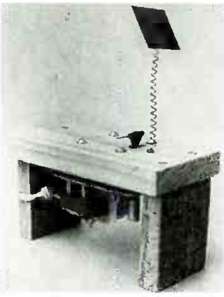
## TECHNOLOGY



## DEPARTMENTS







## AND MORE




# Electronics NOW®

Hugo Gernsback (1884-1967) founder

**LARRY STECKLER,** EHF, CET,
Editor-in-chief and publisher

**EDITORIAL DEPARTMENT**
**CARL LARON,** editor
**JOSEPH J. SUDA,** associate technical editor
**JULIAN S. MARTIN,** associate editor
**TERI SCADUTO,** assistant editor
**MICHAEL A. COVINGTON,** N4TMI contributing editor
**JEFFREY K. HOLTZMAN,** computer editor
**LARRY KLEIN,** audio editor
**DAVID LACHENBRUCH,** contributing editor
**DON LANCASTER,** contributing editor
**EVELYN ROSE,** editorial assistant

**ART DEPARTMENT**
**ANDRE DUZANT,** art director
**RUSSELL C. TRUELSON,** illustrator

**PRODUCTION DEPARTMENT**
**RUBY M. YEE,** production director
**KATHRYN R. CAMPBELL,** production assistant
**KEN COREN,** desktop production director
**LISA BAYNON,** desktop production

**CIRCULATION DEPARTMENT**
**JACQUELINE P. CHEESEBORO,** circulation director
**THERESA LOMBARDO,** circulation assistant

**REPRINT DEPARTMENT**
**MICHELE TORRILLO,** reprint bookstore

Typography by Mates Graphics
Cover design by David Loewy

**Electronics Now** is indexed in *Applied Science & Technology Index*, and *Readers Guide to Periodical Literature, Academic Abstracts*, and *Magazine Article Summaries*.
Microfilm & Microfiche editions are available. Contact reprint bookstore for details.

**Advertising Sales Offices listed on page 136.**
Electronics Now Executive and Administrative Offices
**1-516-293-3000.**
Customer Service:
**1-800-999-7139.**
**7:00 AM – 6:00 PM M-F MST**

Audit Bureau of Circulations
**Member**

# EDITORIAL

## Introducing www.gernsback.com

In my first editorial (September 1996), I mentioned that we were making our long awaited move onto the Internet. Well, that move is now largely complete and everyone here is extremely excited about it.

Our Web site, www.gernsback.com, hosts the home pages of both **Electronics Now** and our sister magazine, **Popular Electronics.** But there is also much more. By the time you read this, our FTP site will be up and running. There you will find all of the current and past story-related files for both titles.

Also in the works is a searchable article index. Need to find out if or when we covered a specific topic? Just go to our site and you'll have your answer with just a few keystrokes. The system is undergoing testing now, and we hope to have it operational by early next year.

Also on the way are discussion forums. If you are looking for somewhere to discuss the pros and cons of a particular project, article, or issue, it's the place to go. You'll also be able to interact with other readers on just about any electronics-related topic.

Our Web site is also where you'll find late-breaking updates for our stories and projects. We, of course, publish significant corrections and updates as soon as we become aware of them. However, due to publishing schedules, it can sometimes take months for them to appear in print. Now, that information will be available to you almost as soon as we have it.

There's also information on our two most current issues, subscription information with online ordering, back-issue ordering, links to our editorial and other staff members, links to our advertisers, and much more. Check it out and let us know what you think. You can contact me at claron@gernsback.com.

Carl Laron
*Editor*

# VIDEO NEWS

WHATS NEW IN THE FAST-CHANGING VIDEO INDUSTRY

BY DAVID LACHENBRUCH

## HDTV is on the Air

The first station to transmit digital high-definition TV is WRAL-HD, now broadcasting from Raleigh, North Carolina, on UHF Channel 23 under an experimental license from the FCC. That sister station of WRAL-TV mainly has been transmitting numbers for field measurements, but is sending full-bandwidth HDTV at its full authorized power of 100 kHz. The station plans to start transmitting actual video programs in the near future, using tapes provided by PBS and CBS. The station's executives have been talking with receiver manufacturers and are confident that HDTV sets will be in area stores by next spring.

Two more HDTV stations were due shortly at our deadline. The industry's model high-definition station, being financed by the Electronic Industries Association (EIA) and the Maximum Service Television trade association, was scheduled to take to the air soon at NBC's WRC-TV in Washington, D.C. Washington-based WETA, a PBS affiliate, is also building an HDTV counterpart, due on the air this year. The first HDTV receivers are expected to sell for more than $2000.

## Olympics in HDTV

At one time, the U.S. electronics and broadcasting community had planned to use the 1996 Summer Olympics in Atlanta as a showcase for American technology by broadcasting the games in HDTV. American HDTV slipped a cog as it wasn't quite ready. But the Olympics—390 hours of it—went on the air in HDTV anyway. It just wasn't American HDTV.

The Europeans and the Japanese collaborated to record 24 hours of Olympic competition daily in high definition. Backed by a grant from the European Union, Germany's ZDF network covered the games in 1250-line high definition, while Japan's NHK used its 1125-line equipment.

ZDF's coverage was converted to 1125 lines and sent, along with NHK's coverage, by satellite to Japan, where it was broadcast using Japan's analog Hi-Vision system from satellite to homes. ZDF's coverage, along with the NHK signal, was also converted to a PALplus signal for transmission to Europe, where it was broadcast to virtually all European countries. PALplus is an improved-definition system that permits specially equipped widescreen TVs to show widescreen pictures with full definition, while other sets display the same widescreen image as a letterbox picture. The additional information required to bring the letterbox picture to 625-line quality is encoded digitally in the black area above and below the widescreen picture.

## DBS Prices Falling

Prices of direct-to-home satellite equipment are falling rapidly, thanks to competition and subsidies by programmers. While the first digital satellite receivers for the DSS system—introduced under the RCA brand, using an 18-inch antenna—sold for $600 and up, some prices are now as low as $199. But there's a catch. The programming for these systems is available by subscription only. Obviously, those who install the equipment have to have programs. So the program providers increasingly are helping to subsidize equipment prices.

The first major move in that direction came from EchoStar, which was in a good position to undertake such a project because it sells both the programming and the hardware. It stunned its competitors by offering a receiver and antenna for $199 with the purchase of a year's programming at $300. The promotion was so effective in test areas that it was offered nationwide last summer.

Not to be outdone, DSS, the biggest selling system, was planning a similar promotion. In it, DirecTV and U.S. Satellite Broadcasting, which supply programming for the DSS system, would give the equipment suppliers—including RCA, Sony, and Panasonic—a subsidy to bring the price down to $399, and then send buyers a $200 rebate in addition, effectively reducing the hardware price to $199. While details have not been finalized at press time, the program should be in effect now, or starting soon, though perhaps in a somewhat different form.

The situation is reminiscent of what happened in the cellular-phone industry, where service providers are subsidizing phone instrument prices. The DBS competition hasn't yet gotten to the point where the receiver is free—but stay tuned.

## WebTv Becomes Contagious

There is absolutely no evidence that combining the 1990's fad of Web browsing with the television fad begun in the 1950's is a workable idea, but profit-starved TV manufacturers and Silicon Valley entrepreneurs are joining forces to test the idea in a large-scale way.

Probably the most persuasive force in that direction is WebTV Network, which has signed Sony and Philips (Magnavox) to supply set-top boxes to let consumers surf the Internet on their large-screen TVs from their easy chairs. The box provides on-line access and e-mail service to TV users, and has a slot for smart-card financial transactions.

The box will cost somewhere between $200 and $400.

The box is connected to a phone jack and the TV's audio and video terminals. It contains a 33.6-kilobyte-per-second modem and a 64-bit Orion MIPS RISC microprocessor. WebTV features its own Internet guide and simple menus for navigation, along with parental-control software. Wireless and wired keyboards will be available as e-mail accessories, although mail can be authored using an on-screen depiction of a keyboard as well. Sony and Magnavox are expected to have the boxes in stores before year-end.

Other TV manufacturers are using different approaches. As reported here, Zenith is fielding a Net-browsing TV, but prefers the built-in approach to the separate set-top box. RCA's parent, Thomson Consumer Electronics, has been demonstrating prototypes of its "Genius Home Theater," which combines Internet access, e-mail, CD-ROM changer, and other computer features with a high-end 35-inch TV set. Thomson says that it might offer a simplified Web-browsing TV or attachment as well.

RCA'S "GENIUS THEATER" PROTOTYPE is one of a host of new PC/TVs.

Another TV manufacturer, Curtis Mathes, plans to introduce a combination computer and TV set. Computer manufacturer Gateway 2000 is already selling such a combination. Dubbed Destination, it includes a 31-inch TV set and an electronic program guide.

Actually, Toshiba probably foreshadowed the so-called "marriage" of PC and TV in 1994 with its "TIMM" (for Toshiba Integrated Multimedia Monitor), a 20-inch monitor and TV set designed for use both as a TV and a high-quality audio and video monitor for PCs. Unfortunately, it didn't sell particularly well. EN

# WHAT'S NEWS

A REVIEW OF THE LATEST HAPPENINGS IN ELECTRONICS

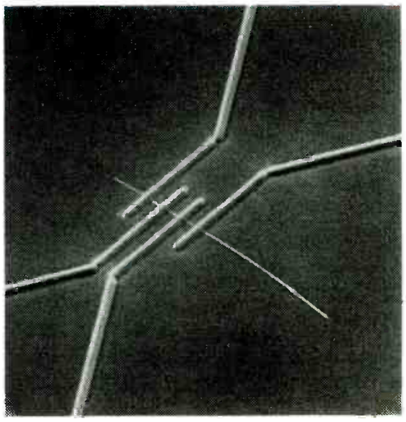
## Measuring Individual Carbon Nanotubes

Researchers at NEC Corporation (Japan) and NEC Research Institute (Princeton, NJ) have succeeded in measuring electrical conductivity in individual carbon nanotubes. Using an evaluation method developed by scientists at NEC and Micrion Europe, they discovered that each nanotube has unique electronic properties, including both metallic and non-metallic behavior, and that the differences between nanotubes are far greater than expected. The results confirm that, at this scale, geometry and electronic properties are closely linked.

By attaching four 80-nanometer tungsten leads directly to individual nanotubes, and using a focused ion beam (FIB) system, the NEC scientists were able to achieve a more accurate and informative evaluation of the nanotubes' properties. It was learned that the current carrying capacity of nanotubes is extremely high, the temperature dependence of the conductivity greatly differs between nanotubes, different segments of a single nanotube do not always have the same temperature profile, and nanotubes have significant variation in resistivities.

The interest in carbon nanotubes has been stimulated by theoretical predictions that their electronic properties would be strongly modulated by small structural variations. In particular, the diameter and helicity of carbon atoms in the nanotube shell are believed to determine whether the nanotube is metallic or a semiconductor. Prior to the NEC method of measuring individual nanotubes, however, experimental evidence had been mainly linked to bulk measurements.

"This work opens up for the first time full electrical measurements on carbon nanotubes," said Dr. William Gear, president of NEC Research Institute. "These tubes may be able to function as wires with a diameter about one hundredth the line-width used in current 16-megabit memory chips. Early results suggest that nanotubes can be fabricated with a very wide range of electrical properties.



NEC RESEARCHERS MEASURE the electrical conductivity of individual carbon nanotubes by attaching four 80-nanometer-wide tungsten leads to each nanotube.

## Solar Success Story

Engineers from Sandia National Laboratories (Albuquerque, NM) played a key role in the development of Solar Two, a large pilot solar power plant that is capable of producing 10 megawatts of electricity—enough to supply power to 10,000 homes. The project was sponsored by the Solar Two Consortium, a group of ten organizations led by Southern California Edison Company, and the Department of Energy (DOE). At a June 5 dedication ceremony, presided over by DOE Secretary Hazel O'Leary, Solar Two was officially connected to the utility grid in Southern California.

Solar Two is unique in its use of molten salt to capture and store the sun's heat. The solar plant uses large, sun-tracking mirrors to concentrate sunlight on a receiver that sits atop a tower. The concentrated sunlight heats the molten salt as it flows through the receiver. The hot liquefied salt is then piped away, stored, and used when needed to produce steam to drive a turbine/generator that produces electricity.

Solar Two's predecessor, Solar One, was a direct-steam solar generator that operated from 1982 to 1986. Solar One generated steam directly from water in its receiver, and was plagued by low energy-storage efficiency and interrupted operation from passing clouds. Solar Two, in contrast, can operate smoothly through intermittent clouds and continue generating electricity long into the night.

Sandia conducted large-scale experiments on the components needed in a molten-salt system at its Central Receiver Test Facility in Albuquerque. "Sandia played a key role in providing assistance by transferring molten-salt technology to the project, by leading the Technical Advisory Committee which oversaw all technical aspects of the project, and by supporting the design, construction, and startup of the plant through the outstanding efforts of its staff," said Gary Burch, director of the DOE's Thermal and Biomass Power Division.

## IC Expo/96

Co-sponsored by Wescon, EE Times, Electronic Buyer's News, and OEM Magazine, IC Expo/96 is scheduled to take place as part of Wescon/96 on October 22–26, 1996, at the Anaheim Convention Center in Anaheim, California. The Wescon International Electronics Conference and Exhibition is a major OEM event for electronics, computer, and communications professionals.

The IC Expo/96 show-within-a-show, an extensive semiconductor trade exhibition, will celebrate the 25th anniversary of the microprocessor—and the 45th anniversary of Wescon—with a series of

*continued on page 12*

# LETTERS

SEND YOUR COMMENTS TO THE EDITORS OF ELECTRONICS NOW MAGAZINE

## L/C Meter Correction

In my article, "Build This Self-Calibrating L/C Meter" (*Electronics Now*, June 1996), I inadvertently submitted the incorrect schematic diagram. The schematic published was for an experimental unit that used a different display module and thus had different pinouts on the CPU-to-display interface. The PCB layout is correct, so any units built using a printed circuit board should be okay. This proves the saying, "To err is human, to really foul things up use a computer."

A copy of the correct schematic can be obtained by requesting it and sending a self-addressed, stamped envelope to the address below. The correct schematic is also available as lcmsch.gif on the Electronics Now BBS (516-293-2283).

NEIL HECKT
*Almost All Digital Electronics*
*1412 Elm Street SE*
*Auburn, WA 98092*

## New Product Correction

Thank you for mentioning HC Protek's D-980 digital Multimeter in the July "New Products" column. Unfortunately, two errors appeared. First, the DC accuracy specification was cited as 5%. The actual specification is 0.5%.

Our Web site URL was also incorrect. The correct URL is http://www.techexpo.com/WWW/hcprotek.

ROY TAFFARO
*HC Protek Applications Engineer*
*Northvale, NJ*

## Non-Stereo Compressor

I would like to share my thoughts about the article, "Build a Stereo Compressor" (*Electronics Now*, August 1996). Although the two-channel compressor project will prove to be a fine addition to someone's audio-processing needs (Analog Devices makes great, innovative ICs), it is not a stereo compressor.

For the unit to operate in the stereo mode, both rectifier log converters from channels one and two would need to be summed into a single control voltage that would then feed directly to the VCAs of both channels in a strapped configuration, thereby preserving correct stereo imaging. By that I mean that any high-level peak appearing in only one channel will cause an equal amount of gain reduction in both channels, keeping the left/right balance correct.

Any two-channel processor, when connected to a stereo signal (*i.e.*, complete mix), would process the left and right channels independently. If a sudden loud signal appeared in only one channel, such as a lead instrument that was panned hard left or right within a total stereo mix, only that channel's VCA would respond, causing the overall level in that channel to decrease. That decrease in level to only one channel will cause image shifting. All mono information (bass drum, bass guitar, etc.) would sound off-center from the original mix.

As a two-channel compressor, I'm sure the unit will be a wonderful addition to an effects rack. As for stereo compressing a final mix, say from CD or DAT to a cassette format—no way!

RON TOZIER
*Newton, KS*

## Laser Article Brought Into Focus

In reading the August installment of "Laser Experiments," I found what I believe to be several serious errors. First of all, a diffraction grating does not consist of thousands of very small parallel prisms per millimeter, as suggested. In actuality, a diffraction grating consists of many closely spaced parallel lines scored onto an aluminized plastic or polished glass surface. Those lines break up light into its component frequencies by the physical process of diffraction (the interference produced when light encounters an obstacle), as their name implies. Each scratch serves as a source of scattered light. Prisms operate through the entirely different process of refraction—the selective bending of different light wavelengths as they pass from one media (such as air) to another (such as glass). If gratings really operated as microscopic prisms as suggested, then they would have to be called refraction gratings!

Another type of grating consists of many parallel apertures or obstacles that ideally present a pass-block squarewave type pattern to the incident wave front. Yet another type (there are many), called a "blazed" grating, consists of grooves cut onto a glass surface whose serrated edges do resemble an array of prisms but which still operates by diffraction. Consult any standard physics or optics text for more details.

Another statement in the article suggested that the focusing of "light" is somehow more crisp and pronounced than that obtainable by other forms of electromagnetic energy such as "radio or sound." The big error here is that sound is *not* a form of electromagnetic energy. In addition, there is no fundamental difference between radio waves and visible light. They are both EM waves that differ only in their frequency. Radio waves are routinely focused by parabolic antennas and the like.

A further misconception was that placing black tapes around a bent glass rod would act as a shield to keep light from escaping out the sides. In reality,

Write To:
Letters,
Electronics Now Magazine,
500 Bi-County Blvd.,
Farmingdale, NY 11735

Due to the volume of mail we receive, not all letters can be answered personally. All letters are subject to editing for clarity and length.

the process called "Total Internal Reflection" is what keeps light trapped within the rod or optical fiber. To operate, the incident light rays must enter the rod at an angle less than some critical angle determined by the material of the rod or fiber and the surrounding medium. If the incident angle exceeds that value, or if the rod/fiber is bent too sharply, then light can indeed leave through the sides. However, black tape will not redirect the light back into the pipe or cause Total Internal Reflection to occur, as implied.

Several times in the article, the author mentioned that lasers are coherent and monochromatic, but still contain all the other colors in the visible spectrum (albeit in small quantities). Thus, the article continued, colored light can be produced by passing laser light through a prism or a frosted plastic sheet. While it is true that no laser is perfectly monochromatic (the frequency spectrum is predominantly distributed over a band known as the line width), its bandwidth is extraordinarily narrow. For a common He-Ne laser, the line width is roughly 1500 MHz, which might seem large compared to radio frequencies but is less than 1/1000 of one percent of the visible light spectrum. Technically, all frequencies in that narrow band are of different "colors." But to suggest that a full-color spectrum can be obtained through refraction of laser light is nonsense. Lasers are called monochromatic or quasi-monochromatic for good reason. Any colors thus perceived are due to interactions with ambient sunlight or non-monochromatic room illumination.

The use of the word "sub-reflection" to describe the speckling effect produced by shining laser light off a diffuse surface is non-informative. The speckles are caused by a stationary interference pattern set up in the space in front of the surface. Due to the long coherence length of the laser light, individual reflections from the rough surface combine together coherently at each point in space with a random but stationary (non-changing) phase to create the speckles. When viewed in sunlight, the speckles might take on various colors.

While lenses are extremely important in optical science, the rules that govern the focusing of laser light (Gaussian beams) are not quite the same as those for non-coherent light. This difference had disastrous consequences for some early designers of optical systems using lasers, who used the standard rules of geometrical optics and couldn't figure out why their systems failed to work! The interested reader can find a wealth of information on these topics in the many available books on lasers, optics, laser electronics, holography, and other related fields.

JAY RABKIN
*Pasadena, CA*

## Audio System Integration Update

In "Audio Update" (*Electronics Now*, August 1996), Franklin Miller stated that it is optimum to match microphone impedance to the input impedance of the mixer. That is wrong. If the impedances are matched, the level will drop 6 dB and the signal-to-noise ratio will drop 3 dB. For condenser microphones with a built-in amplifier, there will be a bass roll-off and added distortion.

Instead, the input impedance should be at least ten times the source impedance. That mismatch is called a "bridging load."

DAVID HADAWAY
*Rindge, NH*

EN

## WHAT'S NEWS

*continued from page 8*

industry events. Hundreds of exhibits will display many of today's most advanced microelectronics products and technologies by leading semiconductor manufacturers. Industry and editorial advisers have structured the event to meet the needs of technology professionals from the communications, computer, and high-end VLSI components industries, who need to know the latest in microprocessors, microcontrollers, memories, ASICs, and communications ICs.

The Applications Conference on Communications and Computer Technologies will provide extensive solutions-oriented presentations in a series of several one- and two-hour sessions. New and emerging technologies will be featured in multiple sessions throughout the conference.

Information about Wescon/96 and IC Expo/96 is available by phone (800-877-2668), fax (310-641-5117), e-mail (m.potthoff@ieee.org), and Web site (http://www.wescon.com).

## Scholarship Donation

The Consumer Electronics Manufacturers Association (CEMA) announced that DeVry Institute has contributed $60,000 in scholarships to the winners of the Electronics Products Servicing Competition, held June 27 at the 1996 Skills Championships in Kansas City, Missouri.

Throughout the year, students compete in local, regional, and state competitions sponsored by the Vocational Industrial Clubs of America (VICA). The competitions culminate in VICA's annual Skills USA Championships, which pit state title winners against each other. CEMA sponsors the electronic skills portion of the championships.

DeVry awarded scholarships to both the secondary and post-secondary winners of the electronics competition. Both scholarships, valued up to $30,000, will cover full tuition to any of the DeVry Institutes in the United States. As a private, degree-granting higher-education system, DeVry, with 13 campuses throughout the United States and Canada, offers bachelor's degree programs in electronics-engineering technology, computer-information systems, business operations, accounting, and telecommunications management, as well as an associate's degree program for electronics technicians.

"Consumer electronics manufacturers rely heavily on qualified technologists and technicians for the installation, servicing, and maintenance of their products," said Don Hatten, vice president, CEMA Product Services. "The generous DeVry scholarships will provide our two winners with a valuable education and an opportunity for promising careers once they graduate."

CEMA, through its Product Services Department, supports vocational education programs that offer training for those entering the servicing profession. CEMA also provides in-depth preparatory training for students seeking engineering degrees.

Information on CEMA is available via EIA/CEMA's World Wide Web Site at http://www.eia.org/cema. Information on DeVry programs can be accessed at http://www.devry.com.

EN

# Q & A

READERS QUESTIONS, EDITORS ANSWERS

## Electronic Dog Whistle

**Q** *I would like to build a transmitter that emits a sound that only dogs can hear. It needs to be able to transmit approximately 100 to 150 yards. - J.S., Duluth, GA.*

**A** Try the circuit in Fig. 1; it's an audio oscillator that adjusts from about 6 kHz to 25 kHz. The speaker is a piezoelectric tweeter; ordinary speakers aren't very efficient at those frequencies.

To check the oscillator, set R2 to its maximum resistance; you'll hear a loud squeal. Then adjust R2 to put the frequency above the range of human hearing. Use a pushbutton switch and train the dog to recognize a distinctive series of ultrasonic beeps.

## What's an Amp-Hour?

**Q** *Can you please explain to me the meaning of amp-hours, and how they are figured in reference to a car battery? — B. M. Huntsville, TX.*

**A** Certainly. The amount of energy you can get out of a battery depends on its voltage (which is fixed), the number of amps that the load draws, and the number of hours before the battery runs down. Multiply the amps by the hours and you get amp-hours.

For example, a battery that can supply 3 amps for 4 hours has a capacity of 12 amp-hours ($3 \times 4 = 12$). The same battery could supply 1 amp for 12 hours, or 12 amps for 1 hour, or 2 amps for 6 hours, and so on.

To give you some realistic numbers, an alkaline D cell is good for about 10 amp-hours (which is actually quite impressive considering its small size). An alkaline 9-volt battery is only good for 0.4 amp-hour, but that's enough to power a 50-mA (0.05-amp) transistor radio for 8 hours. And here's a handy rule of thumb: The amp-hour capacity of a 12-volt lead-acid battery is roughly

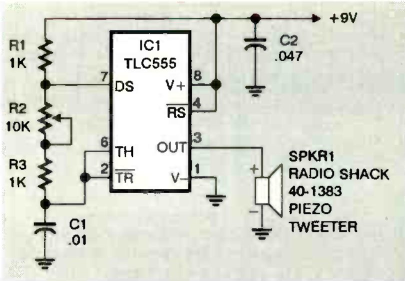



FIG. 1—THIS OSCILLATOR emits a tone that can be varied between 6 and 25 kHz. The higher frequencies can not be heard by most humans, although dogs can hear it just fine.

comparable to its weight in pounds.

Car batteries aren't rated in amp-hours because their total capacity isn't especially important; in fact they're designed never to be deeply discharged. What matters in a car battery is the total number of amps that it can deliver in cold weather ("cold cranking amps"), even though if you kept drawing current at that rate, the battery would go dead in just a couple of minutes.

## NiCd Charging

**Q** *I have seen a number of NiCd charger circuits like the one in Fig. 2. Are the values shown appropriate to charge the battery in 6 to 7 hours. If there is a rule of thumb to follow, it would be appreciated. — P. S. M., Eaton, IN.*

**A** The charging current for an NiCd battery depends on its capacity in amp-hours (see the previous question) and how quickly you want it charged.

The old standard is to charge for 12 to 14 hours at a current of C/10 amps, where C is the capacity in amp-hours. For example, a 1.2-AH battery gets a charging current of 0.12 amp.

To charge a battery in 6 or 7 hours, you'll want to use twice as much current, *i.e.*, C/5. That's about as fast as you can go without using special circuits to monitor the battery voltage and/or temperature.

Since you asked for a rule of thumb, we'll do an approximate calculation; greater precision would gain us nothing because there is so much variation between NiCd batteries.

For good current regulation, the AC voltage should be at least twice that of the battery. The resistance depends on the voltage drop, but since the current is only flowing half the time, the resistance should be only half the value given by Ohm's Law.

Here's a concrete example. Suppose you're charging a 7.2-volt, 1200-mAH (1.2-AH) battery pack from a source of 18 volts AC, and you want to charge in 6 to 7 hours at C/5. First, find the average charging current:

$$I = C/5 = 1.2/5 = 0.24 \text{ ampere}$$

Next, the resistance, using $R = E/I$ and then halving it:

$$R = 0.5 \times E/I = 0.5 \times (18 - 7.2)/0.24 = 22.5 \text{ ohms}$$

Finally, the resistor dissipation is found using $P=I^2R$ with the average charging current:

$$P = I^2R = (0.24)^2 \times 22.5 = 1.3 \text{ watts}$$

So a 22-ohm, 2-watt resistor will do the job just fine. You'll find that batteries of different voltages (such as 7.2 and 9.6 V) can often be charged in the same charger as long as their amp-hour ratings are similar. Also, you can charge a higher-

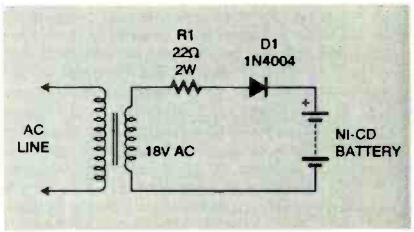



FIG. 2—WHILE THERE ARE many different NiCd-battery charger circuits, a simple resistor/diode combination like this one will do the job.

amp-hour battery in a charger designed for batteries of lower capacity by prolonging the charging time.

Purists will no doubt note that we've ignored the diode voltage drop and the difference between RMS and average current. For all practical intents and purposes, they have no effect in this application.

## NiCd Zapping

**Q** *I have several non-functioning NiCd battery packs. I've found several battery zappers in Rudolf Graf's* Encyclopedia of Electronic Circuits, *but the circuits show widely varying zapping voltages and currents. How do I determine what voltage and current I need to use for this? — G. A. H., Santa Fe, NM.*

**A** Unfortunately, NiCd zapping is not an exact science. In fact, manufacturers don't recommend it at all, because it never leaves a battery as good as new. But we all know that it works and can often enable you to get several more weeks' or months' use out of an otherwise defunct battery.

The purpose of zapping is to clear an internal short circuit by burning away small crystalline structures that have formed inside a cell. There are many different techniques. One method is to charge a 1000-µF capacitor to about 12 volts, then apply it briefly to the battery terminals. Another is to charge the battery briefly with heavy current (2 or 3 amps) while watching the terminal voltage; chances are it will come up to normal after half a minute or so. Make sure the current is indeed limited to 3 amps, since higher currents can make the battery explode.

All of those techniques are hit-or-miss, and the battery usually develops the same problem again in a short time. But there's no harm in trying. If possible, you should open up the battery pack to test and "zap" the individual cells. Be aware that some battery packs contain fuses that can be blown by the zapping process.

### HOW TO GET INFORMATION ABOUT ELECTRONICS

**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, Tel: 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 1991 only) are available from 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 (Tel: 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, Box 637, Spanaway, WA 98387.

**Replacement transistors, ICs, and other semiconductors:** Replacement components for a wide variety of popular devices is marketed by Philips ECG, NTE, and Thomson (SK) and 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; therefore, 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.

**Internet:** On the Internet, electronics is discussed in Usenet newsgroups such as *sci.electronics.repair, sci.electronics.components, sci.electronics.design,* and *rec.radio.amateur.homebrew.* "For sale" messages are permitted only in *rec.radio.swap* and *misc.industry.electronics.marketplace.*

Many electronic-component manufacturers now 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.

## Video In Dim Light

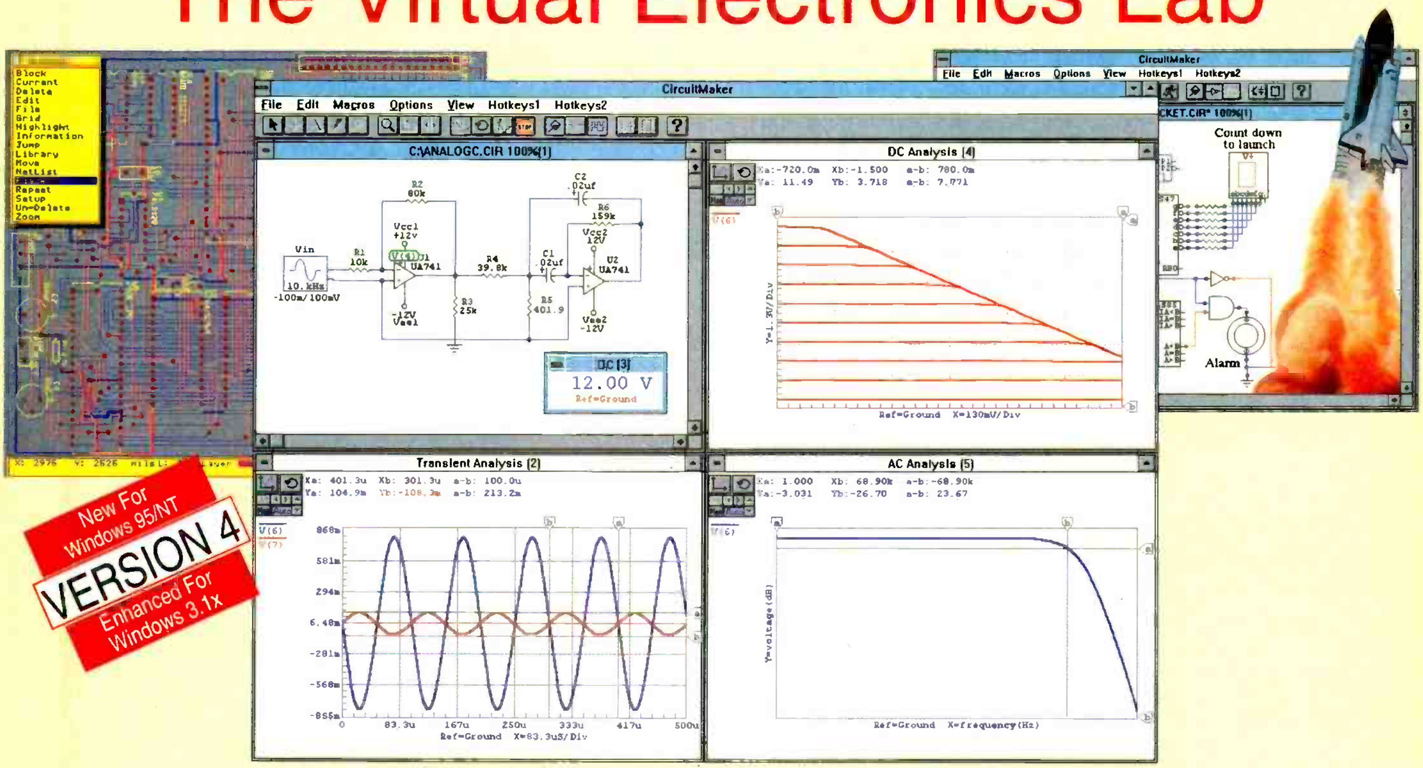
**Q** *I have a Sony 8mm camcorder and would like to be able to shoot video in low-light and extremely-low-light situations. Of course a video light will work up to a certain distance, but what about objects farther away? Is there some kind of adapter that can be mounted on the camcorder to provide daytime range at night? — M. M., Denver, CO.*

**A** You're probably thinking about image-intensifier tubes, which are photoelectric devices that amplify a faint image. These are used in military night-vision binoculars and other instruments. Image tubes and instruments that use them are available from STANO Components, Inc., PO Box 2048, Carson City, NV 89702 (Tel: 702-246-5281, Internet: http://www. stano.night-vision.com). You'll need a complete night vision scope with optics to form a viewable image, not just the tube alone; then you can aim the camcorder into the instrument instead of your eye.

*continued on page 28*

# CircuitMaker®

## The Virtual Electronics Lab™




### Professional Schematic Layout

CircuitMaker's schematic capabilities are unmatched and include many advanced editing features not found in similar programs. These powerful features minimize the time and task associated with drawing a schematic and insure a professional looking final product. Printout and export options are numerous and results are of the highest quality. But that's what people have come to expect from CircuitMaker.

### Unlimited, Indestructible Devices

CircuitMaker ships with over 1500 devices. That's more (at no additional cost) than any competing product. If you need a device that is not included, CircuitMaker provides industry standard SPICE import and a powerful macro capability. These indestructible devices accurately emulate actual devices and enable the user to try all those "what if" scenarios with no risk and at no additional cost.

### Accurate Simulation & Advanced Analysis

CircuitMaker features analog, digital and mixed-mode simulation. Obviously, simulation is of no value if the results are not accurate. CircuitMaker's simulation engine is based on Berkeley SPICE3, which is renowned for it's accuracy. That's why we can factually state that CircuitMaker provides it's user with the most accurate simulation available. Furthermore, CircuitMaker provides a wealth of analysis capabilities not found in other products in it's class. No other product offers this much simulation muscle at such a reasonable price.

### Printed Circuit Board Output

CircuitMaker's PCB output capability helps you complete your design cycle, by generating a netlist that can be imported into any compatible PCB program. This is not a costly "add-on module", it comes standard with every copy of CircuitMaker. MicroCode Engineering also offers TraxMaker, a professional level, PCB layout and autorouting program for just $299. Used in conjunction with CircuitMaker, TraxMaker completes a powerful end-to-end circuit design system.

| | Schematic Capture | Advanced Schematic Features | Digital, Analog, and Mixed-Mode Simulation | Full SPICE Compatibility | SPICE Export/Import | PCB Export | Retail Price |
|---|---|---|---|---|---|---|---|
| CircuitMaker | YES | YES | YES | YES | YES | YES | $299 |
| Electronics Workbench version 4 | YES | NO | YES | NO | NO | NO | $299 |
| Electronics Workbench Engineer's Pack | YES | NO | YES | NO | YES | YES | $599 |

### "CircuitMaker Shocks The Competition, With An Unbeatable Bottom-line"

### Total Customer Satisfaction

At MicroCode Engineering we are committed to total customer satisfaction. When you purchase CircuitMaker you have the confidence of knowing that a trained staff of professionals is available to serve you after the sale. Our free unlimited customer service is second to none! Whether you have general or technical questions they will be answered promptly by a knowledgeable representative.

### FREE Functional Demo

A free functional demo is available on the Internet at http://www.microcode.com, on CompuServe (GO MICROCODE) and on America Online by doing a file search for CircuitMaker.

## Call now to order or request additional information

## 800-419-4242

MicroCode Engineering Inc. • 573 W 1830 N Suite 4 Orem UT 84057-2030 USA • Phone 801-226-4470 Fax 801-226-6532 • Internet http://www.microcode.com

CIRCLE 128 ON FREE INFORMATION CARD

# EQUIPMENT REPORTS

**A PC-BASED BLOOD-PRESSURE MONITOR FROM PULSE METRIC.**

*Monitoring and recording blood pressure is easy with the DynaPulse.*



It seems that people are becoming more and more aware of their own personal health. We're all more concerned today about what we eat, what we're exposed to, and so on. One aspect of that is an increased awareness of our cardiovascular health.

While the best way to monitor that is to make sure you visit your doctor regularly, in our hectic schedules, sometimes that gets put off longer than it should. To keep an eye on such things as pulse and blood pressure, some people have their own equipment. But even so, you have to be careful in taking measurements and then have to record the statistics.

The newest, easiest way to take and keep track of those measurements is to use Pulse Metric, Inc.'s (6190 Cornerstone Court East, Suite 103, San Diego, CA 92121; Tel: 619-546-9461, 800-927-8573) DynaPulse 200M, which is computer-controlled and keeps track of the records for you. The 200M monitor unit is housed in an attractive plastic enclosure that connects to a PC or Mac computer. You need DOS 3.3 or higher, Windows 3.0 or higher, or Macintosh System 6.0.7 or higher.

The kit comes with an inflatable, adult-sized cuff and inflation bulb that plugs into the side of the monitor. Different-sized arm cuffs—child-size and oversize—are optionally available. The monitor connects to the computer via a serial cable. Software then converts your computer screen into a cardiovascular laboratory. We tested DynaPulse on a PC running Windows 95 and it couldn't have been easier to use. We were busy taking readings, printing charts, and storing records within minutes of installing the software.

## About Blood Pressure

The pressure of the blood flowing through the arteries is known, obviously enough, as blood pressure, which varies as the heart beats. When the heart pushes blood out from the heart, the pressure increases, and the *systolic* or maximum blood pressure is achieved. When the heart relaxes, the pressure in the artery decreases, and the *diastolic* or minimum pressure is reached. The average pressure throughout the pulse cycle is called the Mean Arterial Pressure (MAP). The units of measurement for blood pressure are millimeters (mm) of mercury, or Hg. Systolic blood pressure is given first followed by the diastolic blood pressure, or systolic/diastolic in mmHg. Normal blood pressure typically has a high from about 130 to 139 and a low from 85 to 89.

In healthy human beings, blood pressure can increase temporarily during stressful activities, including drinking coffee and smoking, but will return to normal when the activity ceases. However, when it stays high over a long period of time, a person is said to have high blood pressure, or *hypertension*.

Unfortunately, you have to actually measure your blood pressure to know if it's normal or high. There's no other way to know if a problem exists—until it is too late.

## Using the DynaPulse

The DynaPulse 200M is the perfect way to keep track of your blood pressure, your whole family's blood pressure, or even all of your customers' blood pressures if you happen to be a pharmacist or something similar. Note however, that we're only saying "keep track of" blood pressure, and nothing about interpreting it. Unless you are a doctor, you always have to consult one. A doctor is the only person qualified enough to interpret blood pressure and pulse-rate readings.

You can buy the DynaPulse 200M in one of three versions. The clinical version, $499, is designed for hypertension screening in clinical environments with the ability to store a virtually unlimited patient database, trend and statistical analysis, histogram display, pulse-waveform analysis, and a physician's reference. The educational version, priced at $295, is designed for teaching and comes complete with curriculum and lab material. A home version, which costs $179, is simpler and can keep track of up to six people.

We found DynaPulse very easy to use. The software installed without a hitch, and we connected it to the COM1 port on a PC (software settings allow for operation on any available com port). There isn't even an on/off switch on the 200M, as software activates the unit when necessary. An inflatable cuff—just like your doctor's—wraps around your arm and secures with Velcro. A squeeze bulb with a relief valve inflates the cuff. But instead of having the output pressure tube connected to a mercury-filled instrument, it plugs into the DynaPulse monitor, which contains a semiconductor pressure sensor. The monitor, which is powered by four AAA batteries, converts the input pressure readings from the arm cuff into an RS-232 signal that your PC can understand.

When you use the DynaPulse, you can immediately begin measuring blood

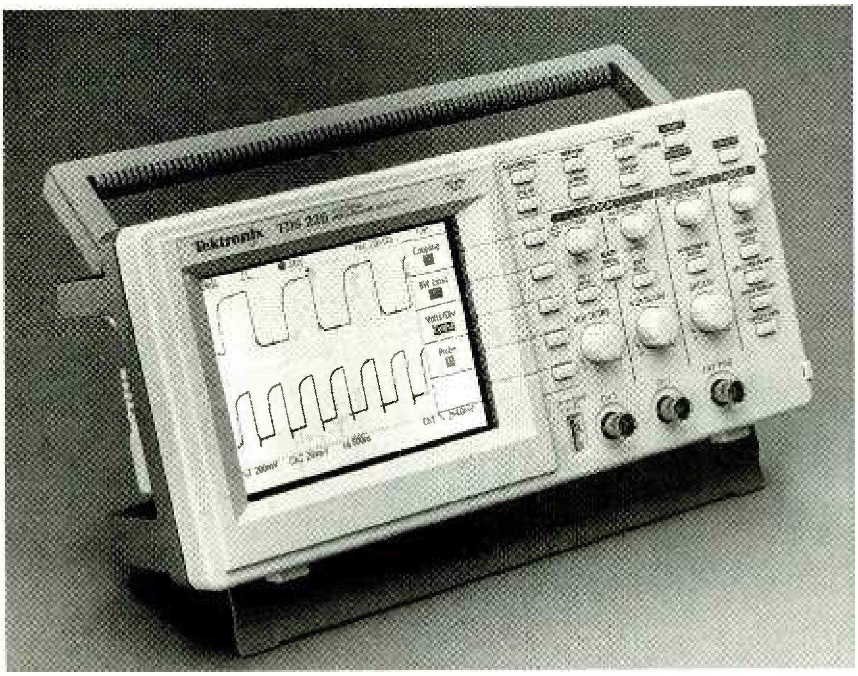
*continued on page 73*

# NEW PRODUCTS

USE THE FREE INFORMATION CARD FOR FAST RESPONSE

## Digital Real-Time Oscilloscopes

THE TDS 200 SERIES OF DIGITAL real-time (DRT) oscilloscopes from Tektronix cost about half the price of existing entry-level digital scopes and offer a combination of features that will




CIRCLE 20 ON FREE INFORMATION CARD

overcome customers' objections to making the switch from analog to digital scopes. Designed for manufacturing, education, and service applications, the 60-MHz TDS 210 and the 100-MHz TDS 220 are priced competitively with similarly equipped analog scopes. They also offer superior measurement capability, analog-like controls and operating modes, and compact size—about one-fourth the size of other benchtop oscilloscopes.

One reason for that compact size is that both units in the TDS 200 series feature a bright, high-contrast, liquid-crystal display with a wide viewing angle. Unlike analog scope displays, the LCD maintains full contrast at all sweep speeds and gain settings. Any signal that triggers the scope will be clearly visible on screen.

The TDS 200 series relies on Tektronix DRT oversampling technology to provide excellent waveform quality, update rate, and stability. Both models sample at 1 GS/s—at least ten times their bandwidth—which allows users to capture signal details invisible on analog scopes. Pre-programmed automatic measurements enable users to quickly quantify waveforms: period, frequency, cycle RMS, mean, and peak-to-peak. Other productivity features include automatic setups (similar to autoranging in a digital multimeter), stored reference waveforms, and stored front-panel setups that are not lost when the power is turned off.

The user interface looks and feels "analog," bringing back many of the front-panel knobs that are familiar to analog-scope users. Routine functions such as gain, sweep speed, and vertical/horizontal positioning, are immediately accessible and respond like analog-scope controls. Automated digital functions are controlled by a simplified on-screen menu system, available in ten user-selectable languages.

The TDS 210 and TDS 220 carry suggested U.S. list prices of $995 and $1695, respectively.

**TEKTRONIX, INC.**
*P.O. Box 500*
*Beaverton, OR 97077-0001*
*Tel: 1-800-479-4490, action code 317*

## DSP Filter

MFJ Enterprises' MFJ-781 DSP filter will add "brick wall" DSP filtering to any TNC or multimode data controller, allowing you to copy signals buried in noise and QRM—signals you can't even hear. The device will improve all modes on any model TNC, and it will give you an array of 100 sharp *No*Ring* linear-phase FIR filters. You can choose 20 filters to include on the front-panel switch for easy, one-knob selection.

The MFJ-781 plugs between your transceiver and multimode. It features input and output level controls and an accurate, easy-to-use input level indicator. Automatic gain control helps keep your audio level constant during signal fade. The on/off/bypass switch provides a true bypass.


CIRCLE 21 ON FREE INFORMATION CARD

Under severe QRM, the filter will greatly improve copy of packet, AMTOR, PACTOR, GTOR, Clover, RTTY, SSTV, WeFAX, Fax, CW, and just about any other digital mode. You can choose from 64 data filters with 16 mark/space pairs, four shifts, and four baud rates. Interference is 40-dB down, 60-Hz outsize passband. You also get 32 CW filters with eight CW tones (300-1000 Hz) and four bandwidths (50-500 Hz). Four customized filters are optimized for VHF packet, Clover, WeFAX, and SSTV.

The MFJ-781 DSP filter has a suggested retail price of $129.95 For MFJ-1278B's, order the MFJ-780 plug-in DSP filter, priced at $99.95.

**MFJ ENTERPRISES, INC.**
*P. O. Box 494*
*Mississippi State, MS 39762*
*Tel: 601-323-5869 or 1-800-6477-TECH*
*Fax: 601-323-6551 or 1-800-647-1800*

## True-RMS Clamp Meter

Electrical contractors, plant-maintenance engineers, electricians, and utility technicians will find B+K Precision's Model 369 multifunction clamp meter to be convenient and useful for measuring high electrical currents without direct electrical contact. The handheld instrument measures true-RMS AC current to 700 amps from 45 Hz to 1 kHz, and DC current to 700 amps with 2% accuracy. AC and DC voltage can be measured to 750 volts with 1% accuracy, using test leads. The clamp can be used to measure resistance from 0.1 to 4000 ohms and frequency from 0.1 Hz to 10,000 Hz with 0.2% accuracy.

CIRCLE 22 ON FREE INFORMATION CARD

The Model 369 can also measure instantaneous AC amperes using its crest mode, which can log peak currents as high as 1000 amps. Data hold instantly freezes the displayed reading. Continuity check sounds a tone to verify an unbroken electrical path. Min-Max mode logs a running record of minimum, maximum, and average values.

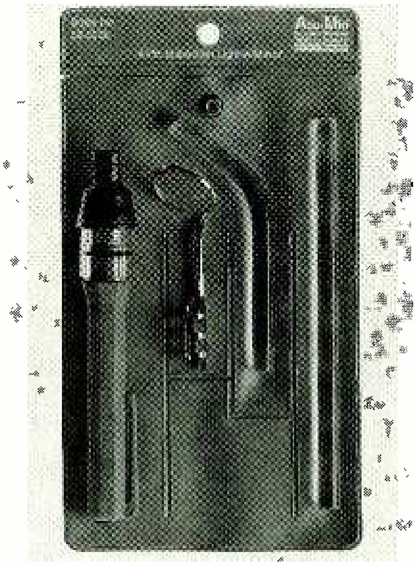
The meter accepts conductors up to two inches in diameter. Its large, 4000-count LCD readout includes a 41-segment bar graph for peaking, nulling, and easy identification of varying signals.

The Model 369 clamp-on meter, complete with battery, clip-on carrying case, test leads, and manual, costs $199.

**B+K PRECISION**
*6470 West Cortland Street*
*Chicago, IL 60635*
*Tel: 1-800-462-9832*
*Fax: 312-794-9740*

## Four-Piece Inspection Light

Specifically designed for the field technician, Moody's Acu-Min Inspection Light allows light to shine on hard-to-reach areas. The set contains a flashlight, a straight conducting rod, a curved conducting rod, and a mirror. The straight rod conducts the battery-powered xenon light down straight passages. The curved rod conducts light around corners to reach areas not normally visible. The small mirror fits snugly on both conducting rods to expand the user's field of view. The set comes packaged in a vinyl pouch.



CIRCLE 23 ON FREE INFORMATION CARD

The Acu-Min Inspection Light (stock #58-0235) costs $42.95.

**MOODY TOOLS, INC.**
*42-60 Crompton Avenue*
*East Greenwich, RI 02818-0230*
*Tel: 1-800-TOOL-INC*
*Fax: 401-885-4565*

## Memory Tester

Aristo Computers' SIMCHECK II is a third-generation, state-of-the-art memory tester. With a fast 486 processor and sophisticated time-delay circuitry, the tester allows users to accurately test today's—and tomorrow's—large memory devices. The stand-alone, portable unit tests both 72-pin and 30-pin SIMM modules in sizes up to 4Gx40 with a 96-pin expansion slot for future add-on companion testers. The SIMCHECK II measures RAS and CAS access time at 1-ns resolution. It includes a generic interface for the Automatic Handler, parallel printer, and other devices. The fully automatic test program allows non-technical personnel to operate the tester with the push of a single button, yet still allows engineers to set up complex custom tests.

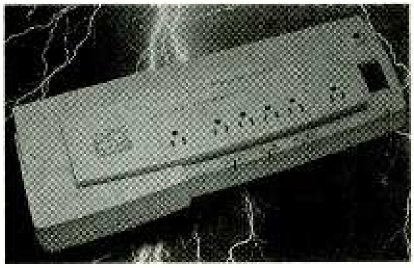
CIRCLE 24 ON FREE INFORMATION CARD

The SIMCHECK II has a retail price of $2495.

**ARISTO COMPUTERS INC.**
*6700 SW 105th Avenue, Suite 300*
*Beaverton, WA 97008*
*Tel: 1-800-3ARISTO or 503-626-6333*
*Fax: 503-626-6492*

## Workstation Surge Protection

The Back-UPS Office from American Power Conversion is a multipath power device intended to combat hardware damage caused by surges and prevent data loss from brownouts and blackouts. The device offers multi-outlet surge protection, phone line protection for on-line users, network data-line protection for corporate workstations, and battery backup for CPUs. Aimed at the small-office/home-office (SOHO) market, and backed by a $25,000 equipment-protection guarantee, the device protects against all power problems on all power paths to a computer and peripherals including printers, scanners, external tape drives, and fax machines.



CIRCLE 25 ON FREE INFORMATION CARD

The Back-UPS Office offers six outlets, all with surge-suppression and EMI/RFI filtering, and three of them also provide battery power for data protection. The device provides 7 to 13 minutes of battery backup during a power disruption, allowing the user plenty of time to shut down the system in an orderly manner. Modem protection safeguards users' Internet access and prevents PC damage from surges and spikes entering through the "back door." An indicator lets the user know when a new battery is needed. A site-wiring fault indicator detects wiring problems in the building that could cause potential fire hazards. Unique "BlockSafe" outlet spacing allows transformer blocks to be used without sacrificing other outlets.

The Back-UPS Office surge protector costs $179.

**AMERICAN POWER CONVERSION**
*P. O. Box 278*
*132 Fairgrounds Road*
*West Kingston, RI 02892*
*Tel: 1-800-877-4080*
*Fax: 401-789-3710*
*Web site: http://www.apcc.com*

## 900-MHz Cordless Phone

Sanyo's Model CLT-986 900-MHz, digital spread-spectrum cordless telephone features a call-management caller-ID system, AC power-failure protection, and—for those who need still more freedom than that afforded by mere cordless phones—a "Speak Station" handset speakerphone for hands-free communication. The 900-MHz direct-sequence, spread-spectrum technology extends the transmission range and virtually eliminates interference. The digital technology also makes it difficult for eavesdroppers to tap into the signal.

CIRCLE 26 ON FREE INFORMATION CARD

AC power-failure protection allows the CLT-986 to be used even during interruptions in the supplied line power. The back-up battery pack, built into the base of the unit, uses four "AA" alkaline batteries. The speakerphone handset also provides two-way paging. Sanyo's call management system is intended for use with the Caller ID service provided by local phone companies. With a recorded log of up to 20 calls, the system maintains a list of caller names with bi-lingual prompts, call times, dates, and last call received, with area-code editing capability. A 16-digit, two-line LCD readout on the handset allows the user to scroll through recorded data. Other features include one-hour quick charge, dual keypad operation, and 20-number memory.

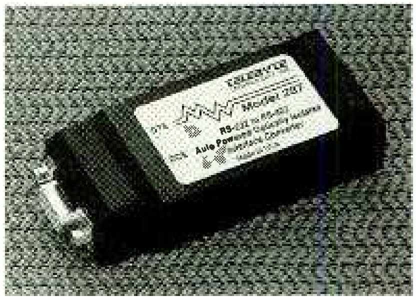
The CLT-986 cordless telephone has a suggested retail price of $349.99.

**SANYO**
*21350 Lassen Street*
*Chatsworth, CA 91311-2329*
*Tel: 818-998-7322*
*Fax: 818-701-4149*

## Interface Converter

New safety standards such as IEC 8081-2 place limits on the shock hazards to which people are subjected when using electronic devices in a medical environment. Telebyte's Model 287 RS-232 to RS-422 opto-isolated interface converter satisfies those stringent requirements for computer systems.

The Model 287 does not require a separate AC or DC input because the power required is extracted from the PC's RS-232 interface. That power is further conditioned to develop an isolated power supply to operate the link side of the interface converter.



CIRCLE 27 ON FREE INFORMATION CARD

A DB9 female connector allows the converter to be directly attached to any PC communications port, and an RJ-12 modular connector creates the link interface. A DTE/DCE switch allows the user to reverse the transmit data and receive data signals to interface to a different type of port. Data is accommodated at rates up to 19.2 kilobytes per second. The transmit- and receive-data signals use the four inner pins of the RJ-12 connector, and the two outside pins are reserved for grounding a shield on the link cable, if one is used. The ground path includes a ground stud to which a 12-inch ground connection is attached. The Model 287 will withstand a 4-kilovolt discharge with the ground connection.

The Model 287 RS-232 to RS-422 converter costs $155.

**TELEBYTE TECHNOLOGY, INC.**
*270 Pulaski Road*
*Greenlawn, NY 11740*
*Tel: 516-423-3232 or 1-800-TELEBYT*
*Fax: 516-385-8184*
*E-mail: sales@telebyteusa.com*
*Web site: http://telebyteusa.com*

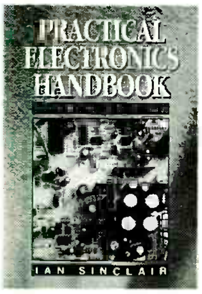
EN

# NEW LITERATURE

USE THE FREE INFORMATION CARD FOR FAST RESPONSE

## Practical Electronics Handbook Fourth Edition

*by Ian Sinclair*
*Butterworth-Heinemann*
*225 Wildwood Avenue, Unit B*
*P. O. Box 4500*
*Woburn, MA 01801*
*Tel: 617-928-2500*
**$32.95**




CIRCLE 337 ON FREE INFORMATION CARD

This comprehensive book provides a practical collection of circuits, rules of thumb, and design data for professional engineers, students, and electronics hobbyists. Enough background is included to make the book accessible to beginners and to facilitate the understanding and development of a range of basic circuits. For those with more electronics experience, the book can serve as a compact compendium of everyday information and a convenient reminder of electronic principles and circuits.

Topics covered include passive components, active discrete components, discrete-component circuits, linear ICs, digital ICs, microprocessors and microprocessor systems, transferring digital data, digital-to-analog conversions, computer aids in electronics, and hardware components. The fourth edition has been updated with new chapters and sections covering topics such as sensing components, connectors, and soldering.

## Switch Catalog #103

*Switches Plus*
*192 Pepe's Farm Road*
*Milford, CT 06460*
*Tel: 1-800-792-4757*
*Fax: 1-800-792-5877*
*Web site: http://www.switchesplus.com/*
**Free**


CIRCLE 338 ON FREE INFORMATION CARD

An all-metal, sealed, vandal-proof keypad leads off the new line of keypad devices included in this catalog. The brochure also features a wide variety of heavy-duty and signal-level pushbuttons, pilots, and selectors; emergency stop switches; snap-acting switches; joystick controls; pulse counters; and power supplies. All products feature UL and international approvals as well as ISO 9001 certification. The 56-page catalog contains ordering information, descriptions, illustrations, technical specifications, and prices.

## Fuzzy Logic for Real World Design

*by Ted Heske and Jill Neporent Heske*
*Annabooks*
*11838 Bernardo Plaza Court*
*Suite 102A*
*San Diego, CA 92128*
*Tel: 619-673-0870 or 1-800-462-1042*
*Fax: 619-673-1432*
**$49.95, including disk**

CIRCLE 339 ON FREE INFORMATION CARD

This engineering guide is written for designers of embedded systems that make use of fuzzy logic. The book provides step-by-step instructions for designing fuzzy-logic systems, and its companion diskette includes a C-language fuzzy kernel, complete with directions for cross-compiling it for a variety of Motorola and Intel microcontrollers. The diskette also contains all of the source code that is presented in the book.

The first three chapters present an overview of fuzzy-logic history, terminology, and theory of operation. Subsequent chapters discuss engineering fundamentals, embedded-systems considerations, and hardware/software partitioning. The book also discusses object-oriented fuzzy-logic design and C++ implementation. A fuzzy-logic primer ties it all together. Appendices include a list of fuzzy-logic development tools and suppliers, and instructions for cross-compiling the fuzzy kernel for a variety of Motorola microcontrollers.

## Multimedia DSO Teaching Aid

*Metrix*
*P.O. Box 332*
*Brea, CA 92622-0332*
*Tel: 714-992-1239*
**$10**

CIRCLE 340 ON FREE INFORMATION CARD

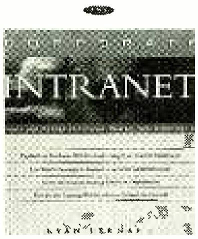
The Metrix OX-8020 CD-ROM is an interactive, multimedia demonstration of how to use a digital storage oscilloscope (DSO). Instruction is presented in French, English, German, and Spanish. Aimed at both teachers and students, the CD-ROM can be used for on-the-job or classroom instruction. Besides an introduction to the use of oscilloscopes to capture and store waveforms, the CD-ROM demonstrates how, after acquisition, data can be manipulated and displayed different ways, and how measurements can be output to plotters, computer files, and monitors.

Although it uses the Metrix OX8020

digital storage scope as a model, the disk can be used with a PC alone. Minimum system requirements are a 486 multimedia PC (with audio board), 8 megabytes of RAM, a video card, a CD-ROM drive, Windows 3.1, and at least 10 megabytes of free hard-drive space.

## The Corporate Intranet: Create and Manage an Internal Web for Your Organization

*by Ryan Bernard*
*John Wiley & Sons, Inc.*
*605 Third Avenue*
*New York, NY 10158-0012*
*Tel: 1-800-225-5945*
*Web site: http://www/wiley.com/compbooks/*
**$29.95**



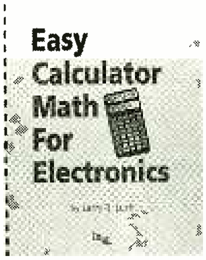

CIRCLE 341 ON FREE INFORMATION CARD

While many companies use the Internet to provide their outside customers with in-depth on-line information, relatively few take advantage of internal, or Intranet, Web sites. A corporate Intranet site is an inexpensive yet powerful alternative to other forms of internal communications. It is a secure, interactive network that allows employees to instantly access, view, and contribute to live product-management documents, regardless of what kind of computer is being used.

This book shows Internet-savvy managers, marketers, and other communications specialists how they can dynamically distribute and share vital information across their organizations—even reaching foreign subsidiaries and home-offices. It presents a practical overview of everything needed to allow a computer network to support an Intranet system. After introducing basic Web tools and technology, the book helps various departments within a corporation budget to plan and promote the Intranet. It explains how to provide outside employees with secure access, and how to create "public" and "private" channels to interface the Intranet with the Internet. Case studies from Sun Microsystems, Chevron Petroleum, Digital Equipment, and Nortel enhance the text.

## Easy Calculator Math for Electronics

*by Larry R. Luchi*
*Limelight Books*
*Division of Tiare Publications*
*P. O. Box 493*
*Lake Geneva, WI 53147*
*Tel: 414-248-4845*
**$17.95 plus $3 shipping and handling**




CIRCLE 342 ON FREE INFORMATION CARD

This study guide helps readers make quick work of math problems involving electronics. It takes the reader through each required step in more than 30 formulas used in electronics; topics include Ohm's Law, phase angles, component values for resonance, transistor characteristics, and much more.

Each formula is carefully explained, with one or more step-by-step examples presented in an easy-view, easy-to-follow format. Explanations of terminology and theory are also included, along with diagrams to help readers understand the material.

## Coaxial Products Catalog #1995

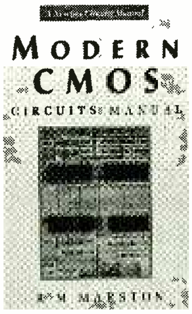
*Pasternack Electronics*
*P. O. Box 16759*
*Irvine, CA 92713*
*Tel: 714-261-1920*
*Fax: 714-261-7451*
**Free**


CIRCLE 343 ON FREE INFORMATION CARD

This compact catalog squeezes a wealth of information into its 81 pages of small-print text. Featured product lines include more than 20 different types of coaxial connectors, coax cable, adapters, cable-cutting and crimping tools, four types of attenuators, adapters, breakouts, coaxial switches, patch cords, terminations, shorts, cable assemblies, directional couplers, power dividers, and twinax cables and connectors. The catalog includes photographs and pricing for single units as well as quantity discounts.

## Modern CMOS Circuits Manual

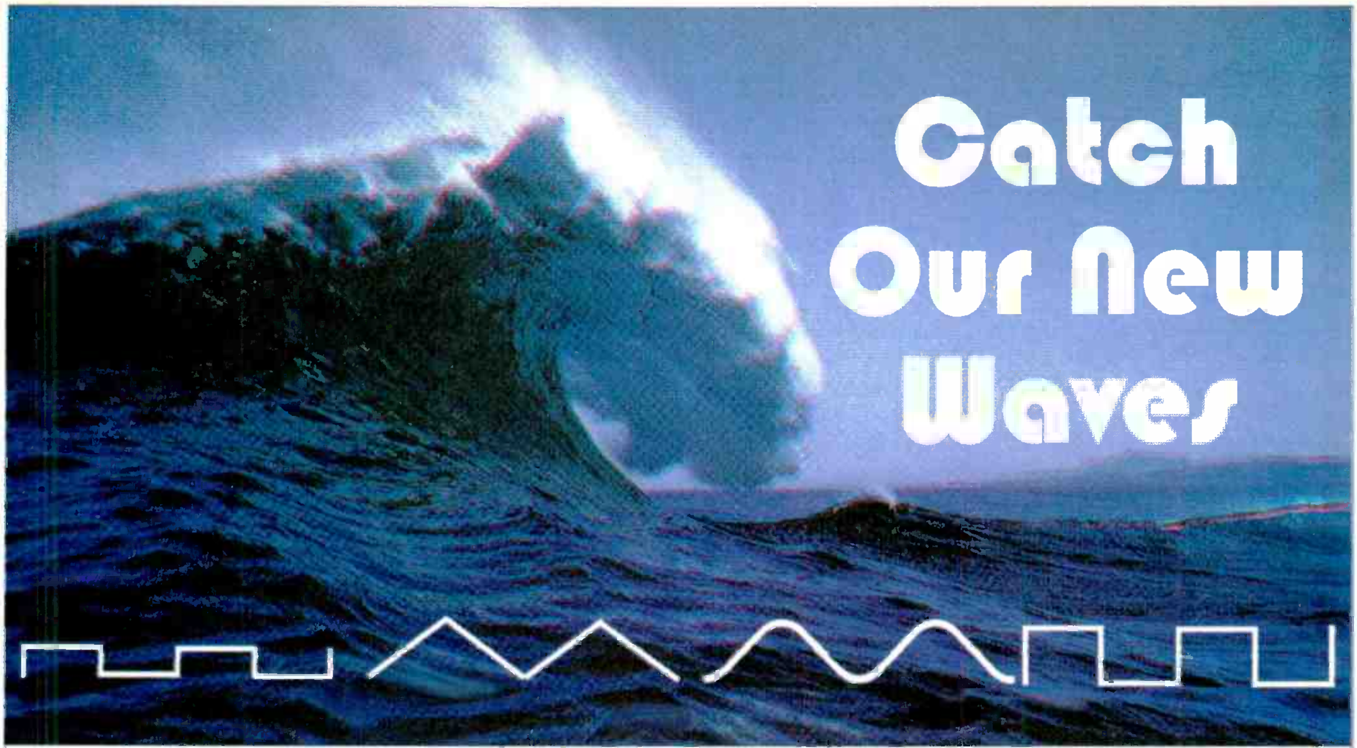
*by R. M. Marston*
*Newnes*
*an imprint of Butterworth-Heinemann*
*225 Wildwood Avenue, Unit B*
*P. O. Box 4500*
*Woburn, MA 01801*
*Tel: 617-928-2500*
**$28.95**




CIRCLE 344 ON FREE INFORMATION CARD

The first in a new series of circuit manuals from frequent **Electronics Now** contributor Ray Marston, this book examines operating principles and practical applications of modern medium-speed and fast CMOS digital ICs. The informative, "how-to" text is accompanied by 470 carefully selected circuits, diagrams, graphs, and tables. Detailed descriptions of more than 120 modern CMOS ICs and their practical applications are included. Aimed at design engineers and technicians, the book's clear layout and easy-to-understand explanations also make it a good starting point for students and hobbyists.

Each chapter opens with an examination of the basic principles of the subject, followed by the presentation of circuits and useful data. The first chapter describes and explains digital-IC basics, CMOS and TTL principles, the various CMOS sub-families, and the basic rules of CMOS usage. Chapter 2 gives a practical introduction to CMOS fundamentals via the 4007UB IC, which can be used in both digital and linear applications. Subsequent chapters deal with modern logic circuitry, CMOS bilateral switches and data selectors, waveform-generator circuitry, clocked flip-flop and counter circuits, ICs, special counter/dividers, data latches, registers, comparators, code converters, and specialized ICs




# Function Generator Breakthrough!

Introducing all new B+K Function Generators offering wider frequency bandwidths at new value pricing. Beats the competition big time!


## Product Features . .

- Proprietary integrated circuit doubles bandwidth for best performance and reliability.
- All the basic functions plus
  —Sine, Square and Triangle waves
  —TTL and CMOS outputs
  —Variable waveform symmetry
  —Variable DC offset.
- Made in the USA

PROUDLY MADE IN THE USA *

* Manufactured in USA from domestic and imported parts.

| Bandwidth | Counter | TTL | CMOS | SWP. | AM/FM | Price | Model |
|---|---|---|---|---|---|---|---|
| 2MHz | | • | • | | | $229 | 4010 |
| 5MHz | • | • | • | | | $284 | 4011 |
| 10MHz | • | • | • | • | | $369 | 4017 |
| 20MHz | • | • | • | • | • | $499 | 4040 |

Compare this price with those $1,200 units!

**For the name of your nearest B+K distributor**
**Call 1-800-462-9832**
8am-5pm, CST, weekdays

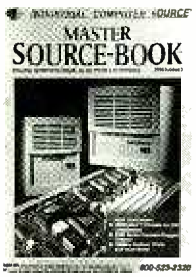
**BK PRECISION®**
MAXTEC INTERNATIONAL CORP.
Domestic and International Sales
6470 W. Cortland St., Chicago, IL 60635
Tel: 312-889-1448 • Fax: 312-794-9740
Canadian Sales: DCS Electronics, Ltd.
Tel: 905-683-4500 • Fax: 905-683-8074

CIRCLE 77 ON FREE INFORMATION CARD

such as multiplexers and decoders. The final chapter presents a miscellaneous collection of CMOS circuits.

## Master Source-Book 1996 Edition 2

*Industrial Computer Source*
*P. O. Box 910557*
*San Diego, CA 92191-0557*
*Tel: 1-800-523-2320*
*Fax: 619-677-0898*
*E-mail: industrial.computer@industry.net*
*Web site: http://www.industry.net/ind-compsrc*
**Free**

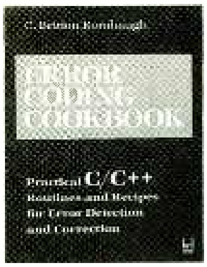



CIRCLE 345 ON FREE INFORMATION CARD

This 192-page catalog is filled with computer and network solutions, including software and complete integrated systems. Product categories include CPUs, chassis, rack enclosures, systems servers, embedded controllers, drive controllers, multimedia cards, monitors, CD and tape backup systems, diagnostics and development boards and software, analog and digital I/O products, PC instrumentation, communications devices, software tools, and applications software. New product highlights include 166-MHz Pentium CPUs and the GIRSystem chassis for EMI containment. Photographs, descriptions, and prices are offered for each product, as well as dimensional outlines where applicable. The catalog also provides reference sections and product comparison charts.

## Error Coding Cookbook: Practical C/C++ Routines and Recipes for Error Detection and Correction

*by C. Britton Rorabaugh*
*McGraw-Hill, Inc.*
*11 West 19th Street*
*New York, NY 10011*
*Tel: 1-800-2-MCGRAW*
**$50, including disk**




CIRCLE 346 ON FREE INFORMATION CARD

Unless you happen to be an abstract mathematician, you're likely to get lost in the maze of error-correction coding that is a crucial element of any signal-processing or communications system. This book strives to simplify the complexities of error coding.

This non-theoretical guide clearly explains the error-coding process. It offers complete, step-by-step instructions on how to select the most appropriate code for your particular application, design the corresponding coders and decoders, and implement many of the most well-known and frequently used codes for error correction. The book's clear descriptions of each code are reinforced by worked-out examples and a brief review of only the necessary math. The accompanying disk provides access to ready-to-use C and C++ programs for generating hundreds of codes for error detection and correction. EN

**Q & A**

*continued from page 16*

## PIC Information

**Q** *I've designed an electronic product that I think could be greatly improved by using PIC microcontrollers. To redesign, I need information about microcontrollers. If you have any information that you can share with me, I would greatly appreciate it. — T. Z., Easton, PA.*

**A** Go straight to the horse's mouth and get a set of PIC manuals (including the *Embedded Control Handbook*) from Microchip, Inc., 2355 West Chandler Boulevard, Chandler, AZ 85224 (Tel: 602-786-7200). Also take a look at their Web page, http://www.microchip.com, and Don Lancaster's web page, http://www.tinaja.com. Don Lancaster is our "Tech Musings" columnist, and he has written a lot about PICs.

Other than the manuals, there's no general book about PICs as far as we know. If you're entirely new to microcontrollers, you may want to start with the 8051 family simply because good textbooks are available. One of the best is *The 8051 Microcontroller*, by Kenneth J. Ayala, published by West; any bookstore should be able to order that for you. If you go with an 8051-family controller, consider the Philips 87C750; it's cheap (under $5) and a development kit that attaches to your PC is available from Philips for less than $100.

## We've Been Surpassed

In the July installment of "Q&A" (see page 14), a reader asked how to light either a red or a green LED at the flip of a single SPST switch. We published a circuit with 3 resistors and a transistor. Several readers wrote in with simpler solutions. Figure 3 shows the simplest, submitted by D. L. Bare of Kirby, Wyoming. Red LEDs have a lower voltage drop than green ones, so if you connect red and green LEDs in parallel, only the red one lights.

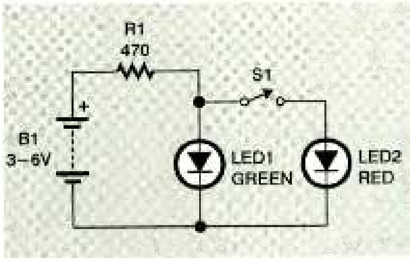



**FIG. 3**—THIS SIMPLER SOLUTION to the switch-operated LED problem takes advantage of the fact that red LEDs have a lower voltage drop than green ones.

Mr. Bare points out that the voltage of an LED is directly related to the amount of energy in each photon—higher at shorter wavelengths of light. Thus infrared LEDs take the lowest voltage, and blue LEDs, the highest. The moral? Never connect LEDs in parallel—if there's even a slight difference in wavelength, the lower-wavelength LED will take all the current.

Thanks to everyone who wrote in!

## Writing to Q&A

As always, we welcome your questions. The most interesting ones are answered in print, usually within 9 months. Please be sure to include plenty of background information (we'll shorten your letter for publication). *If you are asking about a circuit, please include a complete diagram.* We regret that due to the volume of mail, we cannot give personal replies. EN

# The Four-Year Electronics Degree Program That Really Hits Home!

## Bring The Technology Home With A Bachelor Of Electronics Engineering Degree. No Hassles. No High Cost!

*Now's the time to prepare for a profitable career.*

### We've lowered the cost of higher education.

It's true! You can earn a four-year Bachelor of Electronics Engineering Technology degree today ... and prepare yourself for a high-paying electronics career ... without quitting your job or ever leaving your home. Because World College, an affiliate of the Cleveland Institute of Electronics, offers you the total flexibility of independent study programs proven effective for people like you who truly want to succeed! World College independent study lessons help you build valuable skills step-by-step, and expert instructors are personally available to you with a toll-free call. What a way to earn an education!

**Mail/Fax Today or Call 1-800-696-7532**

### A world of opportunity.

Where is your career headed? With a four-year bachelor's degree from World College, you call the shots, choosing from incredible, high-paying opportunities in electronics, telecommunications, computer, electrical power, and many other growing fields.

World College gives you the skills, the knowledge, the power to take advantage of your best opportunity in electronics. And you can do it all at your own pace!

### Without leaving home.

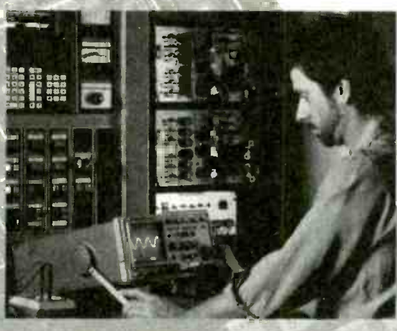
World College continually works to provide its students with the most advanced education tools. From the latest equipment and reference books to breakthrough computer-simulated experiments, students are exposed to the latest technological advancements.

All the equipment, parts, and software you need are included in your affordable tuition, including more than 300 hands-on lab experiments you can complete in your home.

### Choose your own pace.

Earn your bachelor's degree on your time — and at your pace — because you pay tuition to World College only as you complete the upper-level semesters close to graduation. The faster you make it through, the less you pay. So you have an incentive to make your future happen quickly — yet the freedom to choose your own pace!

Send today for your FREE course catalog — and give yourself that future you've always wanted — with an electronics degree education from World College.



*Take charge of your future in electronics.*

**Four Powerful Reasons To Connect With World College Today:**

1. Earn your four-year degree!
2. Self-paced training!
3. Independent study in your home!
4. Expert instruction!

## Give Me The Power!

Send me a FREE World College course catalog today!


(Please Print Neatly)

Name ____________________

Address ____________________

City ____________________

State, Zip ____________________

Phone ( ) ____________________

Age ____________________

**For faster service, call 1-800-696-7532, or call 1-804-464-4600.**

**Or fax this coupon to 1-804-464-3687.**

WORLD COLLEGE
Lake Shores Plaza
5193 Drive, Suite 113
Virginia Beach, VA 23455-2500

CIE
Affiliated with
Cleveland Institute of Electronics

WAE38

# RETAILERS THAT SELL OUR MAGAZINE MONTHLY

**Alaska**

Frigid North Co.
1207 W. 36th Avenue
Anchorage, AK 99503

**Arizona**

Dalis Electronics
2829 E. McDowell Road
Phoenix, AZ 85008

**California**

California Electronics
221 N. Johnson Ave.
El Cajon, CA 90202

Signal Electronics
22307 Ocean Avenue
Torrance, CA 90505

Ford Electronics
8431 Commonwealth Avenue
Buena Park, CA 90621

All Electronics
14928 Oxnard Street
Van Nuys, CA 91411

Gateway Electronics of CA
9222 Chesapeake Drive
San Diego, CA 92123

Mac's Electronics
191 South "E" Street
San Bernardino, CA 92401

Electronics Warehouse
2691 Main Street
Riverside, CA 92501

Orvac Electronics
1645 E Orangethorpe Ave.
Fullerton, CA 92631

Sav-On Electronics
13225 Harbor Blvd.
Garden Grove, CA 92643

Marvac Dow Electronics
980 S. A Street
Oxnard, CA 93030

Kandarian Electronics
1101 19th Street
Bakersfield, CA 93301

Whitcomm Electronics
105 W. Dakota #106
Clovia, CA 93612

Marvac Dow Electronics
265-B Reservation Road
Marina, CA 93933

Minuteman Electronics
37111 Post St., Suite 1
Fremont, CA 94536

HCS Electronics
6819 S. Redwood Drive
Cotati, CA 94931

Halted Specialties Co.
3500 Ryder Street
Santa Clara, CA 95051

Metro Electronics
1831 J Street
Sacramento, CA 95814

The Radio Place, Inc.
5675-A Power Inn Road
Sacramento, CA 95824

HSC Electronics
4837 Amber Lane
Sacramento, CA 95841

**Colorado**

Gateway Electronics of CO
2525 Federal Blvd.
Denver, CO 80211

Centennial Electronics
2324 E. Bijou
Colorado Sps., CO 80909

**Connecticut**

Signal Electronics Supply
589 New Park Avenue
W. Hartford, CT 06110

Cables & Connectors
2198 Berlin Turnpike
Newington, CT 06111

Electronic Service Prod.
437 Washington Avenue
North Haven, CT 06473

**Florida**

Sanyca Electronics
596 NW 99th Ct.
Miami, FL 33172

**Georgia**

Norman's Electronics, Inc.
3653 Clairmont Road
Chamblee, GA 30341

**Illinois**

Tri State Elex
200 W. Northwest Hwy.
Mt. Prospect, IL 60056

**Maryland**

Mark Elec. Supply Inc.
5015 Herzel Place
Beltsville, MD 20705

Amateur Radio Center
1117 West 36th Street
Baltimore, MD 21211

**Massachusetts**

U-Do-It Electronics
40 Franklin Street
Needham, MA 02194

**Michigan**

Purchase Radio Supply
327 East Hoover Avenue
Ann Arbor, MI 48104

Norwest Electronics
33760 Plymouth Road
Livonia, MI 48150

The Elec. Connection
37387 Ford Road
Westland, MI 48185

Elec. Parts Specialists
711 Kelso Street
Flint, MI 48506

**Minnesota**

Acme Electronics
224 Washington Avenue N.
Minneapolis, MN 55401

**Missouri**

Gateway Electronics Of MO
8123-25 Page Blvd.
St. Louis, MO 63130

William Elec & Ind Supply
803 Davis Blvd.
Sikeston, MO 63801

**New Jersey**

Lashen Electronics Inc.
21 Broadway
Denville, NJ 07834

**New York**

Sylvan Wellington Co.
269 Canal Street
New York, NY 10013

R&E Electronics
4991 Rt. 209
Accord, NY 12404

Unicorn Electronics
Valley Plaza
Johnson City, NY 13790

**Ohio**

Philcap Electronic Suppliers
275 E. Market Street
Akron, OH 44308

**Oregon**

Norvac Electronics
7940 SW Nimbus Avenue
Beaverton, OR 97005

**Pennsylvania**

Business & Computer Bookstore
213 N. Easton Road
Willow Grove, PA 19090

**Texas**

Mouser Electronics
2401 Hwy. 287 N
Mansfield, TX 76063

Electronic Parts Outlet
17318 Highway 3
Webster, TX 77598

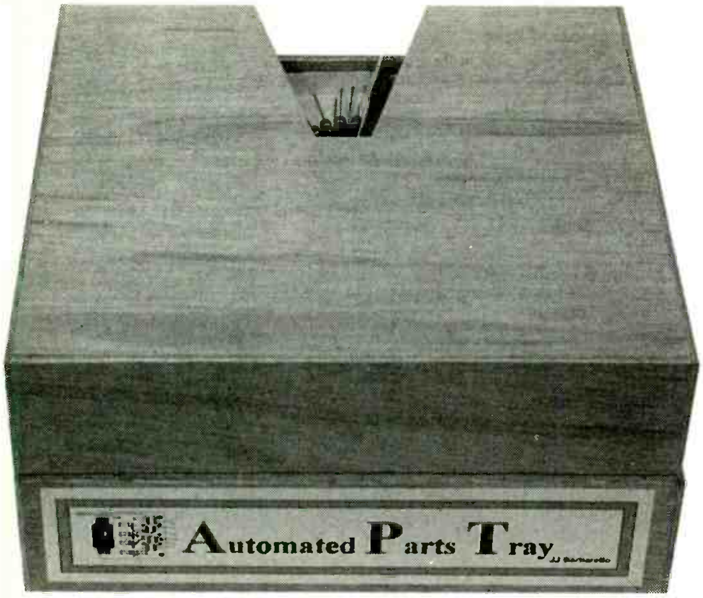
**Washington**

Amateur Radio Supply Co.
5963 Corson Ave., Ste 140
Seattle, WA 98108

**Wyoming**

Chris Supply
2007 S. Douglas Hwy., Ste. C
Gillette, WY 82716

**If you'd like to sell our magazine in your store, please circle 210 on Free Information Card.**




BUILD THIS

# AUTOMATIC PARTS TRAY

*Learn how to use stepper motors, and build a great system that simplifies PC-board assembly in the process.*

JAMES J. BARBARELLO

Stepper motors are simultaneously exciting and intimidating for the hobbyist. There's something fascinating about a precision device with so many uses. That fascination dampens, however, when you consider the logistics of obtaining steppers, not to mention the hardware and software required to drive them. Wouldn't it be nice to see a complete project using parts obtainable in small quantities at low cost?

Well, this project does just that. Using a readily available 5-volt stepper motor and a handful of common parts, we'll create a computer-controlled device called the Automated Parts Tray (APT). Using a short and simple QBasic program, APT demonstrates the principles of optimizing PC-board assembly. APT uses a stepper-controlled rotating parts bin along with a graphical display of PC-board component locations to help ensure that the right parts are inserted in the right spots on the board in optimal order of assembly.

APT can handle boards up to 6 × 8 inches. In addition, the project can be expanded easily to include closed-loop control. Further, it can even be used as the basis for a mini PC-board drilling system. (Those enhancements will be presented in future articles.) Best of all, you don't need a lot of money or special mechanical skills. All key parts are readily available from a single, well-established mail-order source, and parts cost about $30.

**All about APT.** APT is a simplified adaptation of a semi-automatic electronics manufacturing system that has been in commercial use for years. The system is *semi*-automatic in that an operator must manually pick up and insert each part, but the actual part and its location are automatically determined and displayed.

In the commercial version, a series of trays are stacked vertically, like pies in a dessert display in a diner. Each tray contains several bins. The mechanism is such that all bins but one are covered. The cover can be visualized as a pie from which one slice has been removed. The area of the removed slice corresponds to the exposed bin. Each bin contains a specific part (a 10K resistor, a 2N2222 transistor, and so on).

The PC board being assembled mounts in a holder in front of the operator. To prepare for a part to be inserted, an X-Y table under the PC board moves a solid-state light source (a high-intensity LED or low-intensity laser) directly under a hole in the PC board where one lead of the part to be inserted will go. Then a parts tray rotates so the bin containing the correct part is exposed. The operator takes a part from the tray and inserts it into the position indicated by the lighted holes.

Our version contains one tray with twelve bins. However, the software can accommodate tray changes during parts insertion, thereby affording an unlimited number of bins. And instead of using a mechanically complicated X-Y table and solid-state light

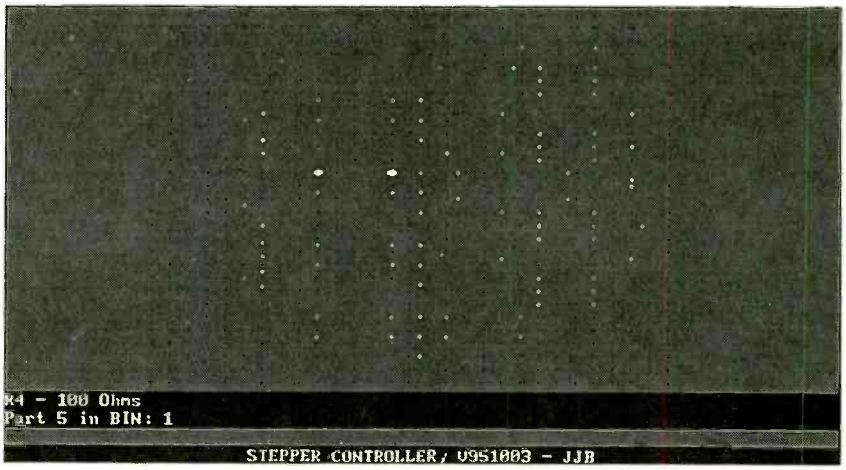



*Fig. 1. The automated-parts-tray screen displays a grid overlaid with mounting holes for each component. The current component is highlighted.*

source, our version displays a graphical replica of the PC board, all component holes, and a special representation of where the current part should be inserted. Figure 1 shows an example.

The mechanics of this project are quite simple, for two reasons. One is our use of an easily obtainable rotating "Lazy Susan" tray available anywhere kitchen products are sold. (We had good luck with a *Rubbermaid* brand tray.) Second is that we control tray movement using a direct-drive system, thereby eliminating the need for lead screws or gears. So let's get started.

**The Stepper and Drive Circuit.** The stepper motor is a two-phase, four-wire type. It consists of a permanent-magnet rotor and two field coils, as shown in Fig. 2. Table 1 lists the specifications for the selected motor. When the field coils are switched in the proper sequence, they attract the rotor, pull it to a precise position, and hold it there. By energizing coils A and B in the sequence shown in Table 2, the rotor will move precisely 7.5°, which amounts to 48 discrete steps through its rotation.

In Table 2, note that the four inner columns represent two things: The motor winding leads (A, A*, B, B*), and the PC parallel-port pin numbers that control those leads. Those numbers correspond to the pin numbers shown in the schematic (Fig. 3). Pin 2 represents the least-significant bit, and Pin 5 represents the most-significant bit. Column six of Table 2 shows the decimal value that should be written to the port to achieve the desired bit pattern for each step in the sequence.

As shown in Fig. 3, it doesn't take much in the way of electronics to drive a stepper. The circuit contains four identical functional blocks. The

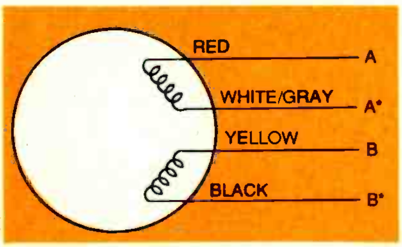



*Fig. 2. A two-phase, four-wire stepper motor consists of a permanent-magnet rotor and two field coils.*

**TABLE 1—STEPPER MOTOR SPECIFICATIONS**

| Item | Description |
|---|---|
| Motor | Bipolar (2 phase) AIRPAX stepper motor (LB2773-M1) |
| Size | 2.25 (D) × 0.99 (H) inches |
| Weight | 0.61 lb |
| Electrical | 5-volts DC, 800 mA, 6.25 ohms |
| Resolution | 7.5 degrees/step |
| Shaft | 0.25 (D) × 0.75 (L) inches |
| Mounting Holes | Two 0.2-inch mounting holes, spaced 2.6-inches apart |
| Torque | 100 g-cm (detent), 1080 g-cm (holding) |

**TABLE 2—MOTION CONTROL SEQUENCE**

| STEP | A(5) | B*(4) | B(3) | A*(2) | Decimal |
|---|---|---|---|---|---|
| 1 | 1 | 0 | 1 | 0 | 10 |
| 2 | 0 | 0 | 1 | 1 | 3 |
| 3 | 0 | 1 | 0 | 1 | 5 |
| 4 | 1 | 1 | 0 | 0 | 12 |

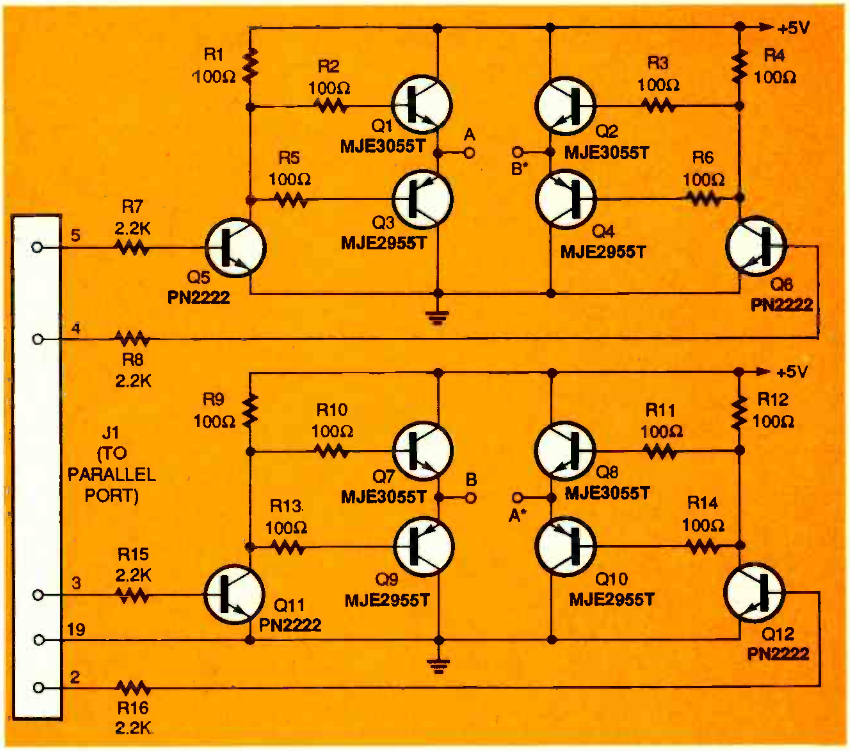



*Fig. 3. The driver circuit allows a standard PC parallel port to alter the direction of current flow in both windings of the stepper motor according to the states of the four inputs.*

purpose of each block is simply to provide a path from one end of a motor winding to either +5 volts or ground. By alternately switching the polarity of the voltage applied across the windings, we can cause motion to occur.

To see how that works, let's concentrate first on the block that controls the A lead. That block contains Q1, Q3, and Q5, along with the associated resistors. If pin 5 of J1 goes high, Q5 conducts, bringing its collector near ground. That in turn forward-biases Q3, which brings its emitter near ground. Of course, $V_{CE}$ of both Q5 and Q3 depends on the current being drawn by the load.

Now let's examine the block that controls the A* lead, including Q8, Q10, and Q12, and the associated resistors. If pin 2 of J1 goes low, the collector of Q12 goes high. That in turn causes Q8 to conduct, and Q10 to remain off. So, with A low and A* high, a current path has been established through Q8, coil A of the stepper motor, and Q3.

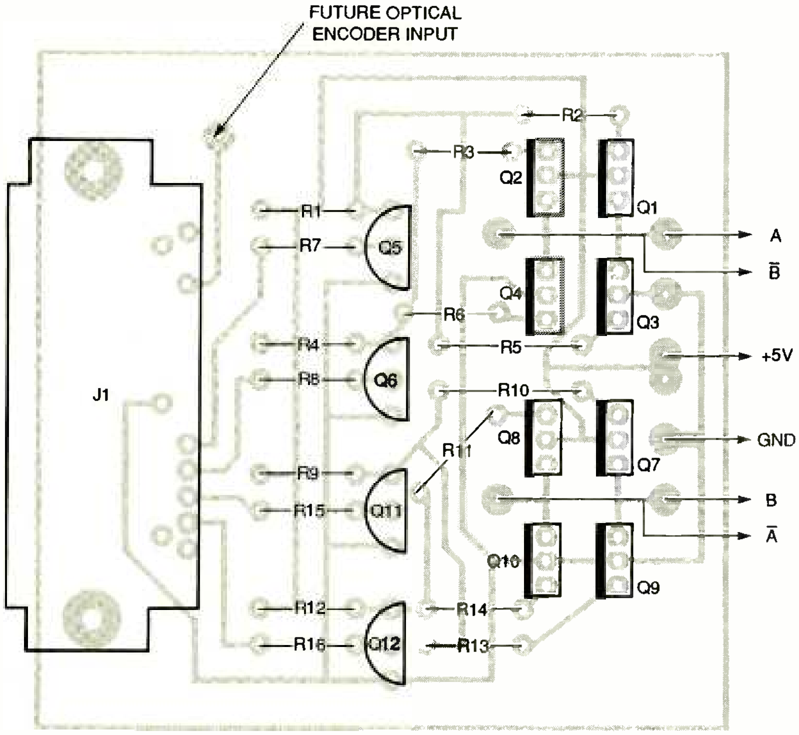
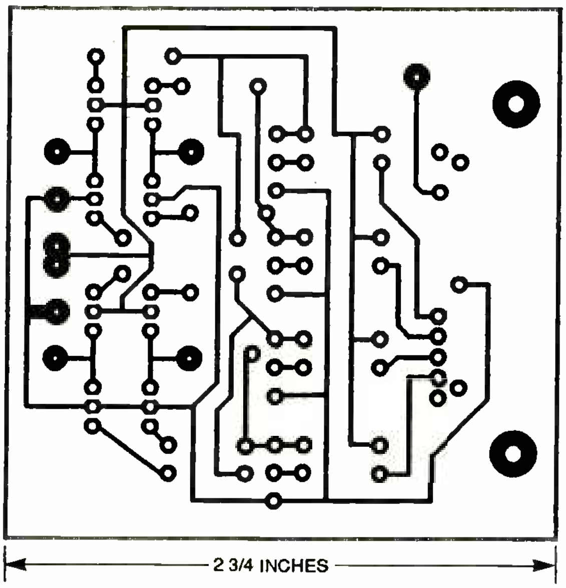



*Fig. 4. Mount all components as shown here. A future installment will show how to use the optical encoder inputs.*




*Use this foil-pattern when etching the PC board.*

**Moving the Stepper.** By driving input pins 2–5 in the proper sequence, we can cause motion to occur. We've already seen the motion-control sequence in Table 2. The question now is how to deliver that sequence in a format acceptable to the motor. The code fragment in Listing 1 shows how. Note that we sequentially output the decimal values from column six of Table 2, with a delay of about 150 ms after each. The delay is required to accommodate the mechanical inertia of the stepper motor. Without the delay, the control sequences would arrive from the PC so fast that the motor would simply sit there and chatter!

**Power Considerations.** Many stepper-motor control circuits use a current-limiting resistor to prevent excessive current from causing the motor to overheat. In our circuit, the relatively large current demand of the motor causes a measurable voltage drop across the power-providing transistors (in the preceding example, Q3 and Q8). Each will have a $V_{BE}$ drop approaching 1 volt. Therefore, the stepper motor coil sees a net of only about 3 volts. With a coil resistance of 6.25-ohms, the current provided is then 3/6.25, or about 480 mA. That is well within the motor's dissipation capability, so no current-limiting resistor is required.

The tradeoff, of course, is that the motor provides less than maximum torque. That's acceptable in our application, but it might not be in others. You could increase torque by increasing the supply to six volts without modifying the circuit. You might be tempted to increase the supply to seven volts to offset the $V_{BE}$ drops in the transistors and provide full power to the coils. That increase is not recommended, however, as you will exceed the motor's ability to dissipate heat, leading, naturally enough, to overheating.

We calculated current demand of each coil in this circuit configuration as about 400 mA. That implies that a 1-amp power supply should be sufficient. However, depending on the actual $V_{BE}$ drops across the transistors, as well as variations in the motor coils, that value could increase to 1 amp or even more. To provide a margin of safety, we recommend use of a 1.5- or 2-amp power source.

There are many sources for new 5-volt, 1.5–2 amp power supplies. However, you can save a bundle by buying surplus. For example, some suppliers sell suitable power supplies for less than $10. A potential draw-

### LISTING 1— MOVING THE STEPPER

```
...
OUT 888, 10 : GOSUB DELAY
OUT 888, 3 : GOSUB DELAY
OUT 888, 5 : GOSUB DELAY
OUT 888, 12 : GOSUB DELAY
...
END

DELAY:
START! = TIMER
WHILE (TIMER-START!) < 0.15 : WEND
RETURN
```

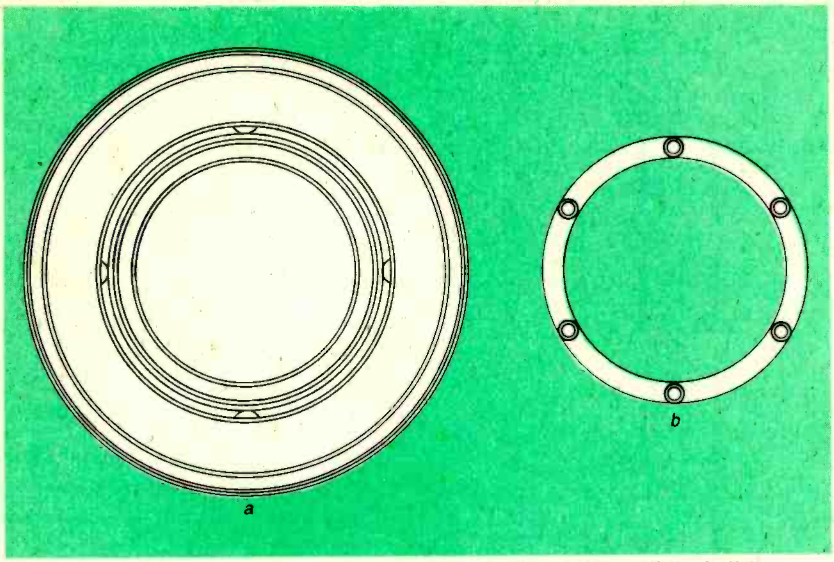



*Fig. 5. The rotating tray—the complete assembly is shown in a, and the ball-bearing ring in b.*

various diameters; to be consistent with our prototype, try to obtain one that has about a 10-inch diameter. Figure 5-a shows a bottom view of a typical tray. It has a concentric ring that is press-fit under four equally spaced tabs. Under the ring is a ball-bearing assembly, as shown in Fig. 5-b. Holding the tray firmly, distort the concentric ring so it can slip past one of the tabs. Then slide the ring free of the tray and discard the ring. Remove the ball-bearing assembly and save it.

Now we have to find the exact center of the tray. That is most easily accomplished with a center finder. If you don't have one, you can use a clear plastic protractor and a straight edge. As shown in Fig. 6, place the two corners of the protractor against the inside lip of the tray and draw a line

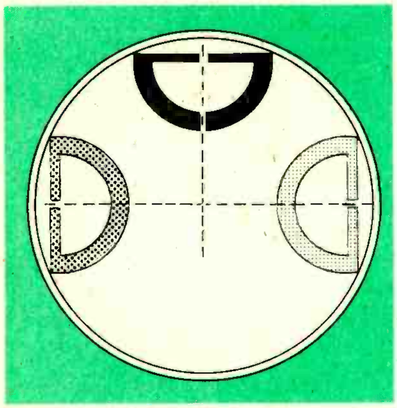


*Fig. 6. Finding the center of the tray using a protractor and a straight edge; the point where the lines cross is the center of the circle.*

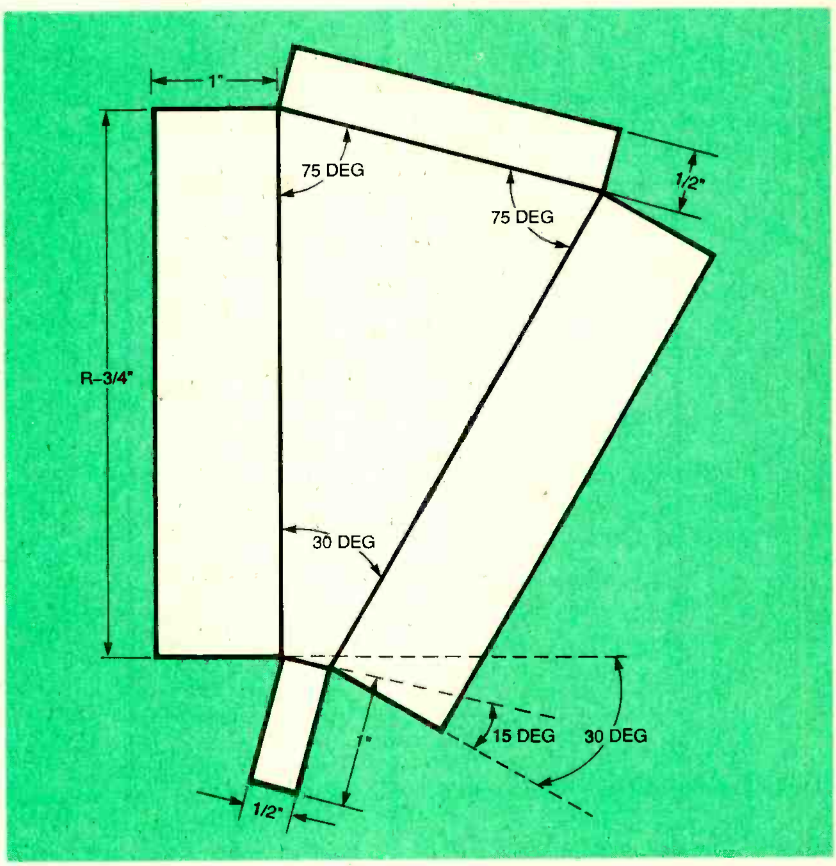



*Fig. 7. Use this pattern to create the bins. The length of a side is given by the radius of the tray minus three-quarters of an inch. You'll need twelve of these.*

back of that type of supply is that it may require a minimum load at all times. If that minimum isn't met, voltage may rise, for example, to about 5.3 volts. That presents no problem in our application.

**Construction.** Begin construction with the motor-control circuitry. A PC board layout accompanies this article; the parts-placement diagram appears in Fig. 4. Install the sixteen resistors first. Then install the eight TO-220 package transistors, ensuring both that you install the MJE3055s and MJE2955s in the right positions, and that they have the correct orientation. Next install the four TO-92 transistors (Q5, Q6, Q11, and Q12), again with the proper orientation. Now remove the connectors (if any) on the ends of the stepper motor leads, and connect them to the appropriate points on the PC board. Attach the positive and negative power supply leads to the PC board.

Now let's look at the mechanics, starting with the tray. Trays come in from the center marker on the straight portion of the protractor through the 90° indicator on the protractor's arc. Do the same thing at three or more locations on the tray. Where the lines cross is the exact center of the tray. (In geometric terms, each protractor

## PARTS LIST FOR THE AUTOMATIC PARTS TRAY

- R1–R6, R9–R14—100-ohm, ¼-watt resistor
- R7, R8, R15, R16—2200-ohm, ¼-watt resistor
- Q1, Q2, Q7, Q8—MJE3055T NPN transistor, TO-220 case
- Q3, Q4, Q9, Q10—MJE2955T PNP transistor, TO-220 case
- Q5, Q6, Q11, Q12—PN2222 NPN transistor, TO-92 case
- J1—DB-25 connector, female, PC-mount
- 5-volt DC, 6.25-ohm coil, bipolar stepper motor (Airpax LB82773-M1; JAMECO 117954 or equivalent); PC board; 5-volt/2-amp power supply (JAMECO 107326, 109276, or equivalent); 2.5-mm female power jack; 2.5-mm male power plug; Universal shaft coupler (JAMECO 106606 or equivalent) (2); Rubber coupler (JAMECO 106622 or equivalent); "Lazy Susan" tray (Rubbermaid or equivalent, 10-inch diameter); ¼-20 × 1½-inch machine bolt; ¼ -20 nut (2); 1¾ × 4-inch aluminum or plastic panel; #4 sheet metal screws (4); #6 or #8 sheet-metal screws (2); 24 × 36-inch piece of "Oaktag" or poster paper; ½-inch plywood; ¼-inch Luan mahogany plywood; glue, nails, DB-25 extension cable, solder, wire, etc.

**Note**: The following are available from James J. Barbarello, 817 Tennent Road, Manalapan, NJ 07726: PC Board; APT-PC ($12.00). Software including source and executable code for all software in the series, sample data files, and an enhanced version of the APT software (including the optical encoder application); APT-S ($12.00). All prices include shipping. International orders add $5.00 (U.S. funds only). NJ residents must add appropriate sales tax. The author will accept phone calls 6–8:00 PM EST., Monday through Friday **ONLY** (908-536-5499). The author will gladly answer written questions if accompanied by a self-addressed stamped envelope.

### LISTING 2—STEPPER CONTROL PROGRAM

```
REM** STEPPERS.BAS   (c) 1995, JJ Barbarello
REM** V951007
CLS : DEF SEG = 64: DEFINT A: add = 888
DIM a(4): a(1) = 5: a(2) = 3: a(3) = 10: a(4) = 12
abinold = 1: ainit = 12: OUT add, ainit
COLOR 15, 1: LOCATE 2, 1: PRINT SPACE$(79)
LOCATE 2, 26: PRINT "APT STEPPER CONTROLLER TESTER"
COLOR 7, 0: LOCATE 10, 20: PRINT "Position Tray At Bin 1, then press Enter"
waitforenter:
a$ = INPUT$(1)
 IF a$ <> CHR$(13) THEN SOUND 800, 1: SOUND 500, 1: GOTO waitforenter
LOCATE 10, 20: PRINT SPACE$(40)
loop01:
LOCATE 10, 27: PRINT "TRAY CURRENTLY AT BIN:"; abinold
LOCATE 20, 10: PRINT SPACE$(60)
LOCATE 20, 23: LINE INPUT "Which Bin (1-12, Enter to end)... "; abin$
  IF LEN(abin$) = 0 THEN END
abin = VAL(abin$): IF abin < 1 OR abin > 12 THEN BEEP: GOTO loop01
abin2 = abin: IF abin2 < abinold THEN abin2 = abin2 + 12
asteps = abin2 - abinold
SELECT CASE asteps
      CASE 1 TO 6
        lo = 1: hi = 4: steps = 1
      CASE IS > 6
        lo = 4: hi = 1: steps = -1: asteps = 12 - asteps
      CASE IS < 0
        lo = 4: hi = 1: steps = -1: asteps = -asteps
END SELECT
OUT add, ainit
bin = abinold
FOR i = 1 TO asteps
 FOR j = lo TO hi STEP steps
  OUT add, a(j)
  IF i > 1 AND i < asteps THEN delay = .075 ELSE delay = .125
  start! = TIMER
  WHILE (TIMER - start!) < delay: WEND
 NEXT j
bin = bin + steps
SELECT CASE bin
      CASE IS = 0
       bin = 12
      CASE IS = 13
       bin = 1
      CASE ELSE
END SELECT
LOCATE 10, 27: PRINT "TRAY CURRENTLY AT BIN:"; bin; SPACE$(2)
SOUND 625, 1
NEXT i
IF steps = -1 THEN
  OUT add, a(lo)
  ainit = a(lo)
 ELSE
  ainit = a(hi)
END IF
start! = TIMER
WHILE (TIMER - start!) < 1: WEND
OUT add, 0
abinold = abin
GOTO loop01
END
```

edge is a chord, and the line you draw is a perpendicular bisector of that cord. Perpendicular chord bisectors are, by definition, along a radius, and therefore cross the circle's center).

Drill a ¼-inch diameter hole in the center of the tray. Obtain a ¼-20 machine screw at least 1½-inch long, and two ¼-20 machine nuts. Thread one nut on the screw and insert the screw into the drilled hole from the top of the tray. Now thread the other

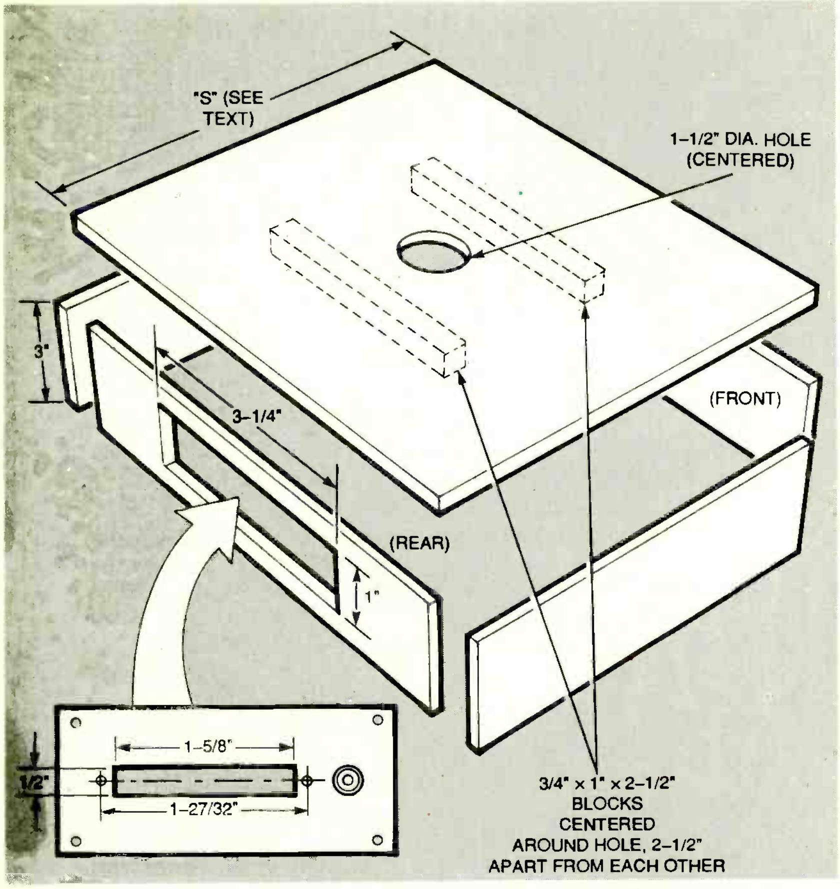



*Fig. 8. One-half inch plywood serves well in building the case. The blocks on the underside hold the stepper motor, and the slot in the rear panel is for a mounting plate that connects power and the parallel port.*

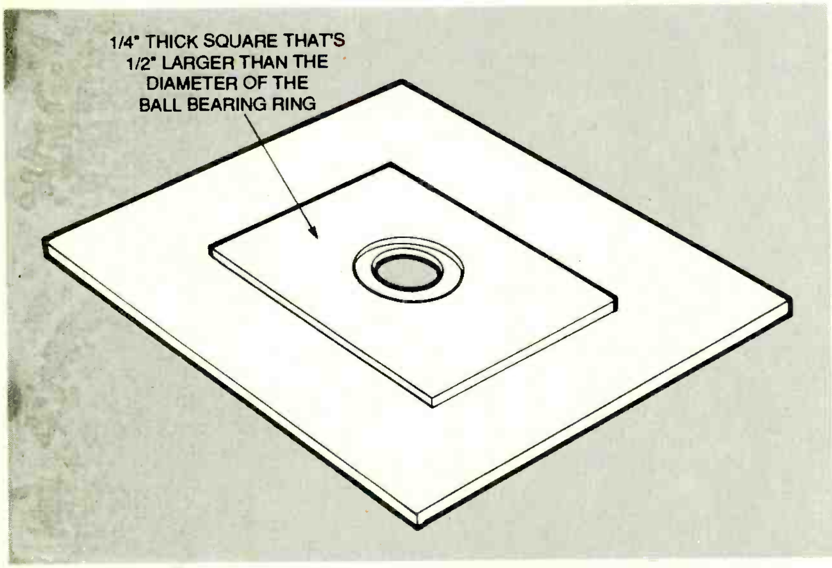



*Fig. 9. The spacer provides clearance for the shaft-coupling mechanism.*

nut onto the screw, locking it in place. Do not tighten the nuts at this point, as the protruding length of the screw will be adjusted later.

The next task is to make the twelve bins. Figure 7 shows a pattern for one bin. Note that all dimensions are constants, except the length, which is defined as R – ¾-inch. Measure the inside diameter of the tray and divide by two to obtain the radius. For example, the author's prototype used a 10½-inch diameter tray, and 10½/2 – ¾ = 4.5-inches. You can make the bins from thin aluminum, wood, plastic, or other materials. An effective alternative is poster paper (commonly called "Oaktag" paper). It's easy to work with, has the thickness of about five normal sheets of paper, and is stiff enough to hold the required bends.

Using the length calculated for your tray, cut twelve blanks. Fold the four flaps upward, being careful to fold them straight and along the lines indicated on the pattern. Secure the tabs with transparent tape. When all twelve bins are complete, arrange them in a circle and secure them to one another where they meet with additional transparent tape. With careful assembly, the bins should fit snugly into the tray. However, an exact fit isn't necessary. The requirement is for twelve approximately equal bins in an assembly that won't rotate inside the inner lip of the tray.

**Building the Case.** Now we're ready to build the case. We used ½-inch plywood for our prototype. Form a square box with a closed top and an open bottom, as shown in Fig. 8. Side dimension S should be ½-inch larger than the outside diameter of the tray, plus twice the thickness of the material you're using for the case top cover. For example, with our 10½-inch tray and ½-inch plywood for the cover, $S = 10.5 + 0.5 + 2 \times 0.5 = 12$ inches.

A good material for the box top is ¼-inch luan mahogany plywood. Draw a line through diagonal corners and mark the point where the lines cross. Draw a line through the center perpendicular to the sides. Draw two parallel lines on either side of that one, each 1¼-inch from the first line. You should end up with two lines straddling the centerline of the top, and 2½-inches from each other.

Drill or otherwise form a 1½-inch hole at the center of the top. The actual diameter or shape is not critical, as long as the opening is at least 1 inch in diameter. Now prepare two ¾ × 1 × 2½-inch blocks. Attach the two blocks to the underside of the top and along the two parallel lines drawn previously. Screw or glue the blocks in place.

Measure the diameter of the ball-bearing assembly (BBA) shown in Fig. 5-b. Add ½-inch to that amount, and

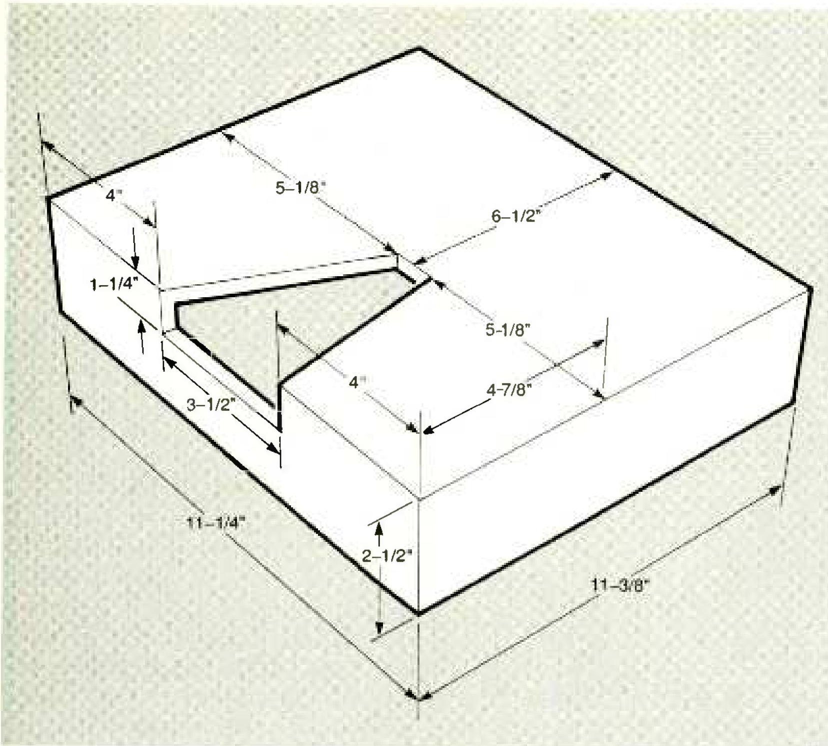



*Fig. 10. The top cover is the same size as the base, and has a wedge-shaped cutout to allow access to the current bin.*

call it L. Cut a piece of ¼-inch material into a square, with sides of length L, to form a spacer. Form a 1½-inch opening similar to that formed in the top and secure the spacer to the top of the case. Align the BBA to the spacer so it is concentric with the center hole, as shown in Fig. 9. After that's done, staple or otherwise attach the BBA to the spacer.

Create a centered rectangular opening 1 × 3½ inches in the rear side as shown. Then make a cover of plastic or metal and mount J1 to the cover. Also mount a power connector, and attach the cover to the rear panel with #4 sheet metal screws.

Using the value of S calculated earlier, build a cover, as shown in Fig. 10. The height should be 2½ inches. Do not drill a center hole; instead, form a wedge-shaped cutout as shown in Fig. 10. Using a 30-60 triangle, draw two lines from the center to one end, forming a pie shaped wedge. Fatten the wedge by drawing lines parallel to the first two lines, but ¼-inch farther out. Extend the two lines down the front side and then connect them, forming a rectangle. Then, to trim the sharp edge of the wedge, draw a line ¾-inch from the center. Cut out the wedge.

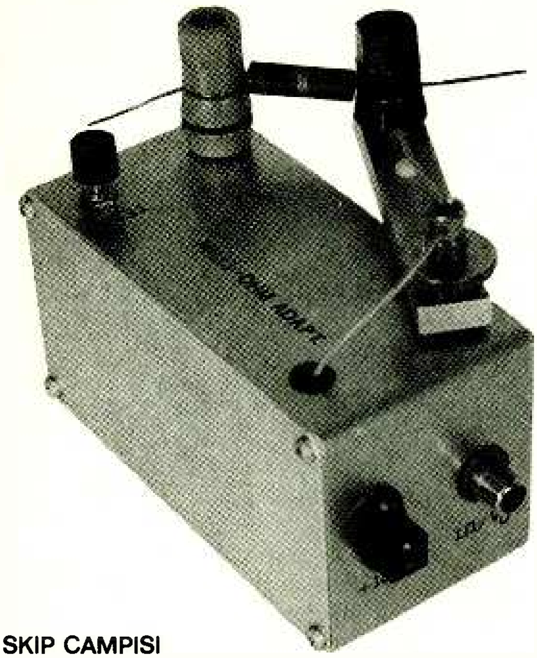
**Final Assembly and Checkout.** To finish up we need to mount the stepper motor and connect its shaft to the ¼-20 bolt with a flexible coupling. Start by centering the tray on the case bottom. Hold it in place temporarily with masking tape. Position the motor against the blocks with the shaft of the motor facing the bolt. If the motor has a gear attached, remove and discard it. Adjust the bolt's depth as necessary so it and the shaft almost touch. Position the motor so the bolt and shaft are concentric, and mark the position of the two mounting holes. Attach the motor to the blocks with #6 or larger sheet-metal screws. Remove the masking tape.

Attach one shaft coupler to the motor shaft, and another to the bolt. Place a rubber coupler in one of the shaft couplers, and loosen the nuts holding the bolt. Mate the two couplers. Adjust the bolt depth so the tray floats 1/16 to ⅛-inch above the BBA. The object is to minimize drag, but allow the bearings to come into use if the tray tips slightly from uneven weight distribution. Tighten the nuts to secure the bolt.

Attach the power connector and the DB-25 connector to the parallel port of your PC using an appropriate cable. Mark the front flap of one of the bins as "1," and place numbered slips of paper in each bin, beginning with bin 1 and going counter-clockwise. Place the bin assembly in the tray so bin 1 is accessible through the wedge cutout in the top.

Type the test program shown in Listing 2 into QBasic. Center bin 1 in the opening and run the program. As you select different bins, the tray should rotate to show the appropriate bin through the opening.

That's it for this installment. Next time, we'll present the general-purpose APT program, show how to create the ASCII data file for a PC board, and use the program to populate the stepper controller's own PC board. We'll also show how to add an optical encoder that can provide position feedback for the stepper motor. Ω



# Build This Milli-Ohm Adapter

*Extend the range of your DMM down to the milliohm level with this inexpensive, easy-to-build adapter.*

SKIP CAMPISI

Have you ever tried to measure accurately a low-value resistance, only to find that your test leads had a higher resistance than the device you were measuring? Even with a meter capable of *nulling out* the lead resistance, the null is never stable due to the hooks or clips used for the connections.

The Milliohm Adapter was specially designed to get around that problem and to do it with an accuracy of ±1% for readings over a range of 10 milliohms (0.01 ohms) to 5.0 ohms. Used with a 4½-digit DVM, the adapter can resolve resistances as low as 10 microohms, and be able to measure the resistance of a short length of hookup wire! Checking switch-contact resistance is a breeze with the adapter plugged into your DVM.

When measuring a resistance below 1.0 ohm, the leads of a resistor contribute significant error to the reading. Thus, a novel circuit approach was taken in designing the adapter. To generate an output-signal voltage high enough to be measured easily, a current of about 1.0 ampere is desirable. That current could easily fry some circuit components and damage the unit under test. However, by applying a low duty-cycle, 1.0-ampere pulse, no damage will occur. By using Kelvin voltage sensing probes right at the connections to the resistance, all of the other voltage drops due to the 1.0-ampere pulsed current in the other leads are essentially eliminated.

**About the Circuit.** The schematic diagram (Fig. 1) for the adapter can be partitioned into four sections: power supply, oscillator, current source, and peak detector. The $R_X$ (resistance to be measured) is connected between BP1 and BP2, and with the 1.0-ampere pulse applied to $R_X$, the resulting output transfer function appearing at J1 is 1.0 ohms-per-volt output to the DVM.

The power supply consists of IC2, a 78L12 voltage-regulator chip that provides regulated +12 volts to the circuit, and a 2N2222 transistor, Q2, which provides −0.7 volts to IC3 and a virtual power ground to the rest of the circuit. Transistor Q2 is used as a diode-connected transistor; that type produces only half of the ripple voltage that would appear if a standard rectifier were used. Battery B1 is user selectable and, although 18 volts is specified in the schematic diagram, it also can be any voltage source from 15-volts DC to 25-volts DC. For example, two series-connected 9-volt batteries will power the adapter quite nicely. Further, note that the prototype shown in the photos does away with B1 entirely; it uses a 117-volt AC power-pack adapter rated at 17.4-volts DC at 50 mA plugged into a jack on the instrument. Power switch S2 was not used on the prototype.

A TLC555 CMOS timer, IC1, is configured as an astable multivibrator operating at a frequency of about 100 Hz. The components used provide a duty-cycle of 99%; thus, a negative-going pulse of about 100 µs results at the output, which in turn gates (switches) the current source on for 100 µs at a duty-cycle of 1%. The resulting average current is 10 mA—safe for almost all circuits and circuit elements.

Light-emitting diodes LED1 and LED2 are standard red LEDs that have a forward voltage of about 1.75 volts each, and they are used as the voltage-reference diodes. As Q1 (a TIP125) has a forward voltage of about 1.5 volts, about 2.0 volts appears across R2 and R3, whose net resistance is 2.0 ohms; thus, a current pulse of 1.0 ampere is generated at Q1's collector. The current pulse is supplied via a capacitive-discharge type setup, from C1 (100 µF), which is recharged via R1 (33 ohms) during the 99% off state.

Adequate compensation for any temperature drift by Q1's two base-emitter junctions are provided by LED1 and LED2, and calibration is provided via CAL potentiometer R4, which adjusts the LEDs' forward voltage by varying the bias current. The prototype adapter uses a one-turn potentiometer for R4; you might wish to use a multi-turn trimmer instead. Also, you can trim fixed resistors R2 and R3 to adjust into R4's calibration range.

The TLC272 CMOS dual op-amp, IC3, is configured as a positive voltage-peak detector, which converts

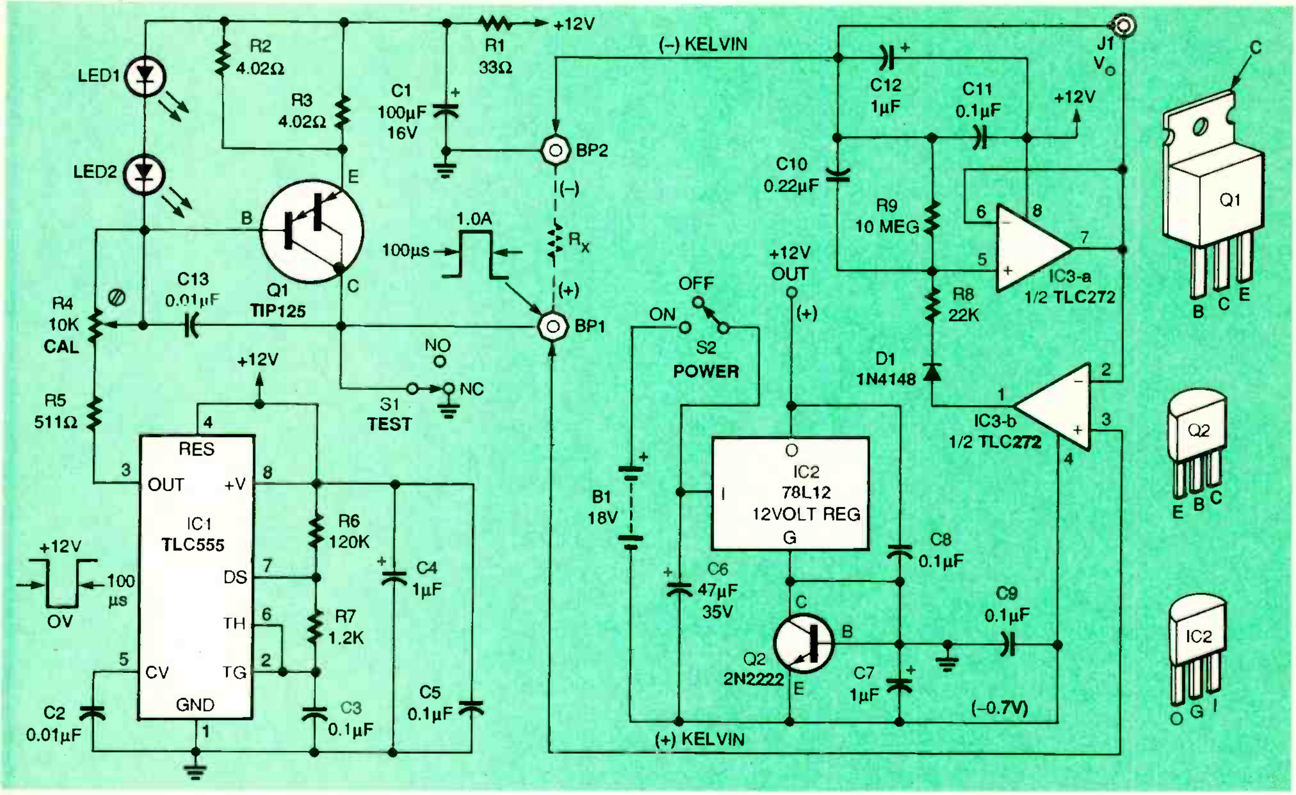
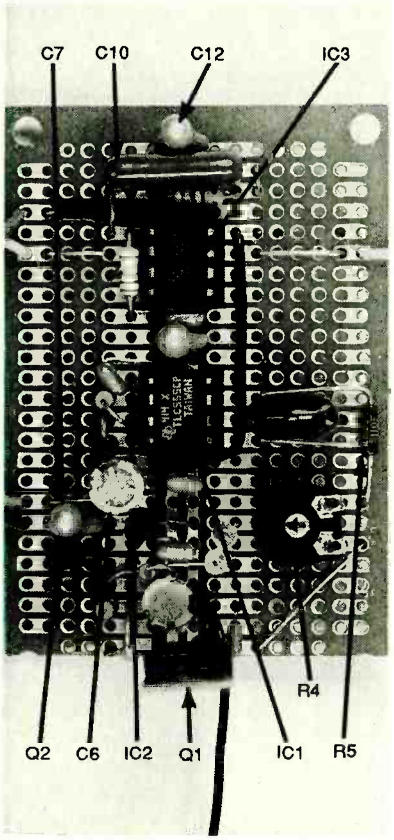
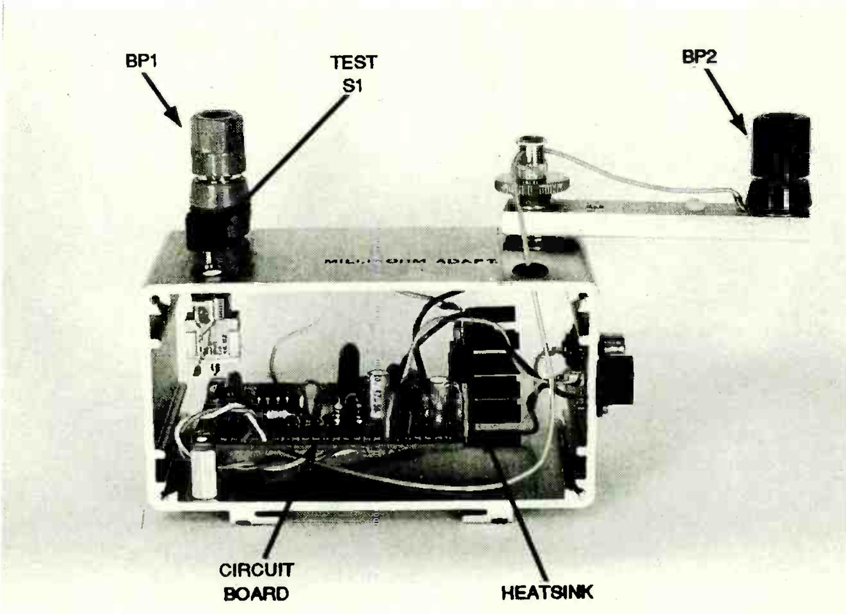



*Fig. 1. Here's the schematic diagram for the Milliohm Adapter. The circuit can be separated into four sections: power supply, oscillator, current source, and peak detector.*




*A piece of a PC board that matches a solderless board supports most of the circuit's parts. Layout is not critical; however neatness is important.*




*A view of the Milliohm Adapter before the side covers are installed. Note that the heat sink has been attached to the Darlington transistor Q1 and stands free of any metallic contact.*

the 1% duty-cycle voltage pulse generated across "$R_X$" to a steady DC voltage having the exact magnitude of the pulse's peak voltage value. Thus, the output at J1 is a DC voltage with the transfer function of 1.0-ohm-per-volt across $R_X$.

**Construction.** The only critical sections of the adapter are the binding-post connections to the resistance to be measured. Use a pair of jumbo (5-way) binding posts rated for 15 amps or more; the posts specified in the Parts List have large-area gold-plated contacts that make the physical and electrical securing of "$R_X$" very good. Once you have selected the binding posts, the next thing you must decide is how to mount them. The spacing between BP1 and BP2 must be mechanically variable to allow easy adjustment for various resistor sizes, wire lengths, etc.

The best method for mounting the binding posts is to leave the positive terminal (BP1) fixed, and have the negative ground terminal (BP2) movable. There are three different options to accomplish this: leave BP2 dangling from its leads without any mechanical mount; cut a slot in your cabinet so that BP2 can slide back and forth in the slot; or mount BP2 on an arm that pivots on a stud, thus rotating away from BP1 for adjustment. The last method was used for the prototype. Pick any of the methods and mount the binding posts so that they are level with each other, using shims or washers where needed. Be sure to insulate BP1 from the cabinet (which has to be aluminum), while BP2 should be electrically connected to the cabinet.

The prototype uses a cabinet made from extruded aluminum having a 3⁄32-inch thick wall for drilling and tapping for machine-screw attachments. For chassis boxes made from aluminum sheet metal, you can use ordinary machine screws, lock washers, and nuts.

The prototype cabinet measures 2-inches wide by 4⅜-inches long by 2⅜-inches high. Binding post BP1 is mounted at one end of the cabinet top, with a 10-32 × 1-inch screw protruding out of the other end. On this stud rides the swing arm, which is made from a piece of ¼-inch thick by ⅝-inch wide by 3-inch long aluminum bar. One end of the arm has a clearance hole for the 10-32 stud, and BP2 is mounted at the other end, along with a lug for the Kelvin connection. The arm rides on washers and is locked in place with a ¾-inch diameter, 10-32-thread knurled nut (a wing nut works fine, also). At its closest position, the binding post terminal spacing is about ¾ inch apart, which can be opened to a maximum of about 5½ inches. Output jack J1 and an optional power-input jack are mounted on one end of the cabinet with normally-closed push-button switch S1 (TEST) mounted on the top, near BP1. Jack J1 has to be isolated from ground. Use fiber shoulder washers or an insulated phono jack made for the purpose. If you use POWER switch S2, mount it near S1 for the most convenience.

Assemble the circuit board, following the parts location shown in the photos, on a 1⅞-inch by 2⅞-inch circuit board (see Parts List) starting with Q1 on one end of the board. Attach a small heat sink to Q1. Install two 8-pin DIP sockets and potentiometer R4 as shown; then add the rest of the components and interconnects leaving long leads for connecting the jacks and switches. The positive Kelvin lead is a separate wire connected directly from pin 3 of IC3 to binding-post BP1, and the collector tab of Q1 is also connected directly to BP1 via a separate wire.

*(Continued on page 79)*

*The power input jack (optional, see text) and insulated RCA phono jack (J1) that supplies the output signal to the DVM mounts on one side of the case*

## PARTS LIST FOR THE MILLIOHM ADAPTER

**SEMICONDUCTORS**

IC1—TLC555 or TLC555CN CMOS timer integrated circuit.
IC2—78L12 12-volt, 100-mA, positive-regulator integrated circuit
IC3—TLC272/TS272CN CMOS dual op-amp, integrated circuit
Q1—TIP125 PNP Darlington transistor
Q2—2N2222 PNP general-purpose transistor
D1—1N4148 switching diode
LED1, LED2—Light-emitting diode, red, T1 case

**RESISTORS**

(All fixed resistors are ¼-watt, 5% units, unless otherwise noted.)
R1—33-ohm
R2, R3, $R_C$—4.02-ohm, 1%, metal film
R4—10,000-ohm, one-turn potentiometer, PC mount, cermet (see text)
R5—511-ohm, ¼-watt, 1%, metal-film
R6—120,000-ohm
R7—1200-ohm
R8—22,000-ohm
R9—10,000,000-ohm

**CAPACITORS**

C1—100-μF, 16-WVDC, electrolytic
C2, C13—0.01-μF, monolythic ceramic
C3—0.1-μF, polyester (Mylar)
C4, C7, C12—1-μF, 35-WVDC, solid tantalum
C5, C8, C9, C11—0.1-μF, monolythic ceramic
C6—47-μF, 35-WVDC, electrolytic
C10—0.22-μF, polyester (Mylar)

**ADDITIONAL PARTS AND MATERIALS**

B1—See text
BP1, BP2—Binding post, insulated, 30 ampere (H.H. Smith #257)
J1—RCA phono jack, isolated (Mouser#16PJ050, or equiv.)
S1—Mini-push-button, spdt, momentary, 3 A
S2—Mini-toggle switch, spdt, 1-amp (optional)
Protyping board (RadioShack 276-150, or equiv.), 8-pin IC socket (2), TO-220 heat sink, post spacers (2, threaded holes at ends with matching screws), threaded ends with screws to match, aluminum cabinet (see text), aluminum bar (see text), wire, phono plug, DVM plug, etc.

**Note:** The semiconductors and precision resistors are available from Mouser Electronics and other sources. All other parts are available at most local electronics stores and electronics mail-order houses.


# BUILD A ZONAL ENLARGING METER

MICHAEL A. COVINGTON

Most enlarging exposure meters tell you how many seconds to expose print paper. The Zonal Enlarging Meter described here does not! Instead, it tells you how light or dark each area of the picture will turn out, based on a selected standard exposure time for your enlarger.

When in the photo darkroom, you position the Zonal Enlarging Meter with one hand and adjust the lens opening of the enlarger with the other hand. The exposure setting technique using the Zonal Enlarging Meter is much faster than twisting the dials on a conventional enlarging meter and it assists in obtaining a correctly exposed enlargement that fits all the brightness zones of the negative into the response range of print paper, from stark white to jet black. Ordinary enlarging meters measure only one zone which is usually a highlight or skin tone, and just guess where the other zones will fall. The Zonal Enlarging Meter lets you measure any area of the enlarger's project image on the paper surface and adjust the lens opening until that area is as light or as dark as you want it to be.

**How it Works.** The heart of the Zonal Enlarging Meter circuit (Fig. 1) is a National Semiconductor LM3915 LED bargraph driver IC, which lights any-

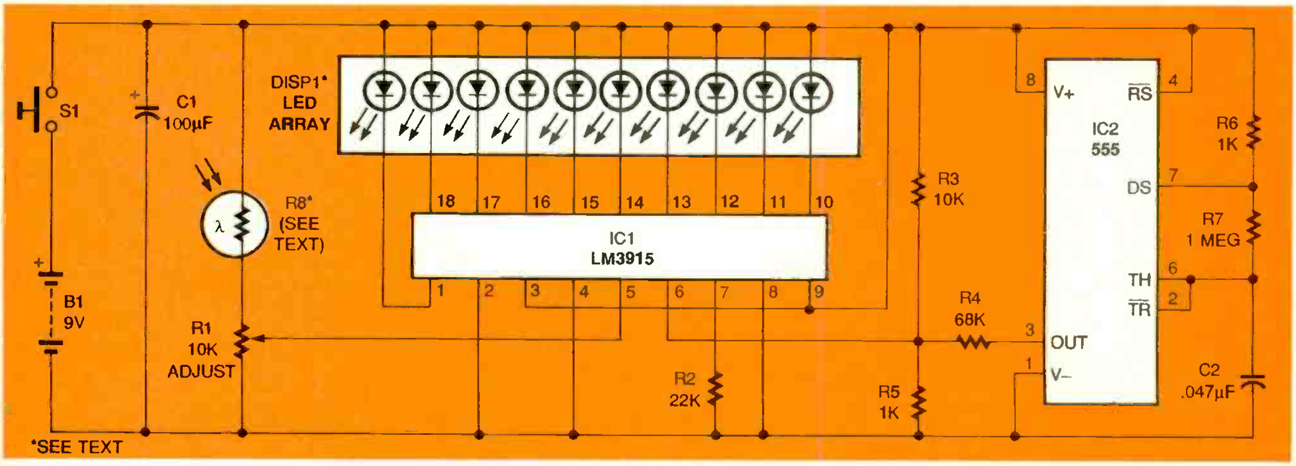
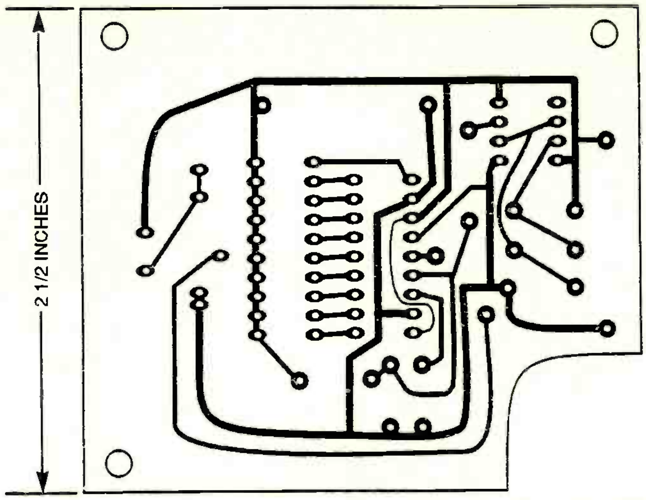



*Fig. 1. Here's the schematic diagram for the Zonal Enlarging Meter. Light falling on photoresistor R8 causes LEDs in the bar-graph display DISP1 to illuminate. The number of LEDs that come on is logarithmically proportional to the light intensity.*

where from 0 to 10 LEDs depending on the ratio of the input voltage on pin 5 to the reference voltage on pin 6.

The trigger voltages for the LEDs in bar-graph display (DISP1) are arranged along a logarithmic scale, just like photographic exposures, and the total voltage range is 10 to 1. Because of some nonlinearity in the photo resistor's response to light-intensity change, the range of light levels that the meter actually covers is more like 30 to 1, which is ideal because it slightly exceeds the density range of a properly exposed negative.

Each LED in DISP1's bargraph display has three states, off, flashing, and fully on; that feature lets you read a total of 20 steps rather than just 10. The flashing effect is produced by the 555 oscillator (IC2), which makes the reference voltage at pin 6 of IC1 fluctuate so that an LED that is just on the verge of turning on will flash. To simplify the circuit, you can leave out this flashing feature by omitting IC2, R4, R6, R7, and C2.




*Same-size foil-pattern diagram for the meter's PC board. Carefully drill holes so that integrated-circuit chips and display chip mount quickly.*

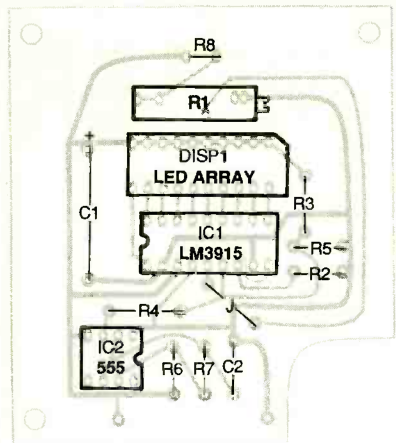



*Fig. 2. Parts location diagram shows that the PC board is uncluttered and easy to assemble. Mounting holes align with the screws used to close the plastic case.*

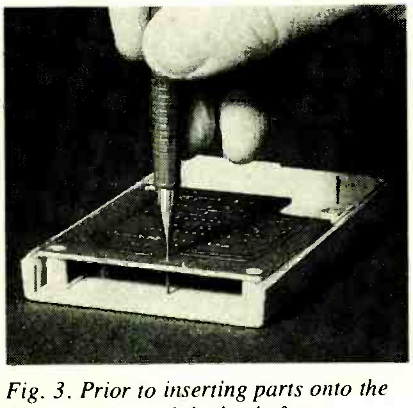


*Fig. 3. Prior to inserting parts onto the PC board, extend the lead of an automatic pencil through the holes in the board to locate openings in the case cover for the LED bar-graph display DISP1 and photoresistor R8.*

## PARTS LIST FOR THE ZONAL ENLARGING METER

**SEMICONDUCTORS**

DISP1—10-LED bar-graph display, red (Mouser 351-2402 or equiv.)
IC1—LM3915 LED logarithmic-bargraph driver integrated circuit (National Semiconductor)
IC2—555 timer-oscillator integrated circuit

**RESISTORS**

(All fixed resistors are ⅛-watt, 5% units.)
R1—10,000-ohm, 10-turn, ¾- to 1-inch long, trimmer potentiometer
R2—22,000-ohm
R3—10,000-ohm
R4—68,000-ohm
R5, R6—1,000-ohm
R7—1-megohm
R8—Cadmium sulfide photoresistor (see text and note below).

**ADDITIONAL PARTS AND MATERIALS**

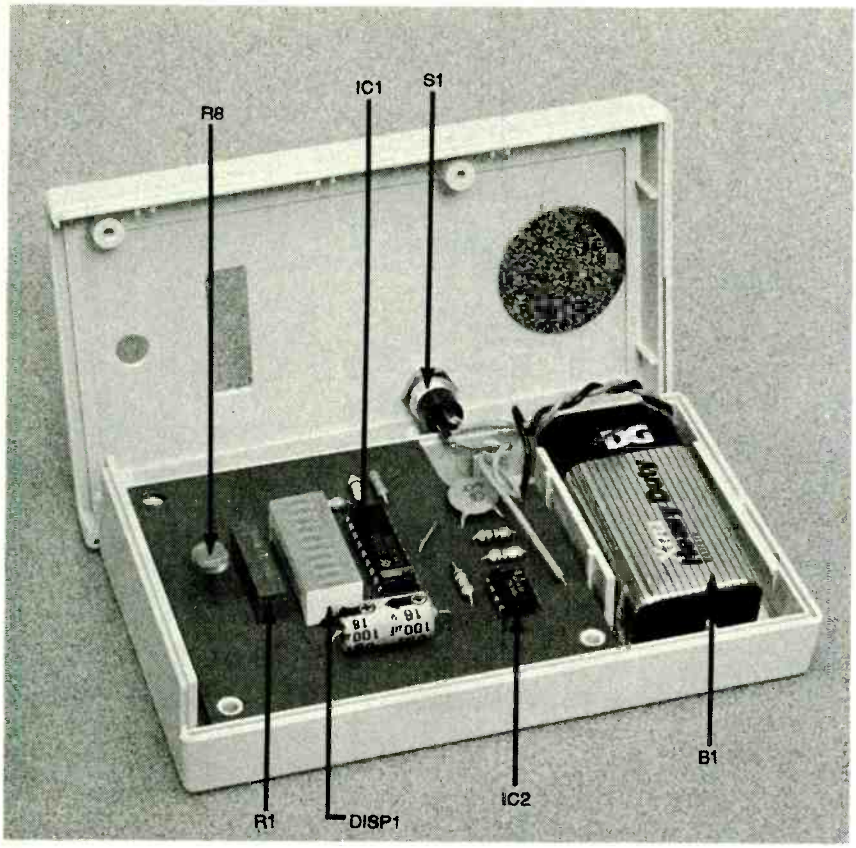
B1—9-volt transistor-radio battery
C1—100-µF, 16-WVDC, electrolytic capacitor
C2—0.047-µF, ceramic capacitor
S1—Normally-open, momentary-contact, push-button switch
Plastic-case enclosure (includes battery connector; Pac-Tec HML-9VB, RadioShack 270-211, or equiv.), PC circuit-board material as needed (see text), wire, solder, etc.

**NOTE:** A suitable photoresistor, type 76C59, is available from Mouser Electronics, 2401 Highway 287 North, Mansfield, TX 76063, phone 800-346-6873.

**Choosing a Photoresistor.** The choice of cadmium sulfide photoresistor (R8) used in the meter depends on what is available and what kind of paper and exposure time you like to use. You'll need one whose resistance is somewhere between 50K and 500K at the light level corresponding to a mid-gray tone in a picture printed on your paper with your exposure time.

One commercially available photoresistor that works well is the type 76C59 available from Mouser Electronics (see the Parts List). It's rated for a resistance of 20K to 50K ohms at a light intensity of 10 lux (1 foot-candle), and 20 megohms in total darkness. The light level for a mid-gray tone in a 5-second exposure on most fast enlarging papers is about 1 lux; at that light level, this photoresistor has a resistance of about 300K.

Another way to get a suitable photoresistor is to buy a surplus assortment and test the photoresistors until you find a suitable one. The testing procedure is simple. First, reject any photoresistors whose resistance in total darkness is less than 2 megohms, or which take more than a few seconds to stabilize when placed in darkness after exposure to room light. One way to put a photoresistor into total darkness is to wrap it in several layers of black cloth, plastic, or electrical tape. Avoid aluminum foil; it reflects light and tends to develop cracks that will throw your readings awry.




*The Zonal Enlarging Meter with PC circuit board and battery B1 in position just prior to closing the plastic case. Note the holes cut for the photoresistor R8 and LED bar-graph display DISP1. The photoresistor is mounted above the PC board to be flush with the inside surface of the case's cover.*

Next, set up your enlarger to make a properly exposed print on your usual paper with your usual exposure time. Then put the photoresistor on a mid-gray area of the projected image, turn off the safelight, and measure the resistance. If it's between 50K and 500K, and the resistance in total darkness is at least 10 times higher, you have a workable photoresistor. If the photoresistor's test measurements are outside that range specified above, you can still use the photoresistor by substituting a different value for R1. The resistance of R1 should be about 1/50 to 1/2 that of the photoresistor.

**Putting it Together.** The Zonal Enlarging Meter is housed in a Pac-Tec HML-9VB plastic enclosure (see Parts List). The illustration of the foil-side pattern of the printed-circuit board provided is same-size and can be used to produce a PC board using any of the photographic techniques available. You can assemble the project equally well on perfboard or a universal, pre-drilled circuit board. The parts location diagram in Fig. 2 should be followed closely no matter what circuit board you use.


*Here's the Zonal Enlarging Meter all closed up and ready for use.*

The photograph in Fig. 3 shows how to locate the holes for the photoresistor and the LED display in the plastic case cover once you've made the circuit board. To cut the rectangular opening for the LED bar-graph display (DISP1) in the case, drill holes in the corners directly over the display, then join them with a jeweler's saw if you have one. If you don't have a jeweler's saw, simply drill more holes until you have an approximately rectangular opening. Either way, finish the hole carefully with a file. Even though it is not attached to the hole in the cover, the photoresistor should stand up high enough on its leads so that it doesn't pick up stray light from the LEDs.

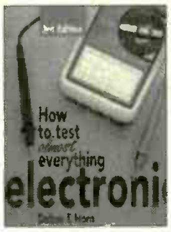
**Calibration.** Set up your enlarger to make a properly exposed print with your usual paper and exposure time. Place the meter on a mid-gray area of the image, turn off the safelight, and press S1. Adjust R1 so that five of the ten LEDs are on.

Now explore the rest of the picture. You will probably find that two or three LEDs come on in the densest areas of the negative that will show detail on the print, and eight LEDs are illuminated in the thinnest areas that will show detail. You may find it useful to make a set of strips of paper exposed at the light level of one LED, two LEDs, up to ten, so that you can see the exact shade of gray that corresponds to each meter reading. Once you have the desired adjustment for your darkroom operation, close up the meter's case. You are now ready to produce quality, full-tonality photographs at a rapid pace on the first try with each negative. Ω


## The leading source of information for electronics hobbyists for over 30 years!

0331898-XX $89.50
Counts as 2

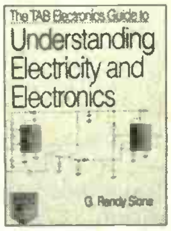
0484392 $13.95



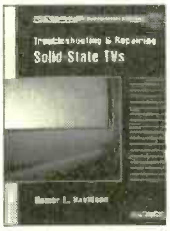
0304068 $15.95

0650780 $24.95

0376115-XX $36.95
Counts as 2



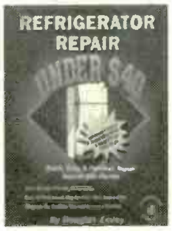
0582165 $16.95



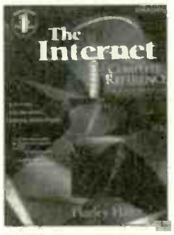
0157537-XX $44.95
Counts as 2

0634955 $11.95

1570519 $17.95

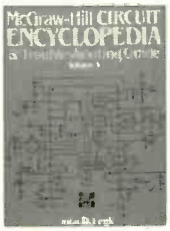


5869179 $12.95



882138X-XX $36.95
Counts as 2

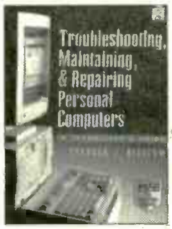
1576568 $21.95



0377162-XX $59.50
Counts as 2

0428433 $60.00

0242046 $39.95



9120989-XX $70.00
Counts as 2

0053553 $50.00

0380767-XX $36.95
Counts as 2

**As a member of the** ELECTRONICS BOOK CLUB® you'll enjoy receiving Club bulletins every 3-4 weeks containing exciting offers on the latest books in the field at savings of up to 50% off the regular publishers' prices. If you want the Main selection, do nothing and it will be shipped automatically. If you want another book, or no book at all, simply return the reply form to us by the date specified. You'll have at least 10 days to decide. If you ever receive a book you don't want due to late delivery of the bulletin, you can return it at our expense. Your only obligation is to purchase 3 more books during the next 12 months, after which you may cancel your membership at any time. And you'll be eligible for FREE BOOKS through our Bonus Book Program.

A shipping/handling charge and sales tax will be added to all orders. All books are softcover unless otherwise noted. If you select a book that counts as 2 choices, write the book number in one box and XX in the next. (Publishers' Prices Shown) ©1996 EBC

**PHONE:** 1-614-759-3666 (8:30 a.m. to 5:00 p.m. EST Monday-Friday) • **FAX:** 1-614-759-3749 (24 hours a day, 7 days a week)

BUILD THIS

# Hobby Spectrum Analyzer

*At less than $100 to build, this spectrum analyzer is a must for every hobbyist!*

BOB KOPSKI


Over the last two months we have discussed the theory behind the $100 *Hobby Spectrum Analyzer* and built and tested its various boards and subassemblies. Now it's time to put everything together and finish up the project.

**Functional Interconnection and Test.** Connect all four functional modules together on the bench top for a final check. This is not the *cleanest* RF arrangement, but it is workable for initial inter-module checkout.

Hook up the bench supply and current meter to the DC/DC converter and regulators battery lead. Turn on the HSA power switch but not the comb generator switch, and slowly run up the variable supply from zero, watching the current drain behavior as you advance to 12-volts DC. Look for a current draw of 26-31 mA. Turn on the comb generator; the current draw should increase 5-8 mA. Turn the comb generator off.

Connect the log amplifier output temporarily to the oscilloscope input, and the trigger output to the oscilloscope's trigger input. Set the vertical coupling to AC, and the range to 0.1 volts/division. Set the sweep to 1-mS per division. Set the IF ATTN to normal, and the INPUT SWITCH to mid-position (50 ohms). You should see a noisy baseline trace having about 0.1 volt peak-to-peak of noise. Be sure the oscilloscope is triggered for a stable display. Turn on the comb generator. You can expect a mess of vertical lines to appear on the oscilloscope. If so, you're now ready to do final assembly and alignment.

**Cabinet Assembly.** All modules and related parts easily fit in the specified cabinet; nevertheless, care is required in marking, drilling, and installing everything.

Start by flattening the dimples in the cabinet bottom where the feet screws were intended to go. The rubber feet can be glued on later. Hold a Universal prototyping board on the cabinet floor and mark four hole locations for the stack bolts. The rear board edge should be located 0.5-inch inside the rear panel, and as far to the right side of the cabinet as possible. Drill the holes. The stack screws are #6 machine screws. It is easier to slip the Universal prototyping boards over the #6 screws if the holes in the boards are drilled out to 5/32-inch diameter.

Next, drill the holes for the four phono jacks on the rear panel located on a line 1⅜-inch up from the cabinet floor to clear the stacked boards inside. Jack-to-jack spacing and electrical assignment are not critical. Glue or double stick tape a ¼- inch thick, ¾-inch wide, 2½-inch wood or foam spacer block on the rear cabinet wall right behind the battery box location. Attach a strip of self-adhesive-backed Velcro tape to the battery box bottom and the cabinet inside floor, and trial mount the battery box.

The front panel is the most difficult mechanical task. With the RF circuit

**PARTS SUPPLIERS**

**DC Electronics**
PO Box 3203
Scottsdale, AZ 85257-3293
Tel: 800-467-7736

**Digi-Key Corp.**
701 Brooks Ave So.
Thief River Falls, MN 56701-0677
Tel: 800-344-4539

**Electronix Express**
365 Blair Road
Avenel, NJ 07001
Tel: 800-972-2225

**Hosfelt Electronics Inc.**
2700 Sunset Blvd.
Steubenville, OH 43952-1158
Tel: 800-524-6464

**Ocean State Electronics**
PO Box 1458
6 Industrial Drive
Westerly, RI 02891
Tel: 401-596-3080

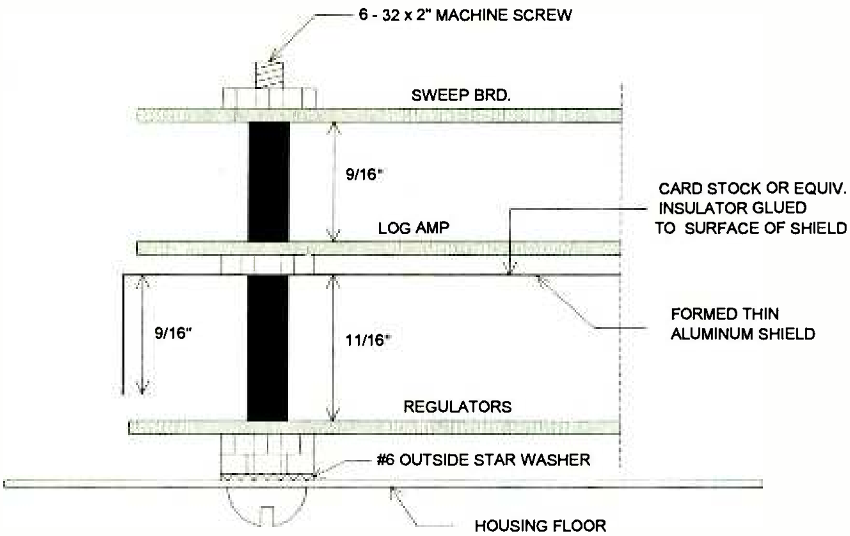
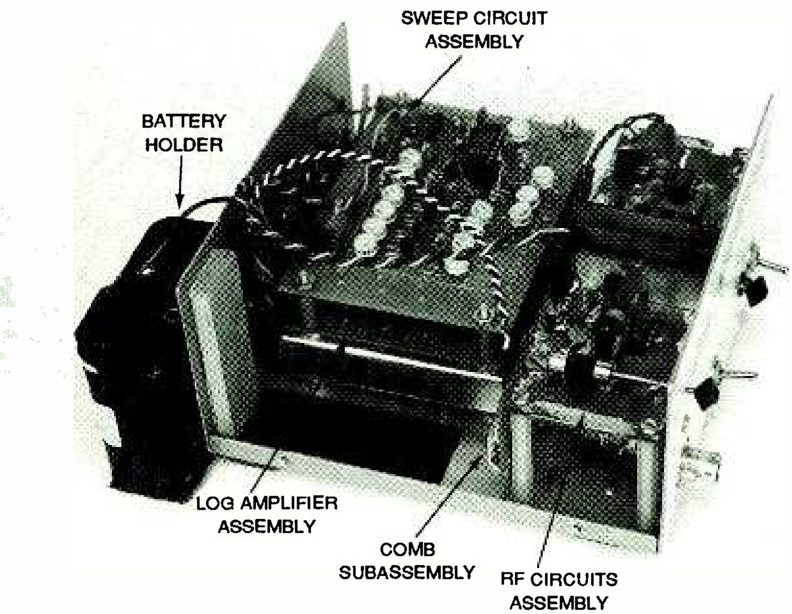



*FIG. 12—MODULE STACK ASSEMBLY details are illustrated here (not to scale). Aluminum shields between the log amplifier module and DC/DC converter and regulators module provides RF shielding from stray radiation generated in the DC/DC converter circuitry.*




*FRONT PANEL OF THE HSA mounts four switches and a BNC connector for the input signal. The rear panel (not shown) has four RCA phono jacks that provide three output signals and a battery test point.*

module in hand, mark off the various hole centers in the front panel. There are two critical hole locations: the 5/64-inch holes for the switch push rods (discussed in a moment). Make sure the alignment is correct before you drill. Use a 5/8-inch chassis punch to make the clearance opening for the BNC connector. Finally, the panel screw just above the BNC connector is a 4-40-1/4-inch screw. It screws into a tapped hole in the BNC mounting plate to draw the latter snug against the rear surface of the cabinet front panel.

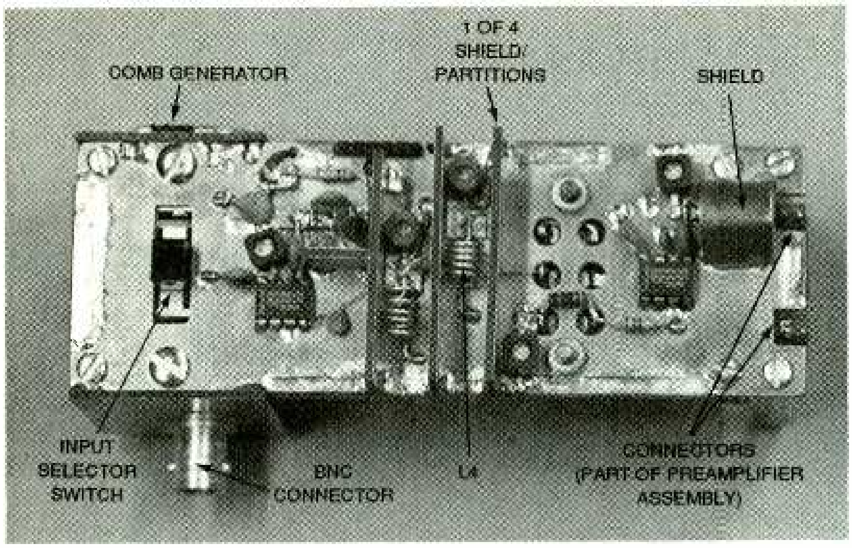
Locate and drill the four mounting holes in the cabinet floor for the RF circuit module spacers ("legs"). The mounting holes for the toggle switches and POWER LED2 are not critical. Make push rods for the switches using 1/16-inch brass rod, a decorative bead glued on for a knob, and model-plane wheel collars to capture the sliding switch knobs themselves. Install all the electronics/interconnections in the cabinet as in the drawings and photos. Temporarily omit the topmost stack nuts (Fig. 12), so that the sweep board can be lifted to access the log amplifier.

**Final Alignment.** Temporarily connect the unused preamplifier output test point to the oscilloscope vertical, and connect the trigger output to the oscilloscope trigger input. Power up. Connect a lead to a source of 145-MHz signal and allow the lead to *radiate* near the double-tuned 145-MHz filter. Tune the second local oscillator trimmer capacitor C27 and the filter capacitor trimmers C13 and C17 iteratively (again and again) for both a visible audio frequency heterodyne and maximum signal as well. Remove the 145-MHz signal.

Position the start of the baseline sweep precisely at the left most graticule line on the oscilloscope. Turn on the comb generator. Readjust the sweep circuit board adjustments (in the same sequence as before) to progressively locate the spectral lines on subsequent graticule divisions. The sweep offset (R7) and sweep gain (R10) board-mounted controls are used to set the lines from zero to mid-screen (50-MHz) beginning with the 10-MHz component on the first graticule line. The remaining adjustments cover the last 50 MHz. Unlike the earlier rough tuneup, you can now use the segment gain adjustments (R17, R19, R21, and R23) for fine-fitting the entire sweep shape. Work with all the screw adjustments; you can't hurt anything, and you'll observe that sweep alignment goes easily.

If you find that you can't quite hit the highest and/or one or two of the lowest frequencies, note that the HSA will likely not tune below 1-2 MHz. As for the high-end difficulties, try adjusting RF circuit module capacitor C6 in conjunction with re-spacing the loops in inductor L2. The trick is to have a suitable ratio of L and C and enough motion in C (via varactor D1) to cover the band.

Fine tune the HSA using one of the comb generator's spectral lines. The 30-MHz line is good, or an external source can be used. Connect the unused preamplifier output to the oscilloscope vertical input and the trigger output to the oscilloscope trigger input. Power up. Center up the



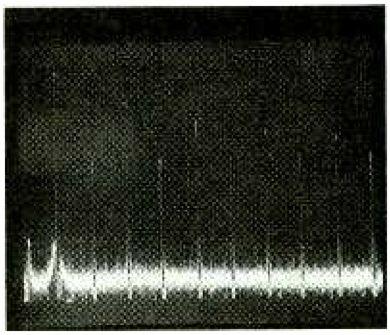

*THE RF CIRCUITS MODULE has two subassemblies—preamplifier and comb generator. Note the partition/shield area in the center that isolates the two sections of 145-MHz bandpass filter. Inductor L4 has a tap on the first turn (bottom in photo) that is difficult to see in this view.*

desired spectral line on the oscilloscope display, and then use the scope magnifier if it has one. You should see a symmetrical heterodyne bubble including a "suck out" at zero beat. Fine tune the IF trimmer capacitors C13 and C17 iteratively for a smooth sharp passband peak with the heterodyne dead center.

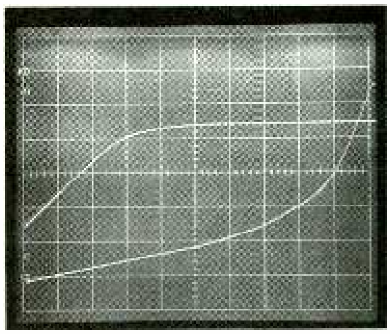
Switch in the IF attenuator and increase signal or oscilloscope gain as necessary to re-display the bubble. It will likely be detuned. Adjust attenuator-compensation capacitor C18 to reshape the display. Note that the bubble should have 1/10 the amplitude of the original signal (it is 20 dB down).

The adjustment of the V+ level is somewhat subjective and somewhat quantitative. Lower voltages reduce the overall HSA gain; the highest values increase it significantly. However, along with higher gains comes more noise, jitter and trash near the baseline. The baseline may also take on an undulating or curvy appearance. Another indication is an unaccounted baseline spike located at about 72 MHz. Setting V+ to a compromise level eliminates all the above unpleasantness and provides for very good operation as well. The prototype's V+ setting is about 5.7 volts.

The spectral line at the 10-MHz position can be used to help adjust HSA amplitude performance. Locate the top of that line on an upper oscilloscope's graticule line at three



*A VIEW OF THE HSA comb generator oscilloscope display after the alignment procedure is completed.*



*THE SWEEP-CIRCUIT OUTPUTS as viewed on an oscilloscope. The lowermost curve is the varactor (sweep) drive waveform—the bottom grid line is 0.0 volts, 5-volts per division. The uppermost waveform is the local-oscillator boost waveform—1-volt/division, top of trace is 4.5 volts. Both curves are displayed on a 1-ms/division time base.*

main graticule divisions up from center face. This is the −30-dBm level. The base-line noise should be down around the third main division below center line (almost six divisions below the signal). Set the IF attenuator to −20 dB. The signal should fall two vertical divisions. If it travels less, increase log amplifier output gain (R28); if it travels more, decrease the gain. Continue the adjustment until the attenuator change and the change in display agree. This calibrates the 10-mV/dB log constant.

Adjust log amplifier input gain (R2) so that logging begins above the base-line noise (positive noise peaks should not appear compressed). In all the steps above, be sure the base-line clipper trimmer (R26) is set to *just* trim off negative going spectral lines and *not* infringe on the magnitude of the base-line noise. Trimmer R26 will require resetting during the above procedures.

With that done, the 30-MHz line should be 10 dB lower than the 10 MHz line. The 50-MHz line should be down 5 more dB. The 70-MHz line should be about 3 dB down from that. Finally, the 90-MHz line should be 21 dB below the 10-MHz line. The latter is the line most likely to be off due to the comb-generator-waveform quality limitations. Finally, pay no attention to the even-order spectral lines; if the comb generator waveform were ideal they would not be present at all.

Frequency flatness is best confirmed with a quality signal source/power meter combination. The rough tuneup of the local oscillator boost given earlier should be fairly good, but if you have access to a flat source you can fine tune the boost function. The adjustments R33 and R30 control boost waveform "zero" and ramp rate respectively. The setting of R35 controls the waveform effect on local oscillator power.

**Hints.** The Hobby Spectrum Analyzer just begins to overload for signals exceeding −30 dBm. This is about 20 mV peak-to-peak on 50-ohm lines. Distortion manifests itself in several ways including baseline "buckling" at the base of such a spectral line, and "splatter" across the display. This situation can often be controlled with the input and/or IF attenuators.

It is sometimes convenient to transformer couple RF energy into the HSA.

*(Continued on page 118)*

# PHONE LINE SENTINEL

***Put an end to phone-call interruptions with the Phone-Line Sentinel—it will let others know when you're on the line.***

**MORDECHAI SAAD**

WE ALL KNOW HOW ANNOYING IT CAN be when you're in the middle of an important phone call and somebody else picks up the line and says "Oh, I didn't know you were on the phone." And it's all the more annoying when they start dialing without first checking for a dial tone. Of course, such an interruption can be devastating to a fax or modem transmission. If you are regularly plagued with such interruptions, then you need one of our Phone-Line Sentinels placed next to every phone in your house. The PC board measures only 1 × 1.8 inches.

## How it works

The nominal voltage of a telephone line, when not in use, is about 50 volts DC. As soon as the line is in use, meaning that a telephone on the line has been picked up, the line drops to about 5 volts DC. Therefore, all we need is a voltage-level sensor to detect whether or not the line is in use. The Phone-Line Sentinel is just that; it monitors the phone-line voltage and lights an LED to let you know when the telephone line is in use.

At the heart of the circuit, shown in Fig. 1, is IC1, an ultra-low-current voltage-level sensor. Using that IC, the circuit draws "no" current (about 5 μA) when the phone line is not in use, and negligible current (about 3 mA) when the line is in use. Power for IC1 is supplied from the phone line via R2, D1, and C1. Transistor Q1, which powers LED1, is driven directly from IC1 whenever the proper voltage level has been detected. Resistor R1 limits the current flow through LED1, and R3, R4, and D2 divide the phone-line voltage down to a proper level for IC1. Protection from phone-line transients is provided by resistor R5 and varistor R6.

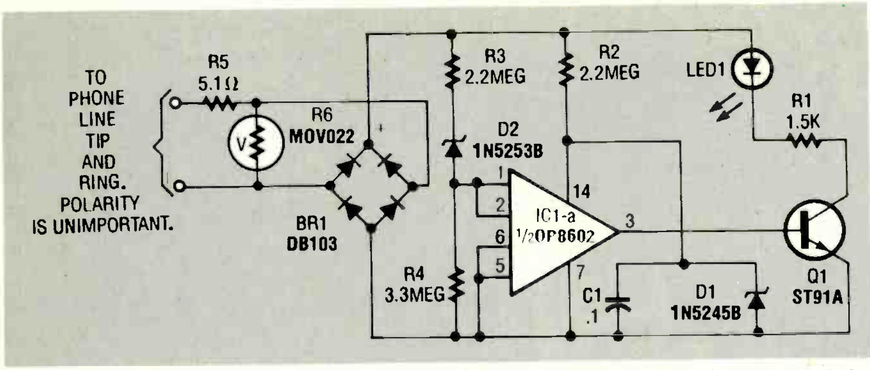



FIG. 1—AT THE HEART of the circuit is an ultra-low-current voltage-level sensor that draws only about 5 μA when the phone line is not in use.

**PARTS LIST**

**All resistors are ¼-watt, 5%.**
R1—1500 ohms
R2, R3—2.2 megohms
R4—3.3 megohms
R5—5.1 ohms
R6—MOV022 varistor
**Capacitors**
C1—0.1 μF, 50 volts, ceramic
**Semiconductors**
IC1—OP8602 ultra-low-current voltage-level sensor
D1—1N5245B 15-volt Zener diode
D2—1N5253B 25-volt Zener diode
BR1—DB103 bridge rectifier
LED1—light-emitting diode
Q1—ST91A NPN transistor
**Miscellaneous:** PC board, modular phone cord or hookup wire, solder, etc.

**Note: The following items are available from TelMore, 11 Market Dr., Syosset, NY 11791: A complete kit, including PC board and all parts in Parts List (above), $14.99. An assembled and tested unit, $19.99. With the assembled units, you must specify which way you want the LED positioned. With the LED pointing straight up, order LIUD-UP; with it pointing to the long side of the board, order LIUD-LS; with it pointing to the short side, order LIUD-SS; and with it mounted off the board on wire leads, order LIUD-W. Add $1.75 for the -W model. Please add $7.50 for shipping and handling to all orders. NY State residents must add appropriate sales tax.**

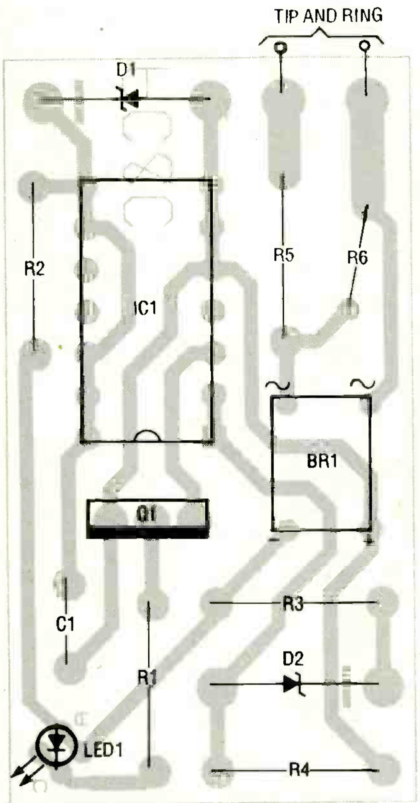



FIG. 2—IF YOU'RE USING A PC board, follow this parts-placement diagram. The LED can be mounted so that it can be bent in any direction, or remain straight up.

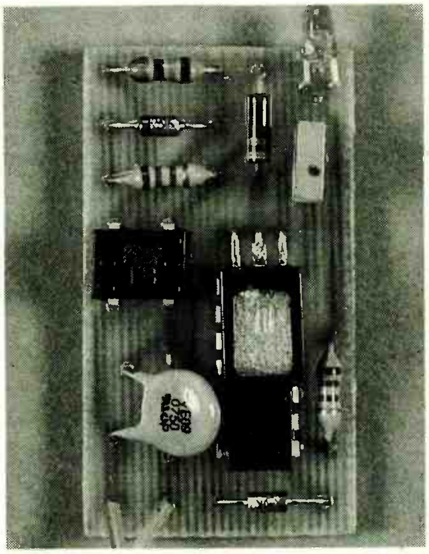
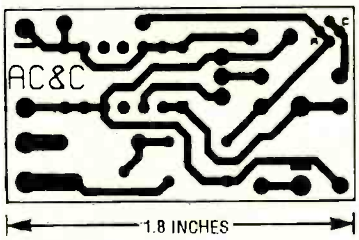


FIG. 3—THE COMPLETED BOARD should look something like this.




USE THIS FOIL PATTERN to make your own PC board.

## Construction

The Phone-Line Sentinel is available as a kit (or completed unit) from the source mentioned in the parts list. However, if you can dig up all of the parts on your own, you can point-to-point wire the circuit, or make your own board from the foil pattern we've provided.

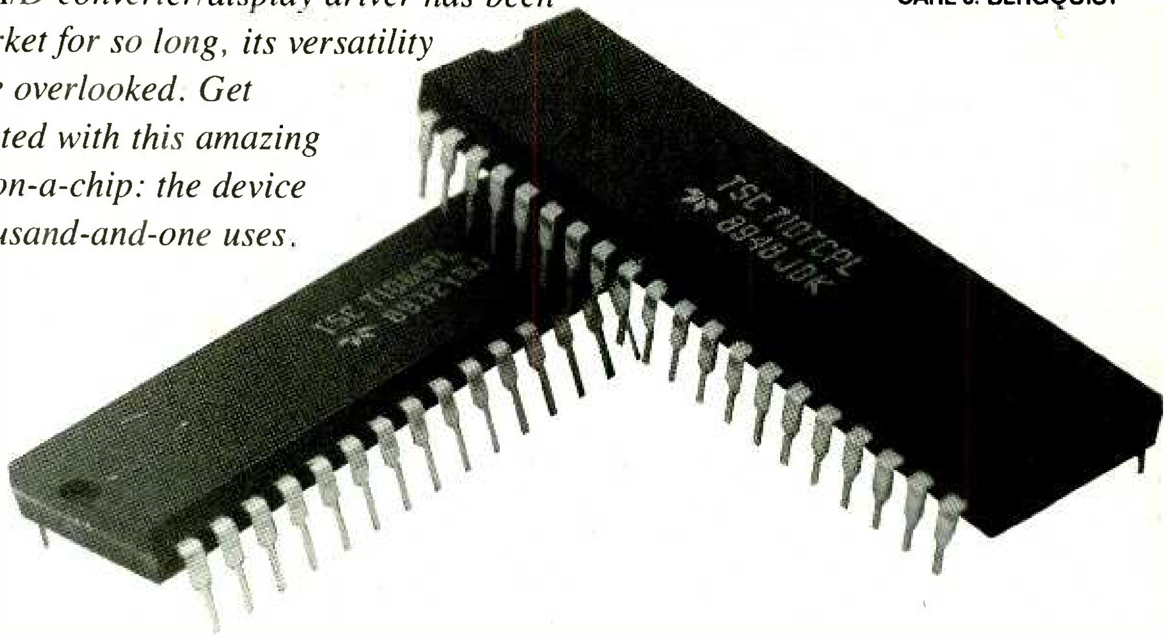
If you're building the circuit using a PC board, simply follow the parts-placement diagram in Fig. 2. If you'll notice, the LED can be mounted on the board in two positions, so that it can be bent in any direction, or remain straight up. You can also mount the LED on leads as long as you like, allowing the board to be hidden from view, or perhaps inside a telephone if there's enough room, leaving only the LED indicator in view. We'll leave the details up to you. Just be sure to observe the LED's polarity on the board regardless of how you install it.

Connecting the unit to a phone line is easy. If you have a spare jack in a desirable location, all you have to do is solder the tip and ring (green and red) wires of a modular phone cord to the board as shown in Fig. 2. Otherwise you can use whatever wire you like and connect it to the line however you see fit. Figure 3 shows the completed board.

Testing the circuit is as simple as using it. Just connect it to the phone line; the LED should be off if the line is on-hook. Then, if you pick up any phone on the line, the LED should light. After the operation of the circuit checks out, it's time to decide what you're going to do with it. Because of the extremely compact size of the board, the neatest thing you can do is mount one inside every phone you own, with only the LED left exposed. If you do a neat job, it will look like it was factory installed. Ω

*The 7107 A/D converter/display driver has been on the market for so long, its versatility tends to be overlooked. Get re-acquainted with this amazing voltmeter-on-a-chip: the device with a thousand-and-one uses.*

CARL J. BERGQUIST




# USING THE 7107

With the invention and introduction of the seven-segment light-emitting diode (LED) display, adding an information display to the front panel of almost any project has become commonplace. Digits are easier to read than analog meters, and tend to "dress up" the appearance of the completed unit.

Those displays, of course, do not light themselves, but rely on logic and driver circuitry to display the desired information. The combination of a binary or decade counter with a decoder/driver is one way to display information on the LEDs, especially in clock applications, but a more versatile method is an analog-to-digital converter.

A number of options are available along that line. Combining a Motorola 14433 3½-digit A/D converter or an RCA CA3162 A/D converter with an RCA CA3161 BCD-to-7-segment decoder/driver chip is one way to go, but for ease of use, low cost, and low component count, it's hard to beat the Intersil/Harris ICL7107/7106 3-½-digit A/D converter/display driver.

Originally designed primarily as a voltmeter, the 7107 is a combination analog-to-digital converter, reference voltage, timing clock, and decoder/driver circuit all on a single CMOS IC. It features high accuracy, low power consumption, and directly drives instrument-sized, common-anode, 7-segment LED displays. The 7106 is the liquid-crystal display (LCD) version of that device and incorporates a backplane driver.

The number of support components needed for operation of the 7107 are minimal: five capacitors, four resistors, a potentiometer, and the display. Add a split five-volt power supply, and the 7107 becomes a complete 3½-digit voltmeter with a full-scale reading of either 200 mV (199.9) or 2 volts (1.999), depending on the values selected for the support components. Another attractive feature is that since both chips have been on the market for several years, their price through catalog distributors has dropped to below four dollars each.

With the basic voltmeter circuit, any measurement, value, or quantity that either exists as a voltage or can be converted to a voltage will provide the input. The 7107 is then easily calibrated to display that measurement or value digitally.

So, the possibilities are limitless. Voltage, current, resistance, inductance, light, temperature, speed, capacitance, frequency, etc., can all be directly displayed through simple transducer circuits. We'll show you how to do that, and armed with that knowledge, it is very convenient to either equip projects and new designs with digital displays, or modernize older gear.

**7107 Circuit Operation.** Figure 1 is the schematic for a basic 2-volt configuration. Power for the chip is applied to pin 21 for ground, pin 26 for −5 volts, and pin 1 for +5 volts. Pins 2–20, and 22–25 connect the device to the LED display, with pin 19 driving the ½ digit, or the leading "1", on the display. Pin 20 indicates when the input voltage drops below 0 volts, so it can be used to drive a minus sign on the display.

Pins 30 and 31 accept the negative and positive inputs, respectively, while pins 35 and 36 handle the reference voltage generated by a resistor-potentiometer divider network. The LO

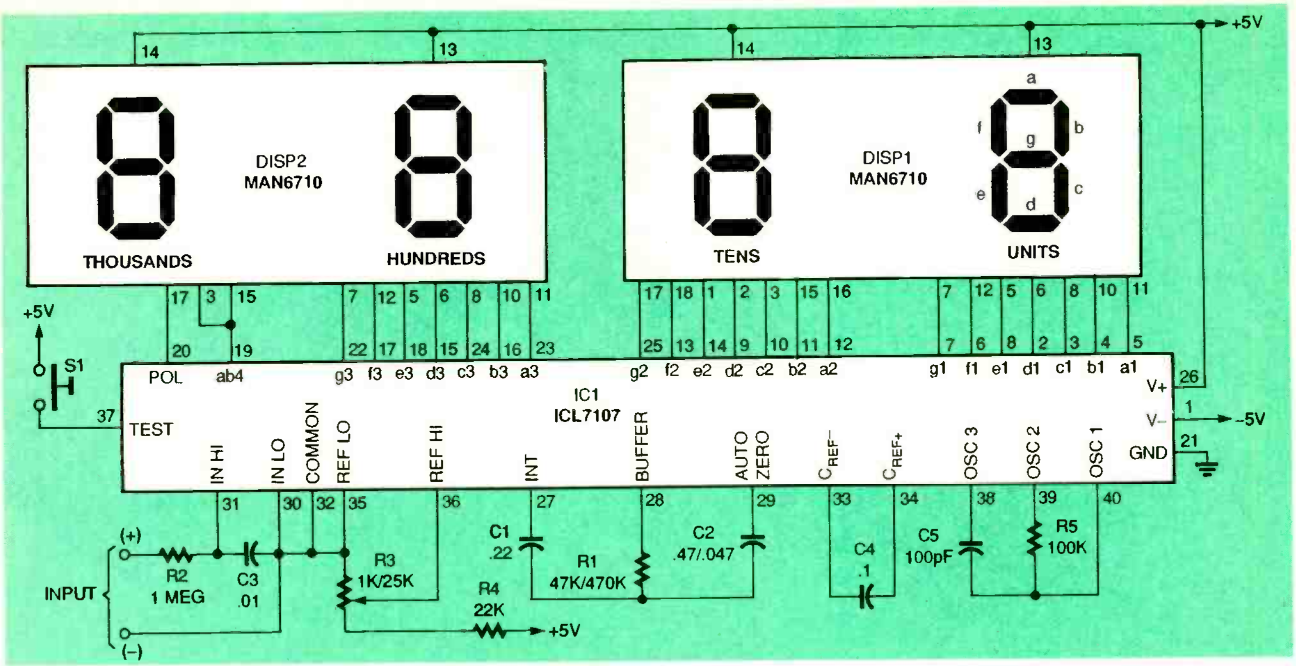



*Fig. 1 The 7107 was originally designed to be a self-contained, highly accurate voltmeter. By changing the values of C2, R1, and R3, the 7107 can have a range of 200-mV or 2 volts.*

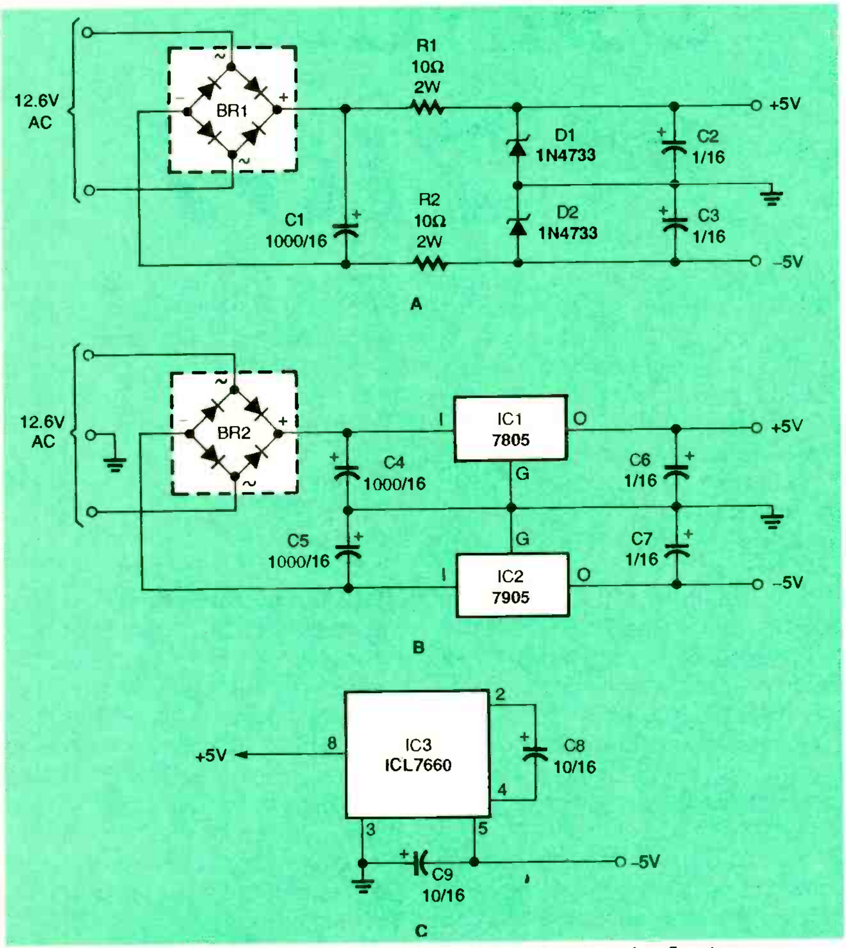



*Fig. 2. Here are a few different methods of generating the + and −5-volt power required by the 7107. A pair of Zener diodes (A) are handy if the transformer you want to use does not have a center tap. A pair of three-terminal regulators (B) and a center-tapped transformer also work well. An interesting alternative is the ICL7660 chip (C), which generates a negative-voltage output from a positive-voltage input.*

reference (pin 35), analog common (pin 32), and negative input (pin 30) are tied together in any application where the input signal is "floating" with respect to the power supply. The analog common also provides the reference voltage for the auto zero feature, which maintains a zero reading for a 0-volt input.

Pins 38, 39, and 40 provide access for the clocking circuit. The recommended values result in a frequency of 48-kHz (3 readings per second), which generally gives excellent performance. If a different frequency is desired, the equation $f = 45/RC$ can be used to find the component values needed. If you keep R at 100,000 ohms, the formula will select the correct value for C. In addition to the RC arrangement, a crystal can be connected between pins 39 and 40, or an external oscillator signal can be fed into pin 40.

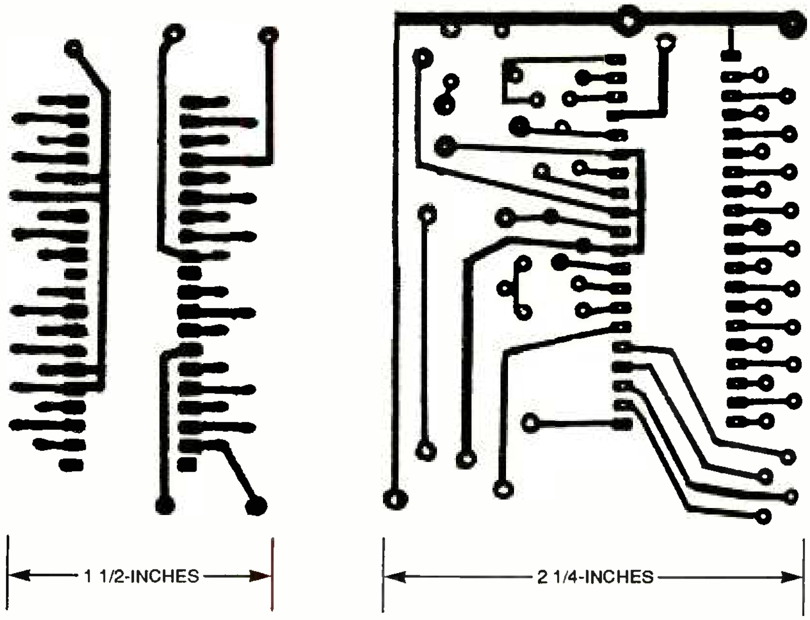
With the exception of R1, C2, and R3, component values are common to both the 200-mV and 2-volt configurations. Resistor R1 provides linearity over the input range. Recommended values are 47,000 ohms for a 200-mV range, and 470,000 ohms for the 2-volt range.

Auto-zeroing capacitor C2 has an effect on noise in the circuit. For the 200-mV scale, a value of 0.47-µF improves noise immunity, while 0.047-µF is adequate for the 2-volt version. That smaller value also improves recovery speed of the circuit. A value of 1,000 ohms for potentiometer R3 in the lower-voltage meter is increased to 25,000 ohms to provide a wider reference range for the higher-voltage meter.

For maximum accuracy and stability, it is best that all capacitors, with the exception of C5, be of the Mylar variety. With its lower dielectric absorption, that type of capacitor will provide superior performance. Capacitor C5 can be a standard ceramic disc or silver-mica type, and all resistors are 5% carbon film.

One disadvantage of the 7107 is the need for a split 5-volt power supply, but there are several simple ways to meet that requirement. If a bench supply is at hand, it usually has +/-5 volts available, either as a separate output or through the use of the adjustable supplies. If that source is not convenient, or a separate self-contained supply is preferred, Fig. 2 shows three different approaches.

In Fig. 2-a, input power from a small step-down transformer is first rectified by bridge rectifier BR1 and smoothed by capacitor C1. A pair of 1N4733 Zener diodes (D1 and D2) regulate the input power to the needed 5 volts.




*Here are the foil patterns for the basic 7107 voltmeter and the LED display. A split power supply and a handful of passive components turn the 7107 into an accurate, easy-to-use instrument. Putting the display on a separate board makes the project more versatile in terms of mounting arrangements. You can also combine both boards into one if you need to.*

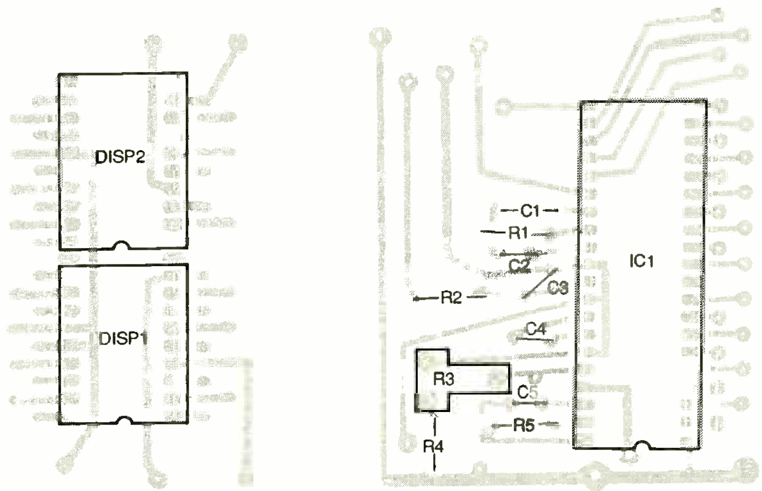



*Fig. 3. If you want to build your own 7107 voltmeter, you can follow the parts placement diagrams here. Using sockets for the 7107 and the displays make troubleshooting easy.*

Actually, the diodes are rated at 5.1 volts, which is well within the 7107's tolerance. Resistors R1 and R2 limit the current that flows through the Zener diodes themselves. The remaining circuitry is a standard "rail" power supply.

Figure 2-b illustrates a similar configuration utilizing positive- and negative-output linear voltage regulator ICs. However, we are using a center-tapped transformer to form a true split power supply. A disadvantage of a center-tapped transformer is the added expense. However, never try to get around that by using a non-center-tapped transformer and connecting one side of the AC input to ground. Although that would work, it would create a "hot" ground· a potentially dangerous situation. Any extra money spent on the proper transformer will be far cheaper then spending several days in a hospital should some component in the circuit fail. Be sure both the 7805 and 7905 voltage regulators have adequate heat sinks.

Figure 2-c uses a voltage-con-

### PARTS LIST FOR THE 7107 VOLTMETER

**SEMICONDUCTORS**

IC1—ICL7107CPL A/D converter/LED display driver, integrated circuit
DISP1, DISP2—dual 7-segment common-anode LED display (MAN6710 or similar)

**RESISTORS**

(All fixed resistors are ¼-watt, 5% units.)
R1—47,000-ohm/470,000-ohm
R2—1-megohm
R3—1000-ohm/25,000-ohm, potentiometer, (see text)
R4—22,000-ohm
R5—100,000-ohm

**CAPACITORS**

C1—0.22-µF, Mylar
C2—0.47-µF/0.047-µF, Mylar (see text)
C3—0.01-µF, Mylar
C4—0.1-µF, Mylar
C5—100-pF, ceramic-disk

**ADDITIONAL PARTS AND MATERIALS**

IC sockets, hookup wire, etc.

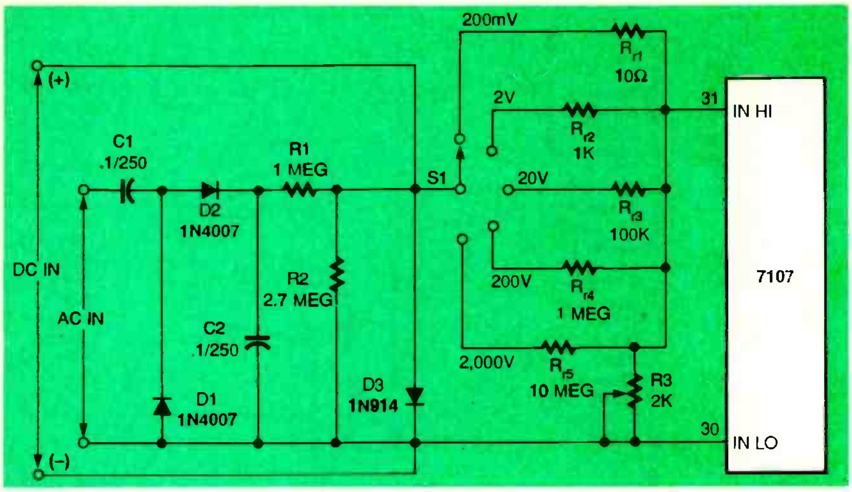



*Fig. 4. Adding this circuit to the 7107 produces a versatile digital voltmeter (DVM). Both AC and DC voltages in five ranges up to 2,000 volts are accurately measured.*

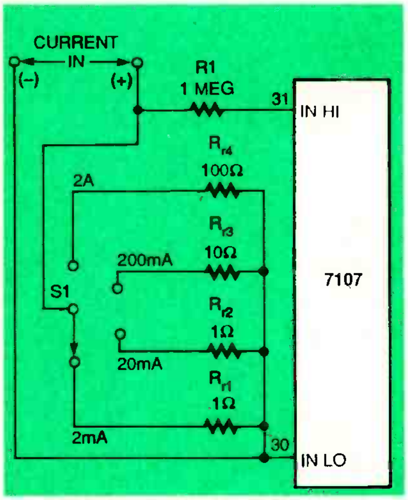



*Fig. 5. With this circuit, the 7107 can measure DC current. The rotary switch lets you select from four ranges, with a capacity up to 2 amps.*

version technique. In that circuit, either the Teledyne TSC7660 or the Intersil/Harris ICL7660 will work. Both are 8-pin DIP packages with identical pinouts. If a 7660 is used, the power supply need only deliver +5 volts. The 7660 converts that input voltage to −5 volts, giving us a split supply.

**Construction of the Basic 7107 Meter.** While breadboard or point-to-point wiring can be used, printed-circuit techniques work best. Foil patterns are included for a printed-circuit board based on the sample circuit in Fig. 1. Separate boards are used for the main circuit and the display. Multicolor ribbon cable works well as hookup wire between the two boards. Keeping the sections separate affords a little more versatility. If you wish, the LED readouts and main circuit can be combined onto one board. It's a simple matter to merge the two patterns together.

Regardless of how you handle your PC boards, use a 40 pin IC sockets for both the 7107 and the LED displays. That makes changing the 7107 or the displays easy if you need to. The parts-placement diagram in Fig. 3 will aid in component insertion at the proper locations. When installing the discrete components, the only orientation to observe is the IC itself, as the capacitors are non-polarized.

Like the display circuit, the power-supply circuit can either be put on the main PC board or kept separate. Convenience or personal preference will, of course, influence which way you decide to go. With all three sections completed and connected together, we can move on to the next step.

**Testing and Operation of the 7107 Meter.** Before installing the 7107 chip itself, confirm that the correct voltages are present at the power supply, and at pins 1, 21, and 26 of the 7107 socket. If a problem is encountered, double-check the wiring and component placement for errors. Once the proper voltages are verified, disconnect the power and plug the 7107 into its socket. Turn the power back on, and the display should read "000".

Apply +5-volts to pin 37, and "−1888" should be displayed. Pin 37 is the test input and activates all segments. A permanent switch can be added if the test function is to be used often. However, do not leave the test on for more than a few minutes if you're using the 7106. The test function on that chip applies straight DC instead of squarewaves to the LCD segments. That might cause the image to "burn" into the LCD.

Apply a known, stable voltage to the + and − inputs. Adjust potentiometer R3 until the display reads that voltage. The meter is now calibrated and ready to go.

Another method of calibration is to read the actual reference voltage at pins 35 (REF LO) and 36 (REF HI). For the 200-mV meter, that reading should be as close to 100 mV as possible. For the 2-volt meter, 1 volt is the needed measurement.

That procedure will also be useful if

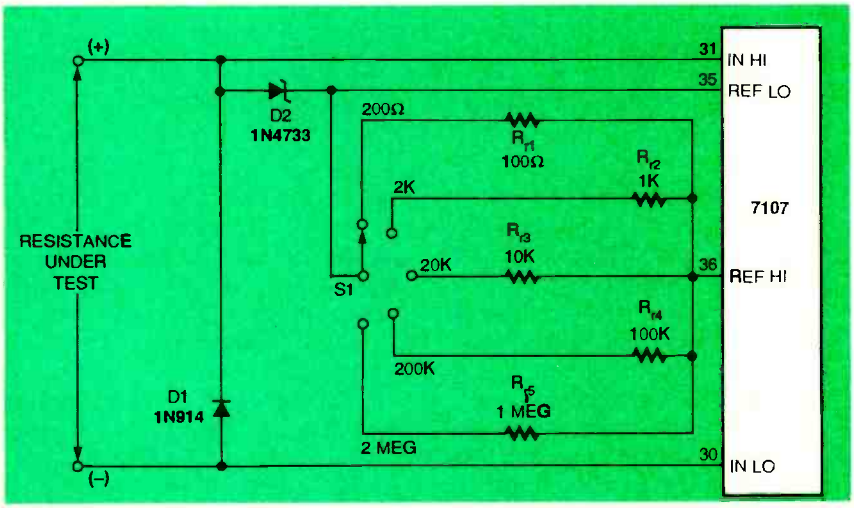



*Fig. 6. Although you could measure resistance with a simple voltage-divider circuit, the use of a Zener diode and a switch-selectable resistor to change the 7107's reference voltage makes it easier to measure resistances up to 2 megohms.*

ormal voltage reference is needed. In some applications where the transducer output is above or below the standard meter parameters, it is easier to adjust the reference voltage to accommodate the transducer, rather than attempt to correct the transducer's output voltage. In any event, always adjust the reference to one half the input voltage.

Additionally, a decimal point can be displayed by hard wiring a 470-ohm resistor from ground to the pole of a four-position rotary switch. With the four contacts connected to the four decimal points on the display, the decimal point can easily be placed wherever it is needed.

**Applications and Input Transducers.** With the basic digital meter built and tested, it's time to put the unit to work. As we mentioned earlier, any value or measurement that is a voltage or can be converted to a voltage can be displayed, but only if we connect what we need to measure to the meter properly. That is where the input circuits and transducers come into play.

**Voltage Measurements.** Since the 7107 is a voltage-measuring device, let's look at that application first. Figure 4 is a circuit for a digital voltmeter (DVM) that will measure voltages from 0 to 2,000 volts in five ranges. The circuit can measure both alternating and direct current, with C1, C2, D1, D2, R1, and R2 acting as a rectifier/filter for AC measurement. Resistors $R_{rx}$ and R3 form a selectable input-voltage divider. Rotary switch S1 connects any one of the five resistors, $R_{r1}$–$R_{r5}$, for the selected voltage range.

Once that input circuit has been connected to the 7107, choose a known voltage source, either AC or DC. Select the appropriate range with S1, and adjust R3 to obtain a display that matches the known source. That will fine-tune the circuit for future voltage measurements.

**Current Measurements.** The next basic measurement to consider is current. We do that by passing the current through a shunt resistor. The shunt develops a voltage across itself in proportion to the amount of current flowing through it. That voltage can be measured by the 7107 meter.

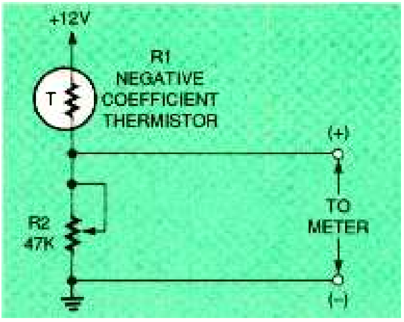



*Fig. 7 A simple voltage-divider circuit using a negative-temperature-coefficient (NTC) thermistor is a low-cost and accurate method of measuring temperature with the 7107. An NTC thermistor's resistance drops as its temperature rises. If you switch the locations of R1 and R2, the reading on the 7107 will drop with rising temperature.*

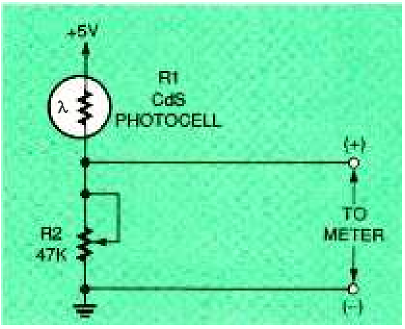



*Fig. 8. We can measure light intensity the same way we measure temperature by substituting a cadmium-sulfide (CdS) photocell for the thermistor in Fig. 7. In most CdS photocells, resistance will drop with an increase in brightness. Should you need to have the 7107's display reading drop as the photocell gets brighter, or if you have a photocell that increases in resistance with exposure to light, simply switch the positions of R1 and R2.*

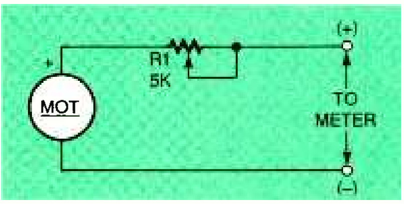



*Fig. 9. You can use a small permanent-magnet motor as a tachometer. Attach the motor's armature to whatever spinning shaft you want to measure, and the voltage generated by the motor can be read directly by the 7107.*

Figure 5 is the schematic of a four-range system, where $R_{r1}$-$R_{r4}$ controls the range and acts as the shunt. Resistors R1 and $R_{r1}$–$R_{r4}$ form a voltage divider that provides the input for the meter. A rotary switch arrangement similar to the range selector in Fig. 4 works nicely for the ammeter as well. The values for the shunt resistor are selected by S1. Using 1% precision metal-film resistors gives the greatest accuracy.

**Resistance Measurements.** The last type of value commonly measured by most digital multimeters (DMMs) is resistance, and Fig. 6 illustrates a method for that. Zener diode D2 develops an external reference voltage, allowing S1 to select one of $R_{r1}$–$R_{r5}$ to control the on-chip reference voltage. A DC voltage is generated across the unknown resistance, and that value is then processed by the 7107 and displayed.

That measurement could also be done with a standard voltage-divider circuit, but the problem with that method is that $R_{r5}$ would have to be in the 500-megohm range for the 200,000- to 2-megohm setting. That is a difficult value to obtain, especially at precision levels. Adjusting the reference voltage results in a workable value for $R_{r1}$–$R_{r5}$.

**Temperature Transducer.** There are a number of ways to measure temperature. Figure 7 is a simple and surprisingly accurate method. In that configuration, a 47,000-ohm potentiometer provides as calibration, and a negative-temperature-coefficient (NTC) thermistor acts as the temperature probe. By applying 12 volts and setting the decimal point on the display between the units and tens digit, readings to an accuracy of 1⁄10° can be achieved. Again, the circuit is a voltage divider.

**Light Measurement Transducer.** The light transducer in Fig. 8 is almost identical to the temperature sensor. The only differences are a 5-volt supply voltage and the use of a cadmium-sulfide (CdS) photocell in place of the thermistor. Changes in ambient light shining on the photocell changes the resistance of the cell. That in turn changes the voltage produced by the divider. Any change in light intensity will be shown in the display. The display can be calibrated to indicate "*f*-stops" for photography work, or can be an arbitrary numerical value for which a chart or graph

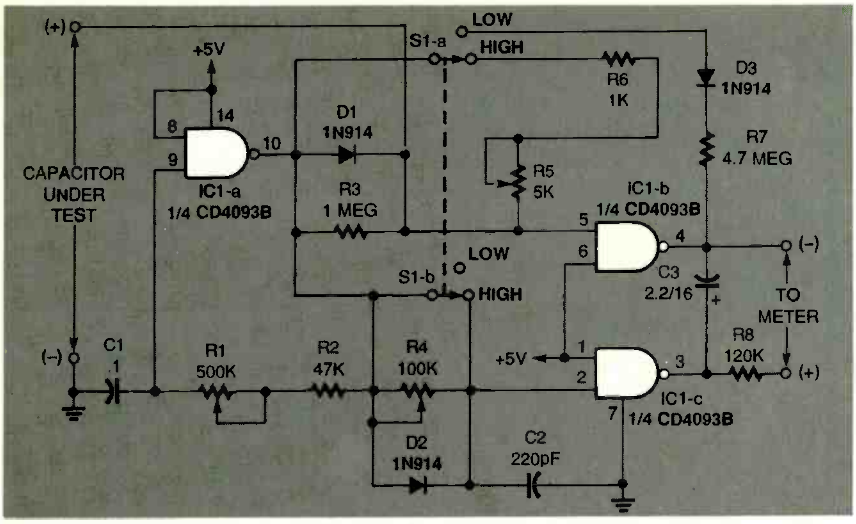



*Fig. 10. With this circuit, the 7107 gains the ability to measure the value of capacitors from 2 pF to 2 µF. Potentiometer R4 adjusts the circuit for a zero reading, while R1 and R5 calibrate the low and high ranges.*

can be developed as appropriate. By using a photocell with a range of 500-ohms illuminated to 2- to 3-megohms dark, very sensitive results can be achieved with the circuit.

Those two circuits illustrate how any device that changes resistance due to any circumstance can be plugged into the divider network. You can try replacing the CdS photocell with a 1,000-ohm potentiometer. After calibrating with the 47,000-ohm variable resistor, the exact value of the potentiometer between 0 and 1,000 ohms will be displayed.

**Speed Measurements.** Figure 9 shows a method of measuring rotary speed. Since the 7107 is a voltmeter, and electromagnetic motors produce a voltage when their armatures are rotated, the measurement circuit is extremely simple. A 5,000-ohm potentiometer is used for calibration, with one end connected to the positive motor pole, and the other tied to the HI input (pin 31). The negative side of the motor goes to the LO input (pin 30). When the motor shaft is coupled to a rotating object, the voltage developed is proportional to the speed of rotation. That system can be used for tachometers, wind-speed indicators, generator-voltage monitors, and the like.

**Capacitance Meter.** One of the most useful bench tools around is the digital capacitance meter. Those meters will save not only time, but money as well. Surplus capacitors are often sold by the pound at a greatly reduced price, but due to factory marking, or no marking at all, it can be hard to determine the values of those. A capacitance meter solves the problem, but most commercial meters are relatively expensive.

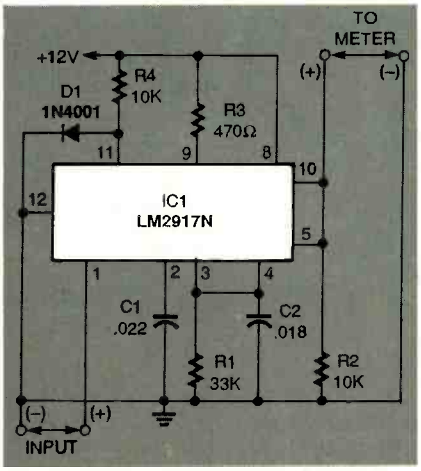



*Fig. 11 Adding an LM2917 to the 7107's inputs lets you measure lower frequencies up to about 10 kHz.*

Figure 10 is the schematic for a unit that makes use of a 4093 quad 2-input NAND Schmitt trigger, and will measure capacitors from 2 pF to 2 µF in two ranges. The low setting handles 2 to 1,000 pF, while the high setting is for capacitor values from 0.001 to 2 µF. The circuit hooks up directly to the 7107.

Once connected to the 7107, calibration is simple. Turn the unit on and adjust R4 for a zero reading. With S1 in the low setting, connect a 100-pF capacitor to the test leads, and adjust R1 for a reading of "0100". Then switch S1 to the high setting, and with a 1-µF capacitor connected to the test leads, adjust R5 for a "1000" display. With that done, the meter is now ready to test and measure capacitors within the meter's range.

It is a good idea to conduct those last two steps with several known capacitors to fine-tune the calibration. While not shown in the schematic, it is common practice when using CMOS-technology ICs to connect the inputs of any unused logic gates (*e.g.*, pins 11 and 12 of IC1) to either ground or the positive voltage. That will reduce power consumption and interference. On a final note, be sure the +5-volt supply is well regulated to maintain accuracy.

**Frequency Measurements.** Figure 11 uses the LM2917N frequency-to-voltage converter in a standard configuration. That device is a simple and inexpensive way of displaying frequency with the 7107. The 2907/2917 series was originally designed for tachometer systems, and is limited to frequencies from DC to about 10,000

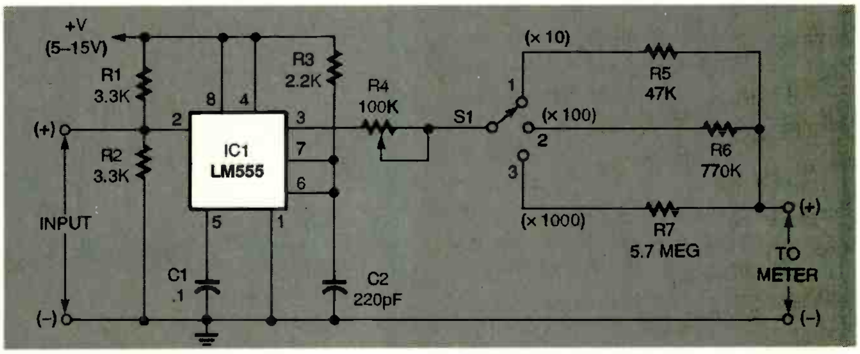



*Fig. 12 To measure higher frequencies than the LM2917 can handle, this circuit does the job quite well. Frequencies in 3 ranges up to 2 MHz (1.999 x 1000) can be measured.*

(Continued on page 79)

BY DON LANCASTER

# Understanding Digital Filters, Using Your Time Profitably, and More

I RECENTLY GOT A HELPLINE CALL FROM SOMEONE WHO STRONGLY FEELS THAT THEY HAVE ONCE AND FOR ALL SOLVED THE CELLULAR-PHONE FRAUD PROBLEM. THAT SOLUTION WAS BASED ON THE USE OF HIS ELEGANT SYSTEM-software modification. The question was how to profitably market the concept. Well, maybe, or maybe not.

Without a closer look, and even if it did not have any obvious or hidden flaws, the chances are that this caller's simple solution would only further escalate the cell wars a notch. But that's not the problem.

The problem is that certain things can be sold by small-scale start-ups or independent individuals, while some can not. Whenever you come up with what you think is a solution to an industry problem, it seems to me that there are three key questions you should ask:

• **Are you an industry insider?** Do you aggressively subscribe to all the field's trade journals, read its books, attend its shows, and network with its experts? Do you thoroughly *grok* the fundamental technical and marketing principles of the industry?

If not, the odds are overwhelming that you're developing a non-solution to a non-problem. You probably do not possess the skills or the tools to even understand the real problem, let alone correct it. And that the "gotchas" here are certain to "git ya."

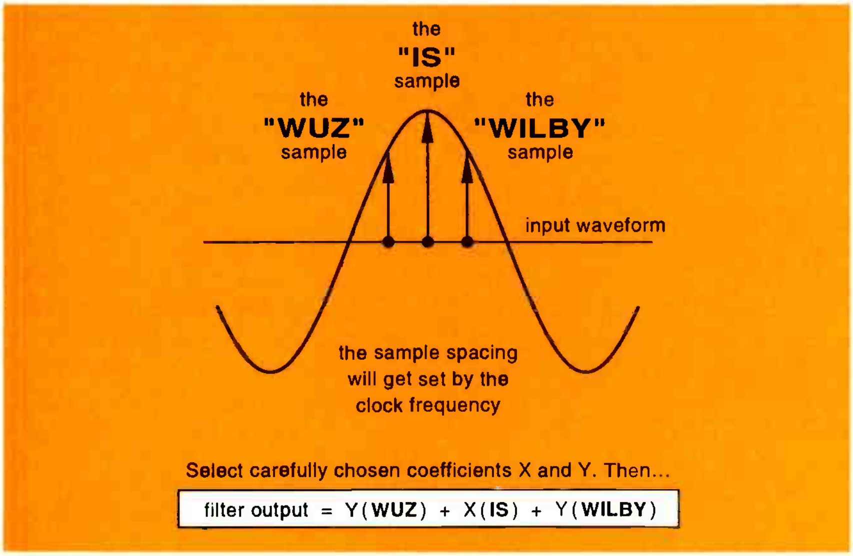



**FIG. 1**—THE "TRISAMP" is a useful building block that can let you understand, design, test, debug, and apply digital filters.

• **Does the field welcome innovation?** If the industry 1) has areas that are highly regulated; 2) has a complex infrastructure; 3) is controlled from a solidly entrenched oligopoly; or 4) requires major changes for your concept to fly, it is not a reasonable place for you to be spending your time and effort. Also, avoid investing time in fields populated by lawyers eager to eat innovators for lunch, or one that is subject to lawsuits, etc.

• **Can you sell six of them?** Your best concepts are those you can sell to real people who have real wallets in their back pockets, with real credit cards in them. If you cannot sell a few of your designs to your friends, there is no way you will ever sell lots of them to your enemies.

Let's look at some "for instances:" If reasonably priced, your improved laptop battery would be instantly gobbled up as a sure-fire winner. But that very same battery technology for an electric car is pretty near certain to get ruthlessly stomped upon.

A new personal-airplane design is guaranteed to bankrupt you—every time. But a variant sold as a quarter-sized R/C model kit could be a very popular product, especially when it doubles as a video platform.

More to the point: A snap-on accessory that an end-user can attach to a phone to eliminate cellular fraud is workable. But fundamental changes in the cellular standards and distribution are not. At least not for most small scale startups or outside individuals.

Sure, it's real difficult not to get excited about a new concept. Long ago, I allowed low-pressure pneumatic

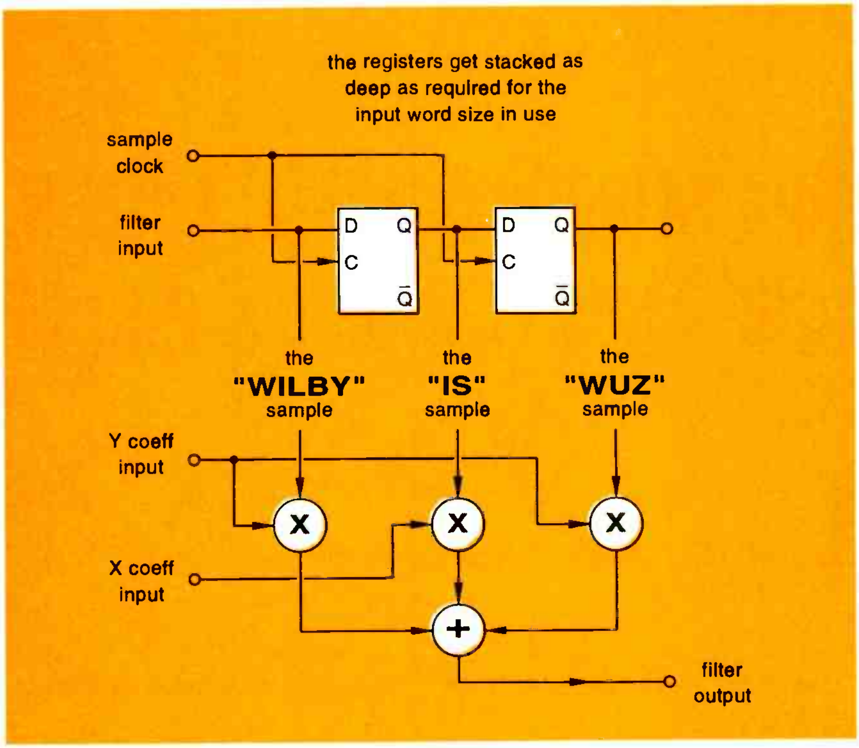



FIG. 2—DIGITAL FILTERS can be much more powerful than analog ones because they can look both forward and backward in time. The need for a "time machine" is avoided by using the shift-register scheme shown here.

robotics to gobble up all sorts of time and resources. And my magic sinewave development is currently using as much as twenty hours a day of my time. But, as hard as it is to do, you must focus on stuff that is technically challenging and still marketable by a small scale start-up if you are to be successful. Asking the fundamental questions outlined above ahead of time can save you lots of hours and grief and lets you focus your time and energy in better directions.

For much more on all this, see my *Case Against Patents* package, WHEN2PAT.PDF on www.tinaja.com, and, of course, my *Incredible Secret Money Machine*.

## Digital Filters

Most books on digital filters seem excessively and unnecessarily arcane to me. This month, let's instead try a totally different and off-the-wall approach.

A filter is just some frequency-selective network that is designed to favor certain frequencies over others. It is usually used to isolate a desired signal or to improve the signal-to-noise ratio of a system. For example, the treble control on your hi-fi is a low-pass filter, the bass control is a high-pass filter, and AM radio tuning uses a bandpass filter.

Traditional filters were originally built with capacitors and inductors. Many of those were replaced long ago by active filters—combinations of resistors, capacitors, and op-amps that exactly fake inductors. You can find more details on that in my *Active Filter Cookbook*.

In contrast, a digital filter takes an existing pile of numbers and runs multiply-and-add calculations upon them to create a new pile of numbers whose behavior will, we hope, be "better" in some way or another than the original. For instance, a stream of digital video can become digitally high-pass filtered to improve its sharpness, or low-pass filtered for softening or to eliminate slanted "jaggies".

## Plus and Minus

There are bunches of advantages to digital filters. First and foremost, a well designed digital filter is always "correct" and never needs "tuning". A digital filter could easily be adjusted over an incredibly wide range using software. Digital filters can often be swept without any nasty transients.

Special circuitry could be totally eliminated if the digital filtering gets done inside a stock microprocessor or a DSP digital signal processor.

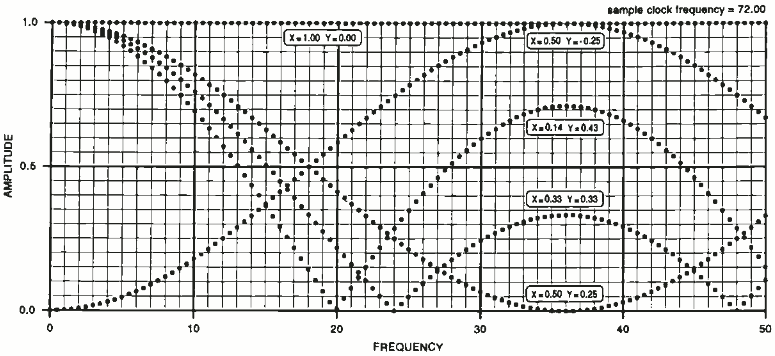



**FIG. 3**—HOW A TRISAMP'S FREQUENCY RESPONSE varies when its X and Y coefficients are changed.

Best of all, a digital filter can do certain tasks that end up being difficult or impossible when using classic analog designs. For one thing, in a sense, they can look forward and backward in time. That is, unlike capacitors and inductors, they can react to currents and voltages that are yet to happen; classic analog components can only react to things that have already occurred.

Examples here include "brick-wall" filters with extremely sharp cutoffs and linear-phase filters that attenuate a waveform's harmonics without any time-shifting distortion.

There are also disadvantages and limitations to digital filters. While they are a lot simpler than some may have you believe, they still are rather hard to understand.

You do already have to have your pile of numbers before you can filter them. Thus, A/D and D/A conversion might be needed in your system.

There is a really ugly property of digital filters called aliasing. If you sample any waveform less than twice per cycle, you might "fold over" and generate lower-frequency noise and artifacts. Very rarely, aliasing can be a valuable tool, one that lets you do digital mixing, downsampling, or a downconversion. But far more often, aliasing is a major nuisance that must be dealt with by prefiltering.

Here's a rule to follow when working with digital filters: Input signals to a digital filter must get prefiltered so that zero energy exists above one-half of your sample frequency. That is, unless you have some really good reason to be doing otherwise!

The dynamic range of any digital filter is limited by several factors. Those include your input and output word sizes, truncation errors, and any round-off errors.

Because you are often adding up very small differences between large values, the internal word size usually has to be much larger than that of the input or output. Thus, digital filters are much more suited to larger input signals than to very small ones.

Simpler digital filters apply integer math or fixed-point arithmetic. Such filters are faster and easier to implement, but have reduced dynamic range.

Exotic digital filters can use a full floating-point processing for all their math. While more accurate, floating-point filters often run much slower, either restricting the maximum input frequency or forcing you to move to non-real-time applications.

Finally, if your filter only works with a small number of samples, you might get into some ugly windowing problems. Softening the edges of a window or making sure that the edges happen where they don't cause problems are two possible cures. Watch out for that windowing detail, or it will nail you every time.

## Trisamp Building Blocks

My approach in the *Active Filter Cookbook* was to use a basic analog building block called a second-order section. No matter how exotic your filter response, all you really ended up with was a pile of those cascaded sections. And each section only had two possible adjustments—the cutoff frequency and its damping.

Let's try something similar here. I'll call our basic building block a "trisamp," and it is shown in Fig. 1. Just as you can use and cascade second order analog sections, you can use and cascade trisamps.

A trisamp gathers in three samples of a waveform. Which I will call "wuz," "is," and "wilby." It then scales them and adds them all together by using this fairly simple rule:

output = Y(was) + X(is) + Y(wilby)

Since a digital filter is a linear type of "thingy," it should not matter what frequency or what phase we use for our analysis. Thus, we can apply just one frequency at a time to determine our overall response and arbitrarily pick an "is" phase of 90 degrees.

For a single-frequency sinewave input, your output should be a scaled amplitude clone of your input. The output will be larger or smaller than the input, depending on the values and signs of X and Y, and upon the ratio of your input frequency to the sample-rate clock.

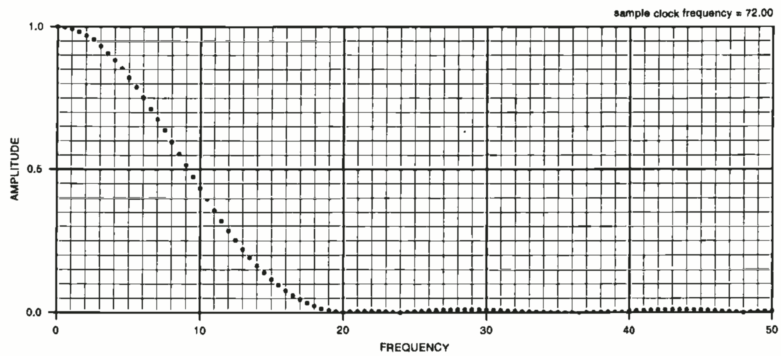



**FIG. 4**—A LOW-PASS FILTER built by cascading three trisamps. This is a "distortionless" or linear-phase filter that is extremely difficult to build using older analog techniques. To simplify your final design, using ordinary algebra easily reduces three cascaded trisamps into a single, seven-sample "septsamp." Additional samples improve response shape.

```
% PostScript triple cascaded trisamp digital filter designer v 2.04

% Copyright c 1996 by Don Lancaster and Synergetics, Box 809, Thatcher, AZ
% 85552 (520) 428-4073 http://www.tinaja.com All commercial rights and all
% electronic media rights are fully reserved. Reposting is expressly forbidden.

% For best results, improve with Guru Gonzo PostScript utilities. Enhanced and
% fully annotated version available as TRISAMP.PS on www.tinaja.com

% draw a graph:
110 350 translate 8 dup scale 0.03 setlinewidth 1 setlinecap gsave 0 0 moveto 51
{0 0 moveto 0 20 rlineto 1 0 translate} repeat stroke grestore gsave 0 0 moveto 21
{0 0 moveto 50 0 rlineto 0 1 translate} repeat stroke grestore 0.12 setlinewidth
gsave 3 { -0.5 0 moveto 50.5 0 rlineto 0 10 translate} repeat stroke grestore gsave
6 { 0 -0.5 moveto 0 20.5 rlineto 10 0 translate} repeat stroke grestore

/dot { newpath 0.150 0 360 arc fill } def % dot utility

/tripletrisamp {0 0.5 50 {/freq exch store 180 freq mul sampfreq 2 div div cos
coeffB mul 2 mul coeffA add /firsthold exch store firsthold abs 20 mul freq exch
dot 180 freq mul sampfreq 2 div div cos coeffD mul 2 mul coeffC add /secondhold
exch store secondhold abs 20 mul freq exch dot 180 freq mul sampfreq 2 div div
cos coeffF mul 2 mul coeffE add coeffC coeffD 2 mul add div /thirdhold exch store
thirdhold abs 20 mul freq exch dot firsthold secondhold mul thirdhold mul abs 20
mul freq exch dot} for} def

% ///// demo - remove or alter before reuse. /////

/sampfreq 72 def                % set sample clock frequency

/coeffA 2.0 4 div def           % center of first trisamp
/coeffB 1.0 4 div def           % pair
/coeffC 1.0 3 div def           % center of second trisamp
/coeffD 1.0 3 div def           % pair
/coeffE 1.0 7 div def           % center of third trisamp
/coeffF 3.0 7 div def           % pair

tripletrisamp showpage quit     % do it and flaunt it
```

**FIG. 5**—THIS POSTSCRIPT TRIPLE TRISAMP exploration utility could make you an instant digital-filter-design expert. The code shown here can be easily expanded.

The X and Y values are known as coefficients. And while you could select different coefficients for "was" and "wilby," that change would add or remove time delay to your response.

Forcing the coefficients for "was" and "wilby" to always be identical can give you the class of "distortionless" filters known as linear-phase filters. Those are especially significant for data communications applications, and can be extremely difficult to do when using the older and more traditional analog design methods.

Which leaves dealing with . . . .

## Negative Time?

So how *do* you find out who "wilby" is without a time-travel machine?

Simply look one stage previous in the shift register scheme of Fig. 2, or access one sample address earlier in a memory data bank. This is sort of the same way any vertically delayed scope lets you look at the waveform edge you have just triggered on.

Let's look at the responses we can expect from a trisamp as we vary its coefficients and the input frequency. Naturally, I prefer to use the superb PostScript general purpose computer language for this. I will use 72 clock samples per fundamental cycle.

Figure 3 shows you several trisamp responses. Positive Y values result in low-pass shapes and negative Y values result in band-pass shapes. Also, in general, the overall peak gain is set by the absolute value of the sum of X and Y. Gains near unity are often used to keep the results from getting too large or disappearing entirely.

For instance, a Y value of zero and an X value of one simply copies the peak value to the output for a flat or an all pass response. Next, consider Y = 0.25 and X = 0.50. At low frequencies, "wuz," "is," and "wilby" are nearly on top of each other, so they pretty much sum to 1.0 and give us nearly unity gain.

But at the frequency whose time period equals exactly 36 clock cycles, an interesting result happens. "Wuz" and "wilby" end up on negative cycle peaks, and "is" sits on a positive cycle peak. In other words, they sum to zero!

Other X and Y coefficients create the shapes shown. By themselves, those shapes may be interesting. But they aren't all that useful. So, to get useful response shapes, you must cascade your trisamps.

Figure 4 shows a highly desirable linear-phase, low-pass filter made by cascading the three trisamps shown. Note the excellent stopband response. And the modest droop in the passband is fairly typical of linear-phase filters. Most important, there is zero excess phase shift to higher frequency harmonics. That property is very important in telecomm filters and for wave analysis.

Yes, you can easily re-graph this result in semi-log frequency-vs.-decibels for a more traditional-appearing, classic response plot. Among other features, that re-plot would make the stopband zeros more obvious.

Actually, nobody really cascades trisamps. Go through some simple algebra and you can quickly prove that any two cascaded trisamps are the same as a five-coefficient filter. And three cascaded trisamps are the same as a seven-coefficient filter. So you apply a pentsamp or a septsamp instead. All digital filtering amounts to is finding the right coefficients to use for the result you are after.

PostScript code to do a seven-coefficient filter made from three cascaded trisamps is shown in Fig. 5. You could easily use that routine to explore fancier digital-filter response shapes on your own. Just modify the coefficients with your favorite word processor or editor. Then send it to GhostScript or route it to almost any PostScript printer.

Lots more PostScript-as-language details are found on www.tinaja.com For an amazing range of applications, PostScript can completely blow away the more traditional general purpose computer languages.

Incidentally, more coefficients are normally chosen for fancier shapes.

# *Plug a Friend into*

# Electronics NOW®

# *and Save $26.03**

***This Christmas give an electrifying gift ... plug a friend into Electronics Now and brighten the whole new year! Whether electronics is your friend's livelihood or hobby, your gift will illuminate the whole spectrum of electronics throughout the coming year and provide a monthly reminder of your friendship.***

Electronics Now will keep your friend informed and up-to-date with new ideas and innovations in all areas of electronics technology ... computers, video, radio, stereo, solid-state devices, satellite TV, medical electronics, communications, robotics, and much, much more.

We'll provide great plans and printed circuit patterns for great electronic projects. In just the last few years, Electronics Now has presented amateur TV equipment, robots, computer peripherals, microcontroller programmers, test equipment, audio amplifiers, telephone projects, relay circuits, and much more.

PLUS ... equipment troubleshooting techniques ... circuit design ... reports on new technology and products ... equipment test reports ... in-depth coverage on computers, video, audio, vintage radio ... and lots more exciting features and articles.

*Basic sub rate — 1 yr/$19.97 2 yrs/$38.97

SAVE $26.03* ... OR EVEN $52.06* ... For each gift of Electronics Now you give this Christmas, you save a full $26.03* off the newsstand price. And as a gift donor, you're entitled to start or extend your own subscription at the same Special Holiday Gift Rate—you save an additional $26.03*!

No need to send money ... if you prefer, we'll hold the bill till January, 1997. But you must rush the attached Gift Certificate to us to allow time to process your order and send a handsome gift announcement card, signed with your name, in time for Christmas.

So do it now ... take just a moment to fill in the names of a friend or two and mail the Gift Certificate to us in its attached, postage-paid reply envelope. That's all it takes to plug your friends into a whole year of exciting projects and new ideas in Electronics Now!

## Names and Numbers

**American Institute of Organbuilders**
PO Box 130982
Houston, TX 77219
(713) 529-2212

**Clement Engineering**
PO Box 1086
Severna Park, MD 21146
(410) 268-6736

**Compu-Mart**
899 Presidential, Ste. 110
Richardson, TX 75081
(800) 864-1155

**Dukane Ultrasonics**
2900 Dukane Drive
St Charles, IL 60174
(708) 584-2300

**Genesis Microchip**
2111 Landings Drive
Mountain View, CA 94043
(415) 428-4277

**Harris Semiconductor**
Box 883
Melbourne, FL 32902
(407) 724-7000

**ICT**
2123 Ringwood Avenue
San Jose, CA 95131
(408) 434-0678

**Mitel**
2321 Morena Blvd., #M
San Diego, CA 92110
(619) 276-3421

**Qualcomm Inc**
6455 Lusk Blvd.
San Diego, CA 92121
(619) 587-1121

**Redmond Cable**
15331 NE 90th Street
Redmond, WA 98052
(206) 882-2009

**Schott**
3 Odell Plaza
Yonkers, NY 10701
(914) 968-8900

**Seagate**
920 Disc Drive
Scotts Valley, CA 95066
(408) 438-6550

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

**Thomson CFS**
40G Commerce Way
Totowa, NJ 07511
(201) 812-9000

**Wale Apparatus**
400 Front Street
Hellertown, PA 18055
(800) 334-WALE

**Western Reserve Games**
21651 Tungsten Road
Euclid, OH 44117
(800) 531-1230

Typical hardware building-block chips offer four coefficients each. Those can get cascaded "wide" to handle twelve to sixteen or more coefficients. Or, they can be cascaded "deep" to handle the number of bits in a fixed-point word. Harris and Qualcomm are two big sources for these dedicated chips, but you can easily do the same thing with a PIC microprocessor.

I've been using digital filters as an important part of my magic-sinewave research. Magic sinewaves are my brand new way for simplifying and dramatically improving the efficiency of such products as variable-speed induction-motor drives, solar panels, and electric cars. You can find a lot more about them and all the new research opportunities they present on my Magic Sinewave shelf, which is in the www.tinaja.com reference library.

### 5SiMX Hard Drives

As we saw a couple of months or so ago, the Hewlett-Packard *5SiMX* is an ideal mid-range PostScript laser printer, one well suited to book-on-demand publishing. Its many features include genuine Adobe PostScript Level II , 24 pages-per-minute print speed, a page-flipping duplexer, 11 × 17 capability, refillable toner cartridges (offering excellent economics), 600 DPI resolution, and photo halftone enhancements; and all the service manuals and parts are readily available.

It also has, at least in theory, a hard disk.

Scant few printer users appreciate how absolutely crucial a local hard disk is for a PostScript printer (though Apple and QMS have had them for years). First, your hard disk lets you store lots of fonts. Second, it lets you stash all of your book-on-demand files so you'll never have to tie up a network resending them. That same storage lets you do a run unattended for overnight BOD publishing.

The same goes in spades for often-used forms or patterns. When a diskless PostScript printer is first turned on, all of those needed font bitmaps have to be laboriously built up into a font cache. Your first few printouts (and anything "new" after that) will always be very slow.

A local hard disk instead saves a font cache for you. There is normally not any speed-difference slowdown on your first few files.

Hard disks are also real useful for PostScript-as-language apps where they can serve as your primary I/O. They are also quite handy to log what is coming into your printer, to solve interface hassles, to convert formats, or to grab otherwise inaccessible data or commands. Once you have used a PostScript printer that offers a hard disk, it is unthinkable to ever again so much as walk through a room housing a printer that lacks one.

The only tiny 5SiMX problem is that the HP disk drive has been undeliverable—and it appears permanently so now as HP has gone completely out of the hard-drive business. Well, it turns out you can easily substitute your own hard drive—for as little as $35—after you know and understand a few simple things.

Let's excerpt some key info from the HPs *LaserJet 5SiMX Developer's Quick Reference Guide:*

"The standard 2½-inch ATA IDE disk drive interface is supported. (ATA stands for 'AT Attachment, as in the IBM PC-AT bus. And IDE stands for Intelligent Drive Electronics.) This printer is designed to allow these drives to be mounted directly to the formatter board.

"The disk drive attaches to four standoffs. It is electrically connected via a ribbon cable.

"The Seagate ST9420AG is the disk that has been qualified to work in the LaserJet 5SiMx printer."

The developer's guide is available through HP Developers. My favorite source for custom cables is Redmond Cable. The oddball 2-millimeter bulk ribbon cable and connectors are sold by Digi-Key or Mouser (this is sometimes called a mini-IDE or "European" cable).

Bargain drives often show up in *Compu-Mart*, *Computer Hot Line*, and similar publications. Note that non-Seagate drives may be larger and have different mounting holes. Older and larger 3½-inch drives are most likely not worth the hassle. Besides needing excess supply current, their larger pinouts take a special adaptor.

**Navigation Resources**

**Advanstar Communications**
7500 Old Oak Blvd.
Cleveland, OH 44130
(800) 598-6008

**GPS World**
859 Willamette St.
Eugene, OR 97401
(503) 343-1200

**Institute of Navigation**
1800 Diagonal Rd., #480
Alexandria, VA 22314
(703) 683-7101

**ITS World**
859 Willamette Street
Eugene, OR 97401
(503) 343-1200

**NASA Tech Briefs**
41 E 42nd St., #921
New York, NY 10017
(212) 490-3999

**Navtech Books & Software**
2775 S Quincy St., #610
Arlington, VA 22206
(800) NAV-0885

**SAE**
400 Commonwealth Drive
Warrendale, PA 15096
(412) 776-4841

**Trimble**
585 N Mary Avenue
Sunnyvale, CA 94086
(408) 481-8000

The last three digits of the Seagate part number are apparently its size. In the case of the unit referenced above, it is 420 megabytes.

Be extremely careful when you experiment here on your own! Any crossed cable can destroy both your drive and the printer electronics. Do not attempt to interface a SCSI drive. Unless you know all about fancy and expensive IDE to SCSI conversions. And, of course, never hot swap an IDE drive! Always turn power off.

On your PostScript software side, the drive is called "%disk0%." Fonts usually go in a fonts subdirectory. Although half a gig is vastly more storage than you are likely to need for this, there's one curious limitation: You are only allowed 1000 different files on your drive. Filenames can be one to 100-characters long. Nulls, backslashes, percents, end-of-file, and spaces are disallowed characters.

Again, much more on BOD in general can be found in my *Book-on-Demand Publishing Kit*.

## Navigation Resources

I just got a flyer from Advanstar Communications on their brand new bookstore. This one focuses on GPS Global Positioning System and GIS Geographical Info System texts.

Because of that flyer, and since it's been a while, I thought we might summarize several of the better navigation info sources as this month's resource sidebar.

A good place to start is with the Navtech Bookstore. Then go on to those shows and publications from the Institute of Navigation. Two important trade journals in this area are *GPS World* and *ITS World*; the latter focuses on "Intelligent Transportation Systems."

Finally, here's a reminder that Trimble has a great nav tutorial it calls *GPS—A Guide to the Next Utility*. Hot links to several useful GPS and nav sources are also found on www.tinaja.com.

## New Tech Lit

New from Thomson-CSF, a new data book on their CCD Image Sensing Products. From Mitel comes an analog and digital Telecomm data book.

The PC1802 Stereo Enhancement Processor chip from ICT uses 3-D psychoacoustics to "spread out" the apparent source of stereo sounds. The new GMVLD10, from Genesis Microchip, is a real-time video-line doubler integrated circuit that is useful for de-interlacing. Uses for it include TV-to-monitor conversions and video walls.

The MIM Module from Clement Engineering can be useful for balloon telemetry and other remote sensing apps. Original jukebox manuals are sold by Western Reserve Games.

Some info on power ultrasonics appears in the *Waves* newsletter from Dukane. Bunches of traditional pipe-organ building info gets sold by the American Institute of Organbuilders, who offer various newsletters and conferences.

Two unusual glass topics: Glass paints are newly available through Wale Apparatus, while Foturan is a new photo-etchable glass product line from the Schott folks.

That long unclaimed $10,000 prize for anybody able to convincingly demonstrate dowsing techniques to locate a buried water pipe has just been upsized to $640,000. Contact www.randi.com for details. There's more on pseudoscience bashing in general on www.tinaja.com

For more on the fundamentals of digital integrated circuits, read my *CMOS Cookbook* and *TTL Cookbook*, either by themselves or as part of my bargain *Lancaster Classics Library*, per my nearby Synergetics ad.

As usual, many of the mentioned resources appear in our Names & Numbers and Navigation-Resources sidebars. A reminder that a no charge technical helpline is available per the Need Help box. Funding and time constraints strictly limit that service to U.S. callers only. Let's hear from you! EN

**NEED HELP?**

Phone or write all your US Tech Musings questions to:

Don Lancaster
Synergetics
Box 809-EN
Thatcher AZ, 85552
Tel: 520-428-4073

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

BY ROBERT EPPERSON*

# Troubleshooting VCR Tape Path Alignment

WHEN EVERYTHING IS SET UP RIGHT IN A WELL-DESIGNED VCR, IT WILL RECORD AND PLAYBACK CLEAR, SHARP PICTURES. BUT EVEN MINOR MISADJUSTMENTS IN THE TAPE PATH COULD SEVERELY IMPACT THE QUALITY OF THE video or the audio, or both. If there are severe misadjustments in the tape path, the tape itself can be damaged.

Figure 1 diagrams the tape path in a Hitachi VHS VCR. It is typical of, though not identical to, the path that VHS recording tape follows in many modern VCRs. The five key areas in the tape path that require adjustment to ensure that the tape travels in the proper vertical plane are shown in the diagram. As we go on we will describe each adjustment point and its importance in a properly aligned tape path.

## Reel Table Height

The first tape-path point in Fig. 1 is where the reel-table height is set. That setting determines the height of the tape as it is taken up or supplied from either the supply or take-up reel tables. If either table height is misadjusted, making the tape lower or higher than normal, the edge of the tape can be damaged. Figure 2 shows how a misadjustment there can cause tape curling. In that example the reel table is too high, affecting the height of the tape at the entry point to the guide. The result is tape curling at the top edge of the tape, which can permanently destroy or distort the audio or control tracks on the tape. As shown in Fig. 3, those tracks are at the top and bottom edges of the tape. That kind of problem shows up as distorted audio, with level changes; intermittent speed changes; or tracking problems.

Another problem caused by improper reel-table height is that it could cause the tape to be rewound into its VHS cassette improperly. That rewinding can cause the tape to bind, and in some instances stretch, causing symptoms similar to those of tape-edge damage.

## Tape Tension

Tape tension is the applied force of the tape at some particular point along the tape path of the VCR. In VHS VCRs, tape tension is regulated to insure video signal interchangeability between VCRs. Incorrect tape tension produces a number of different playback problems. Those problems show up as:

• **Tape Skew**—flagging or bending of the picture at the top of the viewing

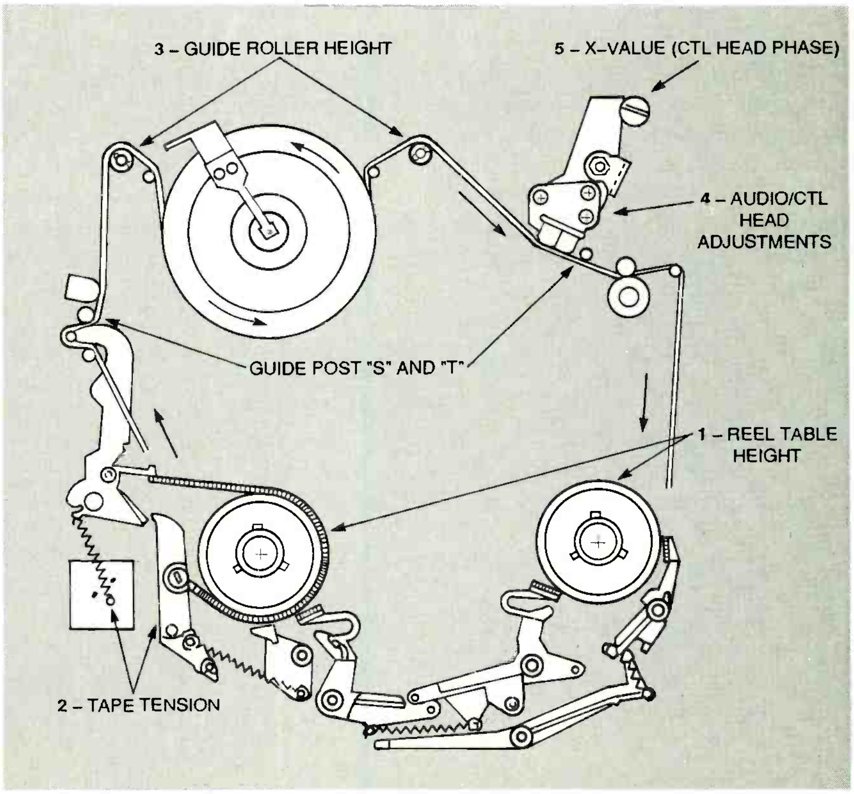



FIG. 1—THE VHS TAPE PATH shown here is from a Hitachi unit, but it is common to many VHS VCR's. Note the five major adjustment points.

*FROM HITACHI Hi-liteHitachi Home Electronics (America) Inc. Suwanee, GA

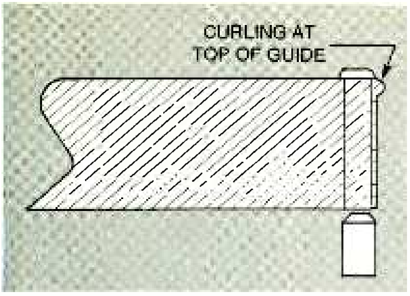



**FIG. 2**—TAPE CURLING AT THE TOP of the tape guide can be caused by a misadjusted reel-table height. If severe, it can physically damage the tape.

screen. That vertical bending is caused by horizontal time-base errors in the horizontal-sync pulses on the tape. Correct tape tension reduces horizontal time-base errors.

• **Intermittent Blue Screen**—triggered by the loss or excessive distortion of the playback video-sync signals. System-control microprocessors often monitor the sync signal, sending control codes to the character generator, which activates the blue screen whenever abnormalities are detected.

• **Upper Cylinder, Tape-Guide Damage**—severe, excessive tape tension can actually damage the upper cylinder and tape guides, causing surface scarring or excessive head wear.

Proper tape tension is clearly one adjustment that must not be overlooked. It is maintained throughout the tape path by a tension band, which is wound around the supply-reel table that continuously controls the braking force applied to the table. That braking force provides a variable resistance to the rotation of the supply reel when the tape is being withdrawn from the cassette-supply hub. To change the braking

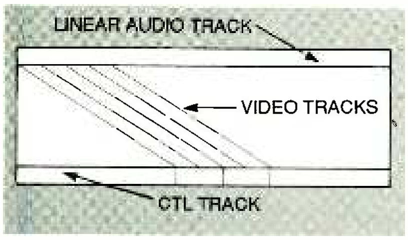



**FIG. 3**—THE AUDIO SIGNAL SITS ALONG the top edge of the VHS tape. Control signals are placed along the bottom edge.

force, a tension band is connected to a tension-arm assembly using a pole that is in continuous contact with the tape as shown in Fig. 4. The tape itself determines the pole position relative to the tape tension at any given point in time. As the tape is pulled from the supply-reel table with more (or less) force, the pole position changes in proportion to the force, and the band around the supply-reel table alternately loosens (with increased tape-pull force) or tightens (with decreased tape-pull force) to maintain a constant back tension (resistance) against the tape.

## Guide Rollers

Figure 5 shows two additional components that play an important part in determining the position of the tape as it travels though the tape path. Since no two VCRs have precisely the same mechanical path for tape travel, the supply and take-up guide-roller heights are adjustable to maintain interchangeability when playing back prerecorded videocassettes. The guide rollers determine the height of the tape at the entrance and exit of the video-drum assembly, and control the tape travel across its surface. That ensures the correct positioning of the video head with respect to the video signals recorded on the tape (particularly the proper placement of the video-sync signals), and the point at which the video heads were switched from CH1 to CH2 during the initial recording.

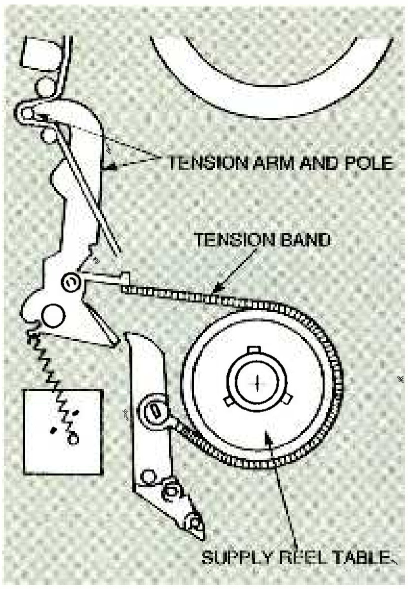



**FIG. 4**—TAPE TENSION MECHANICS are illustrated here. The tension band does most of the work.

Figure 6 shows what happens if a supply-guide roller is misadjusted. Note the noise bar that appears at the top of the screen. The particular guide roller that is misadjusted, and the degree of misadjustment, determines the number of noise bars and where they appear on

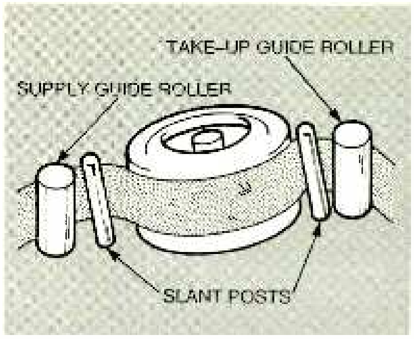



**FIG. 5**—TWO GUIDE ROLLERS—one before the video-drum assembly, one after—determine the tape position as it travels across the video heads.

the screen. A misadjusted guide roller can also cause tape curling, which results in distorted audio and distorted picture (noise bars, vertical jitter, and intermittent blue screen).

## ACE Head

The ACE-head assembly is shown in Fig. 7. It is comprised of three heads that together support the audio and servo functions of the VCR. Those are:

• **Audio Erase Head**—a high-frequency AC bias current flows through the erase head to remove any previously recorded audio signal.

• **Linear Audio Head**—records and plays back the linear audio signal.

• **Control Track Head**—records a 30-kHz signal onto the tape to form a video-head reference. When a tape is played back, the video-head phase is aligned with respect to that recorded control signal.

The ACE head is adjusted to assure proper playback of the linear audio signal and to insure proper tracking when playing back prerecorded tapes. When adjusting the ACE head assembly, two of

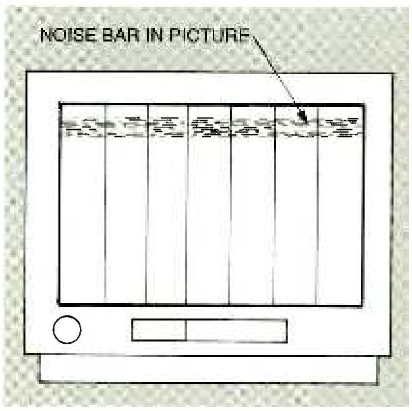



**FIG. 6**—THE NOISE BAR THAT APPEARS in the picture can be caused by a misadjusted guide roller.

*continued on page 72*

BY CARL J. BERGQUIST

# Generating Laser-Light Patterns

THIS MONTH, WE ARE GOING TO TURN OUR ATTENTION TO THE WORLD OF GEOMETRIC PATTERNS AND DESIGNS. THE LASER MARKET IS TEEMING WITH EQUIPMENT, RANGING FROM SIMPLE X-Y AXIS UNITS AND SCANNERS TO elaborate, computerized professional controllers. All are designed to manipulate one or more laser beams into designs, patterns, moving artwork, lettering, or even sheets of light.

Such equipment is remarkable in terms of what it does, but costs start in the $100 range for the most basic set-up and go up to $15,000 and more for highly sophisticated machines.

While such specialized professional equipment is wonderful to work with, it is overkill for our experimentation purposes, and its cost puts it out of reach for many. But that doesn't meant that we can't experiment with laser special effects. Let's take a look at some of the simple and inexpensive equipment that can be built and methods that can be used to produce many of the same effects as the commercial units.

## Simple Pattern Generators

To start, let's re-visit a set-up first discussed in the July 1996 installment of this column, and shown in Fig. 1. Mount a spring to a stand, as illustrated there, and attach a 1-inch-square piece of Mylar or top-surface mirror to the spring's free end. That set-up is the basis for several different simple pattern generators.

One tip when working with springs is that the action can be adjusted by expanding or contracting the coil. As a general rule, a spring becomes springier when stretched. Use that principle to control the amount of reaction to touch or vibration.

Once the set-up is assembled, aim your laser so the beam reflects off the Mylar or mirror onto a flat, light-colored surface, and then give the spring a tap. That tap will make the spring oscillate, and the beam will follow suit. Thanks to the persistence-of-vision characteristics of the human eye, the rapid movement of the spot generates random patterns and designs on the surface.

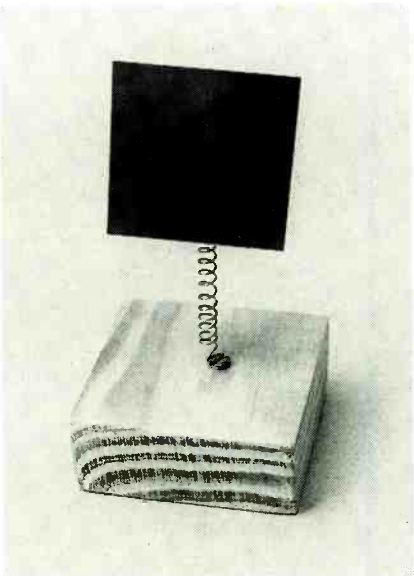


**FIG. 1**—A SQUARE MYLAR REFLECTOR attached to a spring that is anchored to a block of wood is one of the most basic laser-light reflectors.

Repeat that step several times. Note that the patterns are never exactly the same twice. A blast of air or strong vibration can also vibrate the spring and create new light effects. Experiment with different forces and make note of what happens.

## Electronic Pattern Generator

If you set up a small gear-reduction motor, rigged with an arm (say, a nail, for example) that will gently nudge the spring on each revolution, you'll have a way to produce more repeatable patterns for longer periods of time. The photo in Fig. 2 shows one way that can be done.

An electromagnet or solenoid can also be used to pulse the spring and move the reflector. Those devices can be driven from the output of an electronic timer that is also used to control the frequency of the pulse. Figure 3 shows a suitable circuit for a simple timer.

**WARNING! ! !**

This article deals with and involves subject matter and the use of materials and substances that may be hazardous to health and life. Do not attempt to implement or use the information contained herein unless you are experienced and skilled with respect to such subject matter, materials and substances. Neither the publisher nor the author make any representations as for the completeness or the accuracy of the information contained herein and disclaim any liability for damages or injuries, whether caused by or arising from the lack of completeness, inaccuracies of the information, misinterpretations of the directions, misapplication of the information or otherwise.

For more dramatic effects, use a dual timer, like the one shown in Fig. 4. In that circuit, first one electromagnet, then the other, is activated, and the sequence repeats. If the two electromagnets are placed at right angles to each other, a north-south, east-west movement can be established. That movement can produce some very interesting designs, especially if you vary the oscillation rate by changing the capacitance and resistance values.

## Motorized Pattern Generators

Motors and mirrors make an excellent combination for generating graphics. Attach reflective surfaces to the shafts of the motors. Then arrange the assemblies at various angles to each other. Now direct the laser beam between the mirrors and onto a screen. As the motors turn the mirrors, additional angle changes occur that vary the pattern.

Figure 5a shows a variation of the circuit in Fig. 4 that can be used to control a pair of motors. When the motors are connected to the circuit as shown in Fig. 5b, it will turn the individual motors on and off. If, on the other hand, you use the arrangement shown in Fig. 5c to control a single motor, it will make that motor first rotate in one direction and

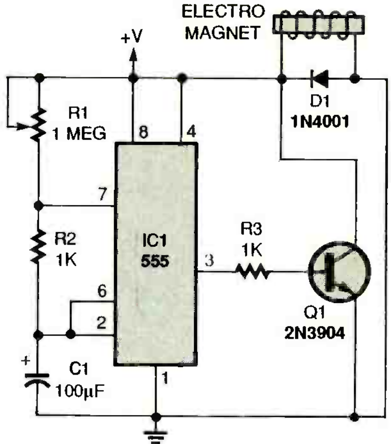



**FIG. 3**—A SIMPLE TIMER built around a 555 gives you a switching electromagnet to use to create laser-light patterns.

then the other. That set-up has all kinds of useful applications.

If you want to add yet another variable, you can provide a speed control by connecting a 5000-ohm potentiometer in series with the motor and power supply. Another variation would be to replace the flat mirrors with either convex or concave surfaces. One last area to consider is reflecting the laser beam off liquid surfaces such as water, oil, paint, etc. Different beam angles and vibrations of the substance being used as the

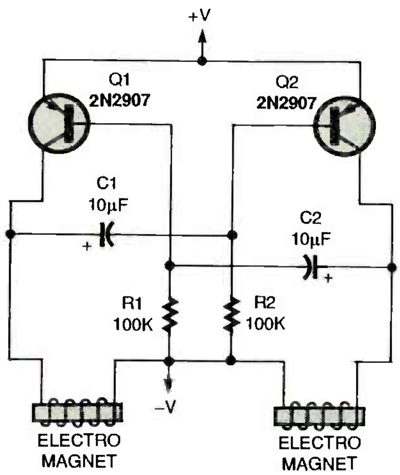



**FIG. 4**—IF THE ELECTROMAGNETS in this dual-timer circuit are arranged perpendicular to each other, a north-south, east-west motion can be established.

reflector can produce some delightful and interesting results.

It is obvious that a nearly endless variety of effects could be produced by making minor or more extensive

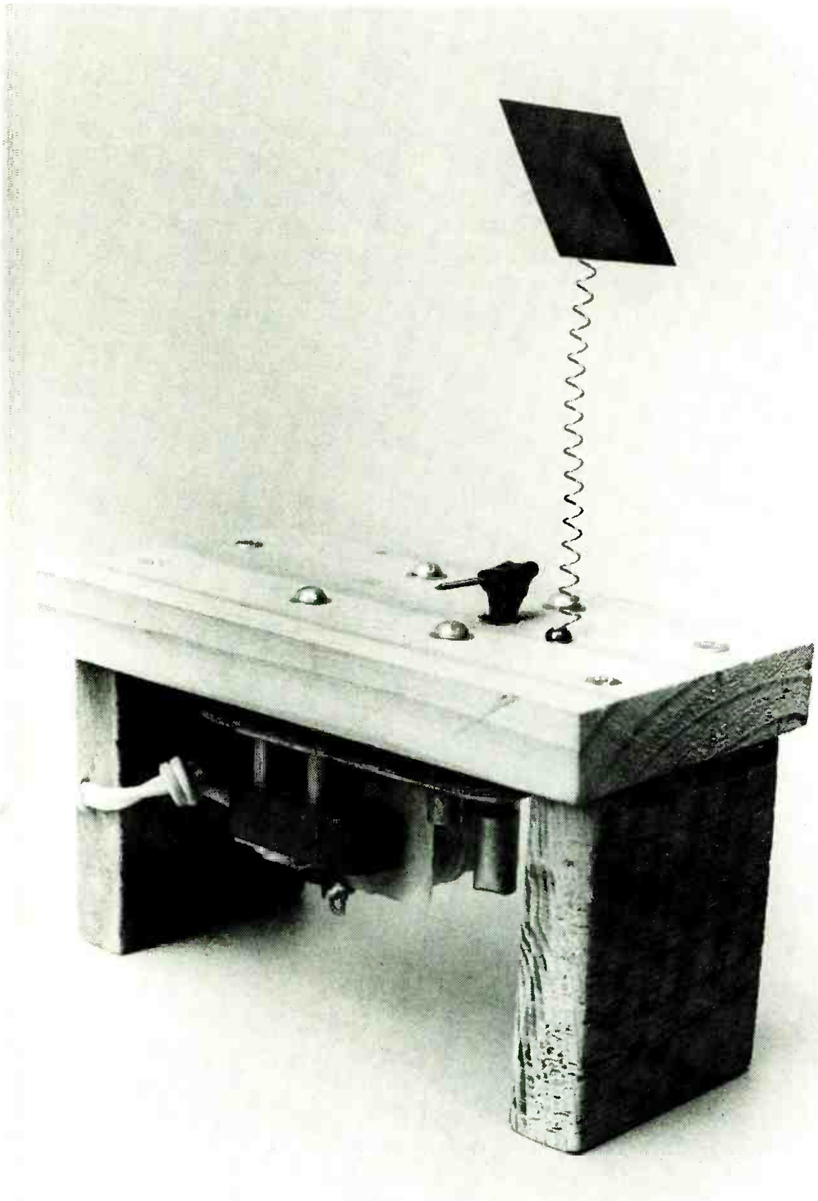


**FIG. 2**—FOR REPETITIVE VIBRATIONS, this simple set-up works well. A small gear-reduction motor rotates a nail, which strikes the spring one time each revolution. That rotation creates a repetitive movement in the reflector.

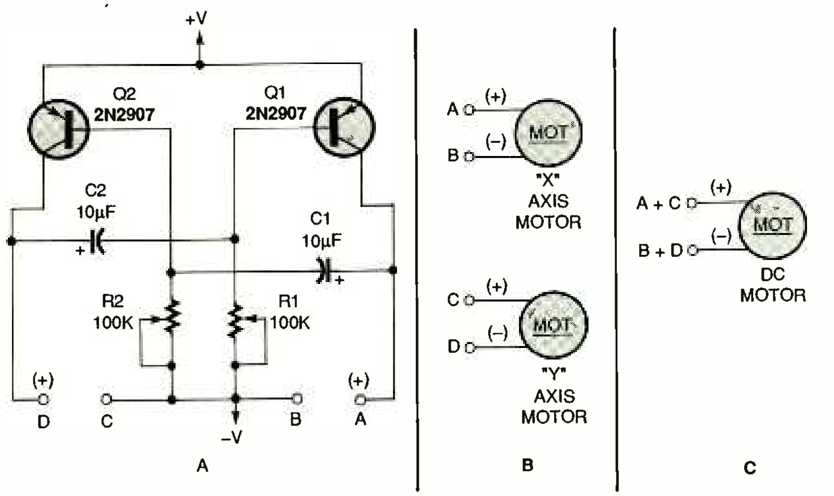



**FIG. 5**—THE MOTOR-CONTROL CIRCUIT (A) can be used to alternately turn two motors on or off (B). It can also be used to make one motor turn first in one direction and then the other (C).

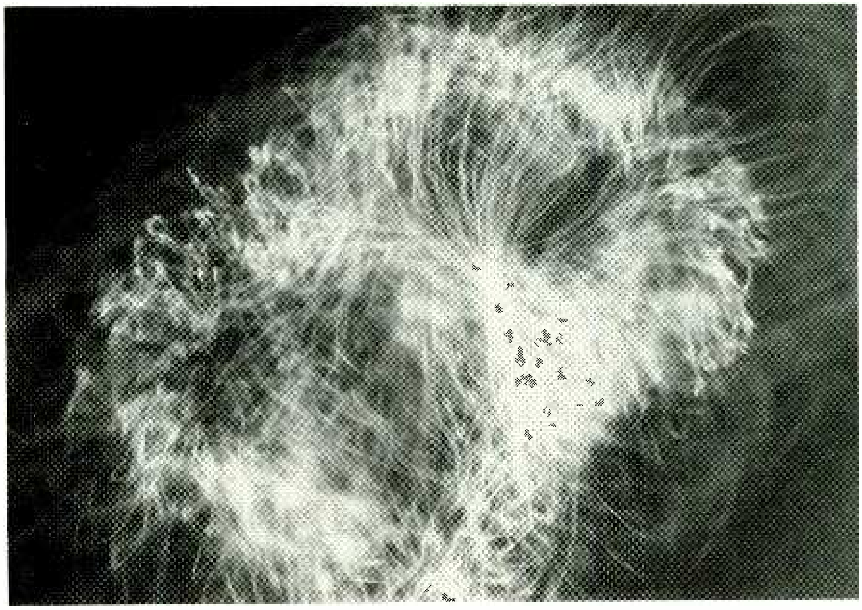
changes to the basic set-up. Spend some time experimenting with the ideas presented, as doing so is a valuable source of knowledge.

## Holiday and Other Displays

So, aside from special effects at rock concerts, what practical applications are there for what we have learned? Well, how about using lasers to create holiday displays that would be the talk of the neighborhood. Holidays, such as Christmas, Halloween, and Independence Day all lend themselves to the special effects lasers could produce. For example, use mirrors, lenses, fiber optics, and such to uniquely personalize Christmas trees and other decorations with stunning light shows. The displays can be stationary or moving. They could spell out a holiday message. You are only limited by your imagination and the complexity of your design. If a PC is available, try setting up a program to control both the optics and mechanics for a variety of unusual results.

Halloween offers an endless opportunity for creativity. Just imagine the selection of spooky displays you could build around your laser. A spectacular demonstration for the Fourth of July could be assembled with the help of mirrors and motors to simulate fireworks. Let your imagination loose and when you do come up with a great idea, put it down on paper and send it to **Electronics Now**, Laser-Experiments Editor, 500 Bi-County Blvd., Farmingdale, NY 11735, or simply e-mail to lartronics@aol.com.

While on the subject of gaining attention, why not take a look at the possibilities for advertising. A swirling, pulsating light show projected on a billboard or a showroom ceiling or wall will immediately attract people passing by. In addition to the movement, there is something about the color and quality of the red light from a helium-neon laser that is difficult to ignore. The collimation not only makes the light bright, but also gives the beam and the surfaces it comes in contact with a shimmering effect that is hard to describe. For whatever reason, the experience is visually pleasant for most people. **EN**



THIS IS ONE EXAMPLE of the kinds of light patterns that you can create using the information in this article.

## SERVICING

*continued from page 69*

the adjustments affect the way the tape travels across the tape path. These are the tilt and height adjustments.

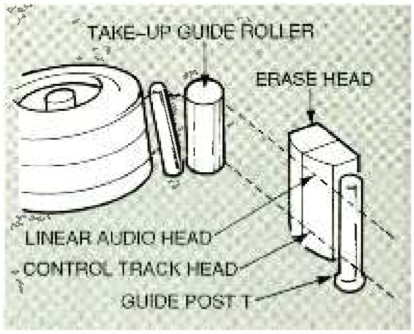



**FIG. 7**—ACE-HEAD ASSEMBLY is composed of three separate heads—audio erase, linear audio, and control track.

## X-Value

The X-value adjustment, also known as the CTL head phase, or tape-interchangeability adjustment, is used to set the position (horizontally) of the ACE head. It insures that the recorded video signal and control-signal phase relationship is maintained when playing back tapes from different VCRs. You can be sure that tracking linearity is correct when the X-value is properly set. **EN**

## EQUIPMENT REPORTS

*continued from page 18*

pressure or you can enter a new user. Each new user gets their own password and set of records. If you want, you can set the upper and lower pressure limits for each measurement—the smaller the range, the quicker each measurement can be made.

With everything connected and the software running, you simply follow software prompts to wrap the cuff around your arm, tighten the air valve on the bulb, start pumping, stop pumping and wait, and then to loosen the valve and release the air. The process takes about 30 seconds. All results appear on-screen and can be saved or printed.

The DynaPulse measures blood pressure in much the same way as a physician does. The inflatable cuff presses on the artery in your arm to the point where blood stops flowing. Then, as pressure is released, blood starts flowing at some point. At that point, the blood swirls in a turbulent flow causing a sound a doctor can hear with a stethoscope, and variations in pressure that DynaPulse can detect. The point where blood starts to flow is measured as the higher pressure point (systolic). At some point as pressure is released, the turbulence ceases; that's the lower pressure point (diastolic).

While it will not (and should not) replace a physician, DynaPulse is excellent for medical screenings by qualified personnel, or for home use to keep track of your blood pressure between doctor's visits. It also makes it very easy to store your results where they will never get lost. You can display long-term trends to monitor the effects of diet, exercise, medication, and so on (again, any diet or exercise regimen should first be discussed with and approved by your physician). Whether you're keeping track of just yourself, your whole family, or an entire organization, the DynaPulse 200M simplifies the task of taking and storing blood-pressure readings. EN

BY FRANKLIN J. MILLER

# Microphone Basics

SOUND IS GENERATED THROUGH A SPECIFIC MECHANICAL PROCESS. THAT IS, SOME PHYSICAL DEVICE MOVES OR VIBRATES, IN TURN MOVING THE AIR AROUND IT. ONE SIMPLE EXAMPLE IS A TUNING FORK. IF YOU HIT THE TUNING FORK with a hammer (see Fig. 1), the fork vibrates at one specific frequency determined by its size and shape. The vibrations of the fork move the air around it. When those movements reach your ear, they are converted into electrical energy and sent to your brain to be processed and interpreted. (Of course, there is a lot more going on here than what we've just outlined; but, for our purposes, this simplified explanation will suffice).

Well, that process could also be used to describe how a microphone works. Like the ear, all microphones are sound conversion devices—they take sound and change it into electrical energy. There are three basic steps in this process:

1. Sound waves move the diaphragm inside the microphone.
2. The voice coil also moves, since it is attached to the diaphragm.
3. When the voice-coil moves, electrical energy is generated in the coil since it is located inside the microphone's magnet structure (magnet and magnetic housing).

The kind of microphone just described, shown in Fig. 2, is a dynamic or moving-coil type. The sound wave that reaches the microphone must be strong enough (or, rather, loud enough) to move the mass of the diaphragm and the coil assembly. That type of microphone works well, but does have some limitations. It usually generates a small peak, sometimes called presence, somewhere between 2 and 5 kHz. Extremely-low and extremely-high frequencies can also give dynamic microphones some trouble. However, dynamic microphones are very durable and do not require any special handling. That's why they are so commonly used.

The amount of electrical energy that a microphone can put out partly depends on the amount of acoustical energy that reaches its transducer. In general, the louder the sound, the greater the electrical energy the microphone will produce, but there are limiting factors—the maximum possible movement of the voice coil for one.

Sound that we hear is usually measured in dB SPL (sound pressure level). That measurement ranges from 25-dB SPL (the level in a quiet broadcasting studio for recording music) to 140-dB SPL (a 50-HP siren). An average full symphony or orchestra has a dynamic

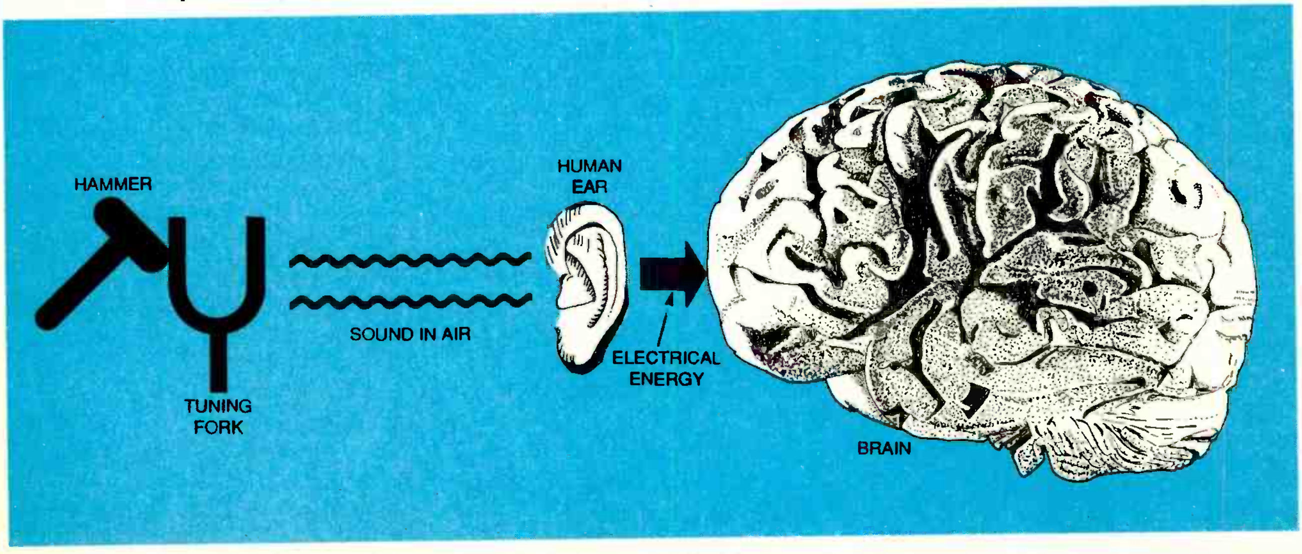



**FIG. 1**—HOW SOUND IS GENERATED. Striking a tuning fork is the method illustrated here.

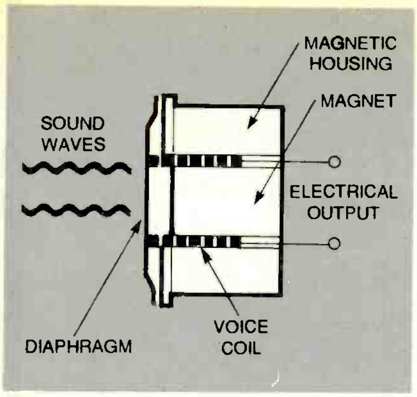



**FIG .2**—MICROPHONES CONVERT sound waves into electrical signals.

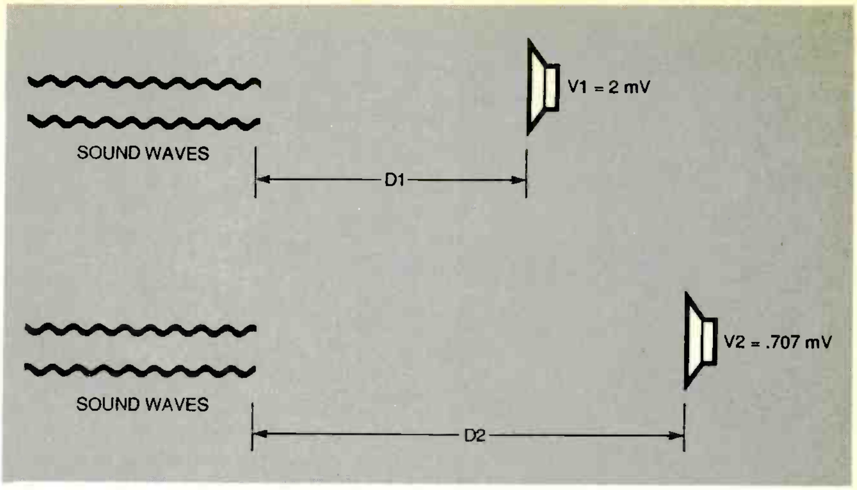



**FIG. 3**—A MICROPHONE'S OUTPUT FALLS OFF as it gets farther away from the source of the sound.

range of 20 to 100 dB. The human ear has a dynamic range of about 120 dB, which is a ratio of a trillion to one. Analog recording has a 60-dB range (a million to one). Digital recording has a range of 90 dB (a billion to one).

As you can see from the above, the human ear is a very fine instrument indeed and should be treated with respect. Therefore, a microphone that can convert the air movement into an electrical signal within the very large dynamic range of the ear has a difficult job, at best.

## Microphone Efficiency

Microphones work best when they are positioned as close as possible to the sound-generating source. As shown in Fig. 3, the voltage produced by a microphone falls off with the inverse square of the distance. Put another way, the voltage the microphone produces increases geometrically as the distance from the sound source decreases. However, there is a limit. If the microphone is too close to the sound source, there is a proximity effect that causes the low frequencies to have a greater build-up than the high frequencies.

It is important to realize that microphones are never 100% efficient (their precise efficiency is not important to this discussion), and many factors come into play to reduce efficiency still further. For example, even temperature and humidity are important factors in the sound-reproduction process. That is one reason why studio recording is ordinarily very uniform, while remote recording can be quite variable. It is also why something that worked once might not seem right at another time. Most of those problems can be solved, but microphone users need to be aware that they can and do occur.

## Types of Microphones

There are several different types of microphones. The first and most common is the dynamic microphone that we have been talking about. It has a small diaphragm with a coil of magnet wire attached to it (see Fig. 4) that sits in the field of a permanent magnet.

The electret condenser type is the next most popular in today's marketplace. It is a permanently charged capacitor type with an FET amplifier built in. It is shown in Fig. 5.

Another type of microphones is the capacitor type; it is the forerunner of the electret type. Its major drawback is that it needs a power supply to charge its plates. An RF capacitor microphone is another quality way to convert sound waves into an electrical signal.

## Acoustical Characteristics

Next, let's look at the acoustical characteristics of microphones, in order of their popularity. Figures 6, 7, and 8 are polar diagrams that show the pickup patterns of various microphone varieties. All three have some common elements and all are for a 1-kHz signal. At other frequencies the patterns might be different.

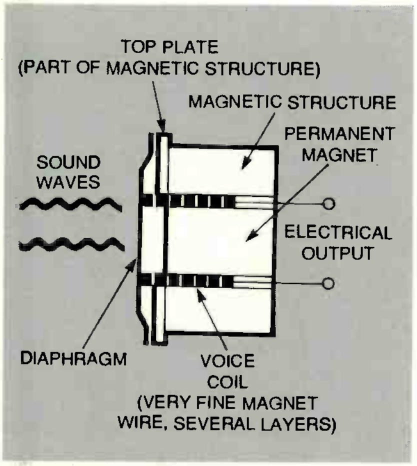



**FIG. 4**—THE BASIC DYNAMIC MICROPHONE. It is probably the most commonly used variety.

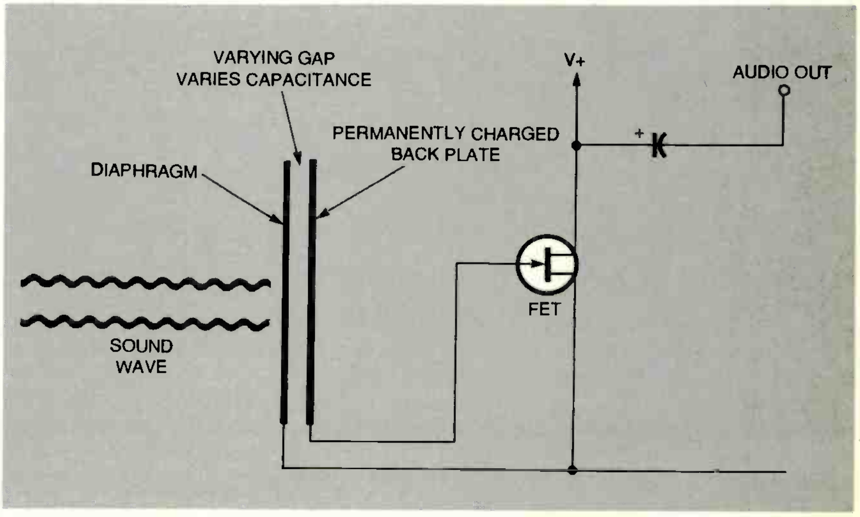



**FIG. 5**—AN ELECTRET CONDENSER MICROPHONE features a built-in FET amplifier.

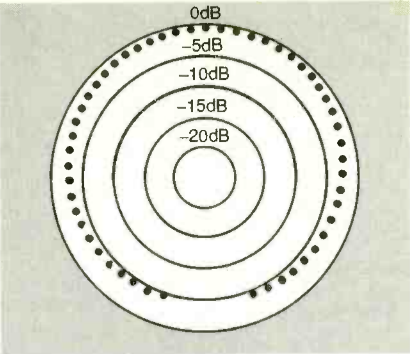



FIG. 6—A MICROPHONE WITH AN OMNIDIRECTIONAL pattern like this one picks up sounds from all directions.

Every microphone has its own polar pattern. The manufacturer will generally supply it with the microphone, or the information might be in the catalog or other literature. The key to selecting the right microphone is to know which pattern is the correct one to use for a particular application.

The most common type is the omnidirectional. As its name implies, an omnidirectional microphone receives the acoustical waves in a pattern that is equal all around in a circular fashion. Note that the plot in Fig. 6 shows that the pickup in the rear does have some loss, but that loss is small enough to ignore.

The next type of pickup pattern is the cardioid. It has better pick-up from the front of the microphone than from the rear, as shown in Fig 7. That type of pickup is very popular for live performances. That's because it greatly reduces the chance of acoustical feedback (although it is far from the total answer to that common problem).

The hyper-cardioid/super-cardioid microphone has some features of the cardioid microphone, but the pickup pattern is even more pronounced (see Fig. 8). Though that microphone is useful where feedback is likely to be a real problem, one drawback is that it might have too narrow a pickup pattern for some applications.

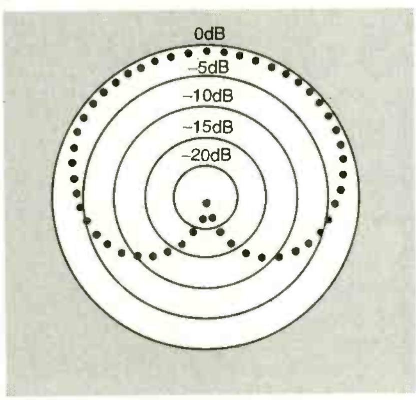



FIG. 7—A CARDIOID PICKUP PATTERN reduces the likelihood of acoustic feedback.

The last type of microphone we will discuss is the gun/interference tube. It is used to pick up sounds at a distance. That microphone has some special uses, especially in electronic newsgathering and in film and TV production, to pick up dialogue where a wireless microphone is impossible to use for some technical reason. While we have not shown a polar plot for that type, obviously, they are highly directional.

It is important to remember that there is no one microphone that can solve all acoustic problems. You must try different ones in different situations. After some practice, you will have a good understanding of what works for what situation. **EN**

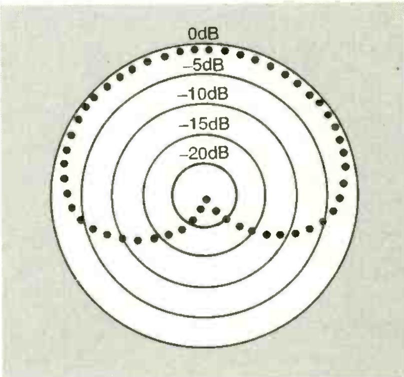



FIG. 8—WHEN FEEDBACK PROBLEMS are severe, try a hyper-cardioid type that delivers the polar pattern shown here.

BY JEFF HOLTZMAN

# IP Addressing and HTML Coding

THERE WERE SEVERAL MISLEADING AND INCORRECT STATEMENTS IN MY COLUMN ON INTERNET RESOURCES (AUGUST 1996). I THINK THAT THE TOPICS ARE IMPORTANT AND INTERESTING ENOUGH THAT WE'LL REVISIT THEM IN somewhat greater depth for our discussion this month.

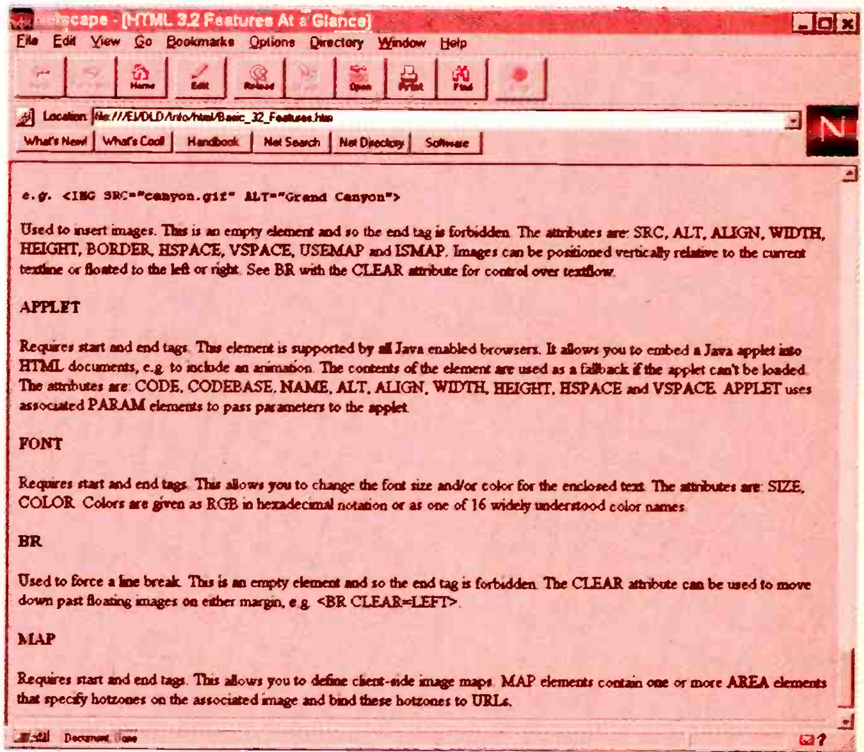
The first problem was my statement, "Thus, a textual address like jkh@acm.org eventually gets resolved to a numeric address like 127.0.0.1." Actually, the numeric address is a machine address, not some sort of user alias. As Lou Sortman pointed out, "There is a mapping between IP addresses and domain (host) names, but the user part of an e-mail address is resolved by the Mail Transfer Agent on the referenced host (or Mail eXchanger) and has nothing at all to do with any part of the IP address." Thanks also to Ron Dozier for information in this area.

Lou also clarified some details of where HTTP ends and TCP begins: "In the HTTP protocol, the client issues a request to the server and the server responds with the status, a header (which you described with the HEAD command), and any requested data (if applicable). Your description added two extra parts (client initiates "transfer" and server acknowledges the connection). Those are not part of HTTP. They are part of the transport protocol (TCP on the Internet)."

Regarding CGI (Common Gateway Interface), Lou stated, "CGI programs can be accessed with the GET method as well as the POST method. You specified that only the POST method can be used. Later, you say that mostly what is transferred with the GET method is simple HTML files. Statistically, that is probably true, but it is also used quite a lot for other file types (sound files, images, etc.) and even CGI programs."

Lou also disagreed with my assessment of CGI: "CGI is not an awkward hack. It is the most portable way of handling CGI programs on differing operating systems and written in differing languages, including interpreted ones such as Perl and the Bourne shell. There is a place for more efficient schemes for executing code on the server, but there are portability and resource consumption issues that would make CGI a better solution in many cases."

I agree that CGI has the virtue of portability. However, it lacks elegance and performance. As the Microsoft steamroller overtakes Internet technology, I think we'll see the company's direct-access Internet Server Application Pro-



Netscape - [HTML 3.2 Features At a Glance]

File Edit View Go Bookmarks Options Directory Window Help

Location: file:///E|/DLD/Arto/html/Basic_32_Features.htm

What's New! What's Cool! Handbook Net Search Net Directory Software

e.g. <IMG SRC="canyon.gif" ALT="Grand Canyon">

Used to insert images. This is an empty element and so the end tag is forbidden. The attributes are: SRC, ALT, ALIGN, WIDTH, HEIGHT, BORDER, HSPACE, VSPACE, USEMAP and ISMAP. Images can be positioned vertically relative to the current textline or floated to the left or right. See BR with the CLEAR attribute for control over textflow.

APPLET

Requires start and end tags. This element is supported by all Java enabled browsers. It allows you to embed a Java applet into HTML documents, e.g. to include an animation. The contents of the element are used as a fallback if the applet can't be loaded. The attributes are: CODE, CODEBASE, NAME, ALT, ALIGN, WIDTH, HEIGHT, HSPACE and VSPACE. APPLET uses associated PARAM elements to pass parameters to the applet.

FONT

Requires start and end tags. This allows you to change the font size and/or color for the enclosed text. The attributes are: SIZE, COLOR. Colors are given as RGB in hexadecimal notation or as one of 16 widely understood color names.

BR

Used to force a line break. This is an empty element and so the end tag is forbidden. The CLEAR attribute can be used to move down past floating images on either margin, e.g. <BR CLEAR=LEFT>.

MAP

Requires start and end tags. This allows you to define client-side image maps. MAP elements contain one or more AREA elements that specify hotzones on the associated image and bind these hotzones to URLs.

Document: Done

THE HTML 3.2 SPECIFICATION adds support for Java Applets, and several new tags for specifying text formatting. HTML 4.0 should be out by the end of the year.

gramming Interface (ISAPI) become much more widely used than CGI. And even if MS were to drop dead tomorrow, other vendors (*e.g.*, Netscape) have comparable solutions.

Lou also disagreed with my assessment of HTML. "HTML was intended to be platform independent. It was quite intentional that there were no font or color tags in the original spec. Leaving the precise manner of interpreting the document content and markup up to the browser was a good thing. The reason that people have problems with documents looking different on different browsers is that they decided that they wanted to do things that HTML was never intended for. HTML is a markup language. It is not a page description language. Ask Don Lancaster (the world's biggest PostScript proponent) about the difference. There may be a need for an open page-description language with hypertext capabilities on the WWW, but the problems that you cite are not shortcomings of HTML."

Here Lou and I have a major disagreement. I'm certainly aware of the distinction between a markup language and a page-description language. The problem is that HTML is rapidly becoming a page-description language.

## HTML and SGML

HTML is an application of SGML (Standard Generalized Markup Language, defined by ISO Standard 8879:1986). SGML purposely separates document content from document structure and document formatting. An SGML "document" actually has two components: the document itself, and a Document Type Definition (DTD). The DTD is like a style sheet (in the MS Word sense). In a pure SGML document, the document has no direct formatting. Nothing is ever marked bold or italic; fonts are not specified by name, nor are colors; nor is any type of layout information (*e.g.*, tab stops and line spacing) embedded in the document. The document never has anything but content and tags specifying format and structure. The tags are interpreted according to the DTD associated with the document.

In that way, the DTD can change without changing the underlying document. Thus, the same document can be presented in several different ways simply by associating the document with different DTDs.

That may seem like an esoteric feature, but it's not. For example, a big problem in creating software documentation is reuse of material. There are printed manuals and on-line, hypertext documents. Often, they share much of the basic content. But it is extremely rare for them to have a strict, two-way, one-for-one correspondence. The on-line stuff invariably needs something that the manual does not, and *vice versa*. Conversely, the manual invariably has stuff that you don't want in the online version, and *vice versa*. Similar types of problems are pervasive throughout every aspect of electronic publishing

**LISTING 1—TEMPLATE FOR DELPHI COMMAND-LINE UTILITY**

```
program Test;
{$APPTYPE CONSOLE}
begin
  writeln('Howdy, world...')
end.
```

The problem with Web pages that look different on different browsers is that the details of the HTML DTD are interpreted differently by different browsers. Netscape interprets the DTD one way, Microsoft another, and so on. If it were just a question of fonts and colors, the graphics designers might be unhappy, but things would still work. It's when Microsoft and Netscape each goes off and defines new tags to accomplish special feats (*e.g.*, frames, tables, embedded applications, and so on) that both page designers and end users end up suffering.

Some of the latest format-related HTML features (*e.g.*, font tags, color tags, and cascading style sheets) in effect embed the DTD directly within the document, and that is directly contrary to both the letter and the spirit of SGML.

It's also true that some of the very oldest HTML tags do the same things. For example, HTML has tags for directly marking text as boldface, <B>, and italic, <I>. However, directly marking text in any fashion is counter to the SGML model. There are more general tags that are usually, but not necessarily, rendered as bold and italic: <STRONG> and <EM>, respectively. Those are the correct tags to use.

## Theory and Practice

Is this a theoretical discussion with no practical application? No. Many Internet citizens still browse with text-only browsers. And as the technology continues to infiltrate other areas (*e.g.*, pagers, cell phones, PDAs), consistent understanding and interpretation of tagging conventions is important. By thinking at a more abstract, general level (*e.g.*, emphasized rather than italic), page designers will better be able to serve a wider audience.

At the bottom of what I dislike about HTML is that it was not designed with a broad set of capabilities and long-term interests in mind. Rather it was a hack thrown together to prove a concept. The creators then lost control, and market evolution took over. Long term, that's probably best. But short term, it makes life difficult for end users, page developers, browser vendors, and new technologies, such as alphanumeric pagers. PostScript, though proprietary, was designed with a full set of capabilities. It has not shown the need to evolve every few months. But that's moot, because HTML is the standard for the Internet. How long will it be before we see HTML-based laser printers?

## Delphi Tip

Delphi is a Pascal-based visual development environment for Windows 32 (Win95 and NT). I compared it in some depth with MS Visual Basic in last month's column. Delphi can also be used to create traditional command-line utilities, although Borland has certainly deemphasized that capability, and has hardly documented how to do it.

Listing 1 shows a shell for such an application. The key is line 2, which tells the compiler that this is to be a console app, not a GUI app. To compile the program, use DCC32.EXE, which is located in Delphi's ..\BIN directory. Also, the compiler must be able to find SYSTEM.DCU, which is located in the ..\LIB directory. To do some really retro non-GUI command-line based development, all you need is the compiler, the system unit, and your favorite text editor. It'll all actually fit on a floppy disk with plenty of room to spare!

That's all for now. Until we meet again next time, you can stay in touch via jkh@acm.org. EN

## USING THE 7107

(Continued from page 60)

Hz. While it is not well-suited for frequency counters, it is an excellant choice for automobile tachometers, audio-frequency meters, pulse- and function-generator displays, and other such applications. The 2917 interfaces directly with the 7107, but might require a simple op-amp buffer at the input. If the output is erratic, a 0.1-µF Mylar capacitor connected in series with the positive input will usually correct the problem.

For frequency counting, the LM555 timer is a better choice, as that chip will handle higher frequencies. Figure 12 is the schematic for a 555 frequency-to-voltage converter that can display up to a maximum of 1.999 MHz. The 100,000-ohm potentiometer (R4) functions as calibration, and S1 selects one of three resistors that determines range.

The display reading is multiplied by 10 for range 1, 100 for range 2, and 1,000 for range 3. A 1999 reading in range 2 would be equivalent to an input frequency of 199,900 Hz. A display of 0865 in range 3 would represent 865,000 Hz.

The range of the counter can be further expanded through the use of input pre-scalers. Those ICs will divide an input frequency, usually by 10, before applying it to the counter. A single pre-scaler would increase the input capability to 19,990,000 Hz, while cascading two pre-scalers would take it up to 199,900,000 Hz. Again, there is the multiplication factor to consider. When using pre-scalers, the displayed value is multiplied first by the range factor, then by the pre-scale factor to get the actual measurements.

The 11C90 and 95H90 ICs are two common pre-scalers, but the drawback with them is their expense. Those chips are not exactly economical, although the 95H90 can sometimes be found on the surplus market for as little as $6 to $10.

**Other applications.** Now that you're an expert on the 7107, the knowledge gained will perhaps prompt you to expand projects, designs, or equipment, and possibly inspire ideas for future projects. LED and LCD displays are highly informative, and can add

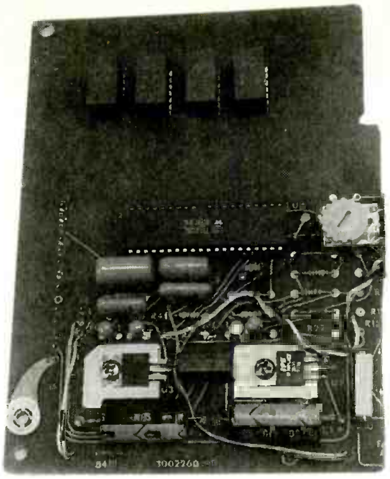


*Fig. 13. A section of an alarm board, bought through surplus, that contains a 7107. This particular board also contains the ± 5-volt power supply.*

to the functionality of many types of electronic equipment. A project that takes advantage of the 7107's voltage-measuring capabilities is the author's "Versatile Power Supply" article in the December, 1995 issue of **Electronics Now**. That project is a bench-type power supply with a 7107-driven LED readout that displays the level of the output voltage.

Only a few applications were covered in this article. With a little thought or as practical needs arise, many other ideas will present themselves. For example, the Intersil data book illustrates a circuit for a digital torque meter, using a resistance-dependent strain gauge.

One area to watch for an economical source of devices is the surplus market, as the 7107 and 7106 can be found on many circuit boards. The surplus circuit board in Fig. 13 is an example of that type of source. The chip is usually mounted in a socket, and can be removed for use in one of your own projects. Frequently, the basic meter circuit is intact, and can be used as is with minor modifications. The 7107 can be found in some alarms, satellite receivers, antenna-positioning units, salvaged digital panel meters, counters, controllers, and a variety of other equipment. Be sure and keep an eye out for them when surplus "bargains" are advertised.

So, pick up a couple of 7107s and try adding one to your next project. The chip is quite easy to work with, and the results you could achieve can be very gratifying. Ω

## MILLI-OHM ADAPTER

(Continued from page 42)

Run a wire directly from the ground connection of C1 on the board to a lug on the 10-32 stud supporting the swing arm. The common connection including C10, C11, C12, R9, and J1 is the negative Kelvin lead, which is *not* to be connected to ground on the board. Connect the Kelvin lead in this fashion: Run an insulated lead from the common connection of C10, C11, and C12 through a grommet located in the top of the cabinet near the stud, then through an "eyelet" located on the stud itself, and finally make the connection to the lug on BP2.

Mount the completed board on a pair of ½-inch spacers in the bottom of the cabinet and connect the remainder of the panel components to the board. Install the ICs in their sockets and close the cabinet. Prepare an output cable using a twisted pair of wires (do *not* use coaxial cable) with an RCA phono plug on one end, and a suitable plug for your DVM on the other end. A 12-inch length is sufficient.

**Calibration.** Power up the adapter and allow it to warm up for about five minutes, allowing the temperature to stabilize in the cabinet. Connect the adapter to your DVM, open the cabinet, and connect a clip-lead jumper from the base lead of Q1 to its emitter lead. The resulting voltage, which can now be read on your DVM, is the *offset voltage* of IC3; make a note of that voltage, which can be anywhere from 0 volt to ±10 millivolts. Remove the clip lead. Using your DMM, measure the exact value of $R_C$ (4.02 ohm, 1%), minus your test lead resistance. Connect $R_C$ to BP1 and BP2, push the TEST switch, S1, and adjust CAL potentiometer R4 so that the output from J1 (about 4.02 volts) indicates the exact value of $R_C$ *added* to IC3's offset voltage. Re-assemble the cabinet and the milli-ohm adapter is complete and ready for use.

In actual use, connect the unknown resistance ($R_X$) at the exact points on its leads from which you want to measure, take the reading, and *subtract* IC3's offset voltage for the proper value at 1 ohm/volt. That procedure will ensure the best possible accuracy. Ω

# TECH-SYSTEMS

1309 Hwy. 71Belmar, NJ 07719
908-280-0007 FAX: 908-280-0111

**800-435-1516**

**BUY - SELL - TRADE**

**VISA & MasterCard Accepted**

***90 Day Warranty / 10 Day Right of Return***

***N.I.S.T. Traceable Calibration Available on Most Items***

## SPECTRUM ANALYZERS

| | |
|---|---|
| TEK 492/01/02 Spectrum Analyzer 50KHz to 21GHz | $6.995 |
| Option 01 Adds Internal Preselection and 02 Adds Digital Storage | |
| TEK 492/02 Spectrum Analyzer 50KHz to 21GHz | 6,650 |
| Option 21 18GHz to 40GHz Waveguide Mixer Set | 1,775 |
| TEK 496 1kHz - 1800 MHz. Spectrum Analyzer | 4,750 |
| TEK 7L12 100KHz to 1800MHz Spectrum Analyzer Plug-In | 1,850 |
| TEK 7L13 1KHz to 1800 MHz Spectrum Analyzer Plug-In | 2,495 |
| TEK TR503 Tracking Generator w/TM503 Power Supply | 1,450 |
| HP 141T/8552B/8555A 10 MHz to 18GHz Spectrum Analyzer | 2,195 |
| HP 141T Variable Persistence/Storage Display | 595 |
| HP 140T Non-Storage Display | 425 |
| HP 8553B 1KHz to 110MHz RF Section | 450 |
| HP 8554L 100KHz to 1250MHz RF Section | 550 |
| HP 8554B 100KHz to 1250MHz RF Section | 795 |
| HP 8555A 10MHz to 18GHz RF Section | 995 |
| HP 8556A 20Hz to 300 KHz LF Section | 450 |
| HP 8552B IF Section | 650 |
| HP 8552A Economy IF Section | 295 |
| HP 8443A 0.1 to 110MHz Tracking Generator | 550 |
| HP 8444A 0.1 to 1300MHz Tracking Generator | 795 |
| HP 8444A/059 0.5 to 1500MHz Tracking Generator | 1,350 |
| HP 8445B 1.8 to 18GHz Preselector | 650 |
| HP 182T Mainframe | 495 |
| HP 182T/8557A 10KHz to 350MHz Spectrum Analyzer | 1,495 |
| HP 182T/8558B 100KHz to 1500MHz Spectrum Analyzer | 3,350 |
| HP 8557A 10KHz to 350MHz Spectrum Analyzer Plug-In | 1,250 |
| HP 8558B 100KHz to 1500MHz Spectrum Analyzer Plug-In | 2,395 |
| HP 8559A 0.01 to 21GHz Spectrum Analyzer Plug-In | 4,450 |

## OSCILLOSCOPES

| | |
|---|---|
| TEK 465 100MHz Portable Scope | $595 |
| TEK 475 200MHz Portable Scope | 795 |
| TEK 485 300MHz Portable Scope | 995 |
| TEK 2465 300MHz Portable Scope | 2,595 |
| HP 1741A 100MHz Portable Scope | 495 |
| HP 1725A 275Hz Portable Scope | 695 |
| HP 54200A 50MHz/200Msa/s Digitizing Scope | 2,250 |
| HP 54200D 50MHz/200Msa/s Digitizing Scope | 2,650 |
| HP 54201D 300MHz/200Msa/s Digitizing Scope | 2,995 |
| HP 54110D 1GHz/40Msa/s Digitizing Scope | 5,995 |
| HP 54111D 500MHz/1Gsa/s Digitizing Scope | 6,995 |
| TEK 7603 w/7A18 (X2) & 7B53A Scope | 695 |
| TEK 7104 w/7A29 (X2), 7B10 & 7B15 Scope | 5,995 |

Over 600 TEK 7000, 5000 & TM Series Mainframes and Plug-Ins
Call for pricing information

## WAVE - DISTORTION - MODULATION

| | |
|---|---|
| HP 331A Distortion Analyzer 5Hz - 600 kHz | $195 |
| HP 332A Distortion Analyzer with AM Detector | 295 |
| HP 333A Distortion Analyzer with Auto Nulling & High Pass Filter | 395 |
| HP 334A Distortion Analyzer with Auto Nulling/High Pass Filter/ AM Detector | 495 |
| HP 3581C Selective Level Meter | 995 |
| TEK AA501 Distortion Analyzer | 1,295 |
| BOONTON 82AD/01/03/04 Modulation Meter | 995 |
| Marconi 2305 2.32GHz Modulation Meter w/IEEE | 4,995 |

***OVER 3000 ITEMS IN STOCK !***
***Inventory Changes Daily!***
***OVER 500 DC & AC POWER SUPPLIES !***
***Any Voltage - Any Current ! CALL***

**CALL FOR FREE 40 PAGE CATALOG**

## COMPONENT TEST

| | |
|---|---|
| HP 4342A Q Meter (22KHz to 70MHz) | $2.495 |
| HP 4342A/001 Q Meter (10KHz to 32MHz) | 1,650 |
| BOONTON 5110 LCR Meter 100Hz, 120Hz & 1 KHz Test Frequency | 1,450 |
| *includes 5110-1 Test Adapter & 5110-4 Kelvin Clip Adapter* | |
| BOONTON 728D Digital Capacitance Meter 1MHz Test Freq. 2pF to 2000pF | 750 |
| TEK 576 Curve Tracer | 2,995 |
| TEK 577/02 Curve Tracer | 1,695 |
| HUNTRON TRACKER 5000 Computer Controlled Troubleshooting System | 1,350 |
| SAUNDERS 150C/09 Crystal Test Oscillator Microprocessor Controlled/IEEE/1 to 60MHz | 1,695 |
| GENRAD 1630AV Inductance Measuring System | 2,995 |

## STANDARDS & CALIBRATORS

| | |
|---|---|
| FLUKE 5100B/03/05 Multifunction Calibrator | $5,750 |
| FLUKE 3330B DC Calibrator | 1,995 |
| FLUKE 515A Portable Calibrator AC/DC/RES | 1,695 |
| FLUKE 332B DC Calibrator | 595 |
| FLUKE 5205A AC Amplifier | 2,650 |
| FLUKE 5450A Resistance Calibrator 1 OHM to 100 megohms/8ppm | 1,995 |
| FLUKE 730A DC Transfer Standard | 450 |
| FLUKE 750A Reference Divider | 450 |
| FLUKE 720A Kelvin Varley Divider | 1,895 |
| ESI RV722 DC Divider 1ppm Accuracy | 1,295 |
| DATRON 4200/30/80 Autocal AC Standard | 2,495 |
| BOONTON 25A Power Meter Calibrator | 450 |
| BOONTON 2500A Power Meter Calibrator | 450 |
| HP 8477A Power Meter Calibrator | 495 |
| HP 11683A Range Calibrator | 775 |
| TEK PG506 Calibration Generator | 1,350 |
| TEK TG501 Time Mark Generator | 1,350 |
| TEK SG503 Leveled Sine Wave Generator 250KHz to 250MHz | 1,350 |
| TEK SG504 Leveled Sine Wave Generator 245MHz to 1050MHz | 2,650 |
| RFL 829G Multi-Function Calibrator | 1,495 |

## FREQUENCY COUNTERS

| | |
|---|---|
| HP 5314A 100MHz Universal Counter | $225 |
| HP 5315B 100MHz Universal Counter | 495 |
| HP 5316A 100MHz Universal Counter | 695 |
| HP 5328A/011/030 512MHz/IEEE Universal Counter | 695 |
| HP 5328A/011/031 1.3GHz/IEEE Universal Counter | 895 |
| HP 5340A/011 18GHz/IEEE Microwave Counter | 1,950 |
| HP 5342A/011 18GHz/IEEE Microwave Counter | 2,750 |
| HP 5300B/5303B 525MHz Counter | 450 |
| HP 5257A Transfer Oscillator for HP 5245 Counters | 175 |
| HP 5255A 3 to 12.4GHz Frequency Convertor | 175 |
| HP 5359A Time Synthesizer | 1,895 |
| SYSTRON DONNER 6054B 20Hz to 26.5GHz IEEE Microwave Counter | 2,295 |
| TEK DC5009 Programmable 135MHz Universal Counter | 695 |
| TEK DC505A 225MHz Universal Counter Plug-In | 295 |
| TEK DC508 1.3GHz Universal Counter Plug-In | 450 |

## SIGNAL SOURCES

| | |
|---|---|
| HP 8640B/003 512MHz Signal Generator w/Reverse Power | $1,895 |
| HP 8640B/001/002 1024MHz Signal Generator w/Audio Oscillator | 2,795 |
| HP 8656A 100KHz to 990MHz Synthesized Signal Generator | 2,995 |
| HP 8660C/86603A/86632B 2600MHz Synthesized Signal Generator | 3,995 |
| HP 8660A/86602A/86632B 1300MHz Synthesized Signal Generator | 2,350 |
| HP 8620C Sweeper Mainframe | 395 |
| HP 86222A 0.01 to 2.4GHz RF Plug-In | 1,495 |
| HP 86222B/001 0.01 to 2.4GHz RF Plug-In w/Crystal Markers & 70dB ATTN | 1,795 |
| HP 86290C 2 to 18.6GHz RF Plug-In | 2,395 |
| HP 86260A 12.4 to 18GHz RF Plug-In | 995 |
| HP 8697A 26.5 to 40GHz RF Plug-In | 1,450 |
| HP 214B Pulse Generator | 1,995 |
| HP 8005B 20MHz Dual Pulse Generator | 450 |
| HP 8007B 100MHz Pulse Generator | 695 |
| HP 8013B 50MHz Dual Pulse Generator | 695 |
| HP 3312A 13MHz Function Generator | 895 |
| BOONTON 2000 20GHz Sweep Generator | 2,450 |
| TEK FG501 2Hz to 2MHz Function Generator | 195 |
| TEK FG502 1KHz to 11MHz Function Generator | 295 |
| TEK FG503 1 to 3MHz Function Generator | 195 |
| TEK PG501 50MHz Pulse Generator | 250 |
| TEK PG502 250MHz Pulse Generator | 495 |
| TEK PG508 50MHz Pulse Generator | 795 |
| APPLIED MICROWAVE/EPSCO PG5KB 5kW/575 to 925MHz RF Pulser | 2,995 |
| VELONEX 380 5kW High Power Pulser | 2,995 |
| COBER 605/P27 2kW/10Hz to 1MHz High Power Pulser | 1,350 |

**We Buy & Sell Service Manuals**
**Coax/Waveguide Components**

**WANTED !**

**Surplus Electronic Test Equipment**
**FAX US YOUR LIST**

**FAX: 908-280-0111**

CIRCLE 273 ON FREE INFORMATION CARD

# Electronic SHOPPER®

BLOWOUT! **TIMELINE INC.** BLOWOUT!

**Over 10 years and 27,000 customers and still growing**

## LIQUID CRYSTAL DISPLAYS

**240x64 dot LCDs with built-in controller.**
AND 4021ST-EO. *Unit is EL back-lit.* $79.00 or 2 for $149.00
OPTREX. DMF5005 $69.00 or 2 for $129.00

**160 x 128 dot LCD** with built-in controller (T6963C)
20 character x 16 line $79.00 or 2 for $149.00
Mfr.: Toshiba TLX-1013-EO. *Unit is EL back-lit. Dim: 5¹⁄₁₆"L x 4⁹⁄₁₆"H.*
*The built-in controller allows you to do text and graphics.*

### Alphanumeric—parallel interface

| | | |
|---|---|---|
| 16x1 .........3 for $25.00 | 20x2 .................$12.00 | 40x1 ...................$8.00 |
| 16x1 (lg. char.)....$12.00 | 20x4 ...................$25.00 | 40x2 .........2 for $25.00 |
| 16x2 ......................$8.00 | 20x4 (lg. char.)....$25.00 | 40x4 ..................$25.00 |
| 16x2 (lg. char.)....$12.00 | 24x2 ...................$12.00 | 4x2 ......................$5.00 |
| 16x4 ....................$15.00 | 32x4 ...................$10.00 | |

5V power required • Built-in C-MOS LCD driver & controller • Easy "microprocessor" Interface • 98 ASCII character generator • *Certain models are backlit, call for more info.*

### Graphics and alphanumeric—serial interface

| size | Mfr. | price | size | Mfr. | price |
|---|---|---|---|---|---|
| 640x480 (backlit) | Epson | $35.00 | 480x128 | Hitachi | $15.00 |
| 640x400 (backlit) | Panasonic | $25.00 | 256x128 | Epson | $20.00 |
| 640x200 | Toshiba | $15.00 | 240x128 (backlit) | Optrex | $20.00 |
| 480x128 (backlit) | ALPS | $15.00 | 240x64 | Epson | $20.00 |
| | | | 160x128 | Optrex | $15.00 |

## LASER PRODUCTS

**HeNe Laser Head** (10Mw max. output) TEMOO. 15.5" long MFG: NEC **$99.00**
**Laser Power Supply** (for HeNe tube) **$89.00**

**LASER SCANNER ASSEMBLY $29.00**
Assembly intended for a laser printer. Includes laser diode, polygon motor (6 sided) and misc. optics and lenses.

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

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

**POLYGON MOTOR UNIT & DRIVER $79.00**
Ten-sided first surface mirror mounted on an armature that spins at 125 revolutions per second yielding a beam sweep rate of 1250 sweeps per second. The driver for the polygon unit requires 24 volts and plus and minus 12 volts to operate. There is also an f-theta lens in front of the polygon scanning mechanism with a three inch diameter. Great for optical experiments, etc. Very high quality units. (MFR: JAPAN ELECTRONICS)

## NETWORK

**Proteon ProNet-4 Model p1347 Token Ring Board $49.00**
16 bit • 4 Mbps • IEEE 802.2 and 802.5 compatible • twisted pair • interoperable with IBM Token Ring network

## POS & BAR CODE

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

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

## POWER SUPPLYS

**SWITCHING POWER SUPPLYS $12.00 or 2 for $20.00 115/230 Volts**
**73 WATT** (2) 4 pin power connectors attached • Dim: 8.5" L x 4.5" W x 2" H
Output: +5V @ 2-9.75, A, +12V @ 0-1.5 A, -5V @ 0-0.4 A, -12V @ 0-0.5 A
**68 WATT** Dim: 5.5" L x 3.2" W x 1.7" H • Output: 5V @ 4 A, 12V @ 4A
**60 WATT** Dim: 8¾ x 4¼ x 3 • Output:5V @ 6A + 12V @ 1A - 5V @ 1A - 12V @ 1A

## CHARGE COUPLED DEVICES

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

**MATRIX TYPE**

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

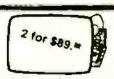
**LINEAR TYPE**

**4096 element CCD $19.00**
**1024 element CCD $15.00**
**2048 element CCD $15.00 • 1728 element CCD $15.00**

## MONITORS

**Non-Enclosed TTL**
Comes with pinout. 12V at 1.4 Amp input • Horizontal frequency 15Khz. • Ability to do 40 and 80 column.
**5 inch Amber $29.00 • 7 inch Amber $39.00**
**9 inch Amber or Green $29.95**

**5" COLOR MONITOR $49.00**





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

## MISCELLANEOUS

**ADAPTEC 4070A (RLL) OR 4000A (MFM), SCSI Controller, your choice $25.00**

**IBM 370 option XT and AT emulation boards $35.00**

## HACKER CORNER

**POINT OF SALE BANK TERMINAL $49.00 or 2 for $89.00**
• LCD Display 20 Char. x 4 Line • Printer 16 Column Dot Matrix - Epson • 24 Key Domed Membrane Keypad • Intel 80C32 Processor • 2 PCMCIA Sockets (ICC Slots) • Dallas DS1287 Realtime Clock • 2 Solid State Buzzers (Piezo Electric) • 4 Crystals • Rockwell Modem Chip • Telephone Line Interface (4 Pin "RJ" Connector) • RS-232 Interface (8 Pin "RJ" Connector) • NI-CAD Battery Pack Inside
Note: We have not been able to bypass an access code in the software. Thus, while time of day and other introductory things are displayed on LCD, the full original capabilities of this unit cannot be guaranteed. Also, we do not have a source for the smart cards that were to go in the PCM CIA sockets. Requires 12 volt adapter for power. (Not included) Dimensions: 9-1/2L x 6-1/4W x 2-1/2 D • Original cost over $450.00

**CAMERA BLOCK $149.00**
***FOR ROBOTICS AND EVERYTHING ELSE***
Unit is for Hi Band 8mm CamCorders, includes 8X zoom lenses, D/D converters, built-in CCD 2/3 in, 420 thousand picture elements, complementary mosaic filters. Excellent performance. High resolution, high sensitivity, low lag, low smear, good color reproduction, no distortion, 1/60-1/10000sec variable speed digital shutters, TTL auto focus, auto white balance, one-push auto white balance, auto/manual iris and gain up switch. Can be controlled by a 4bit micro computer. Remote controlling is possible for zoom and focusing. NOTE: These are PAL (European Standard) Units. **SONY PART #EVI-101 (PAL)**

**CELL SITE TRANSCEIVER $79.00 2 for $149.00**
These transceivers were designed for operation in an AMPS (Advanced Mobile Phone Service) cell site. The 20 MHz bandwidth of the transceiver allows it to operate on all 666 channels allocated. The transmit channels are 870.030-889.980 MHz with the receive channels 45 HMz below those frequencies. A digital synthesizer is utilized to generate the selected frequency. Each unit contains two independent receivers to demodulate voice and data with a Receive Signal Strength Indicator (RSSI) circuit to select the one with the best signal strength. The transmitter provides a 1.5 watt modulated signal to drive an external power amplifier. channel selection is accomplished with a 10 bit binary input via a connector on the back panel. Other interface requirements for operation are 26 VDC (unregulated) and an 18.990 MHz reference frequency for the digital synthesizer. The units contain independent boards for receivers, exciter, synthesizer, tunable front end, and interface assembly (which includes power supplies and voltage-controlled oscillator). Service manual, schematics and circuit descriptions included.

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

**Portable Micro Terminal $99.00 or 2 for $149.00**

SOLD OUT

Flip up LCD display (9-16 VDC) • Can communicate with any computer having RS 232 port • Can communicate with another Microterminal [illegible] electronic notebook • On board microprocessor, data RAM (32K) and Video RAM (64K) • [illegible] diagnostics and set up capabilities. • Original intention for POS applications. • display size 40x16 (256 x 128 pixels.) Dimensions: 6.3" W, 11"L, 2"H. (With LCD up height is 7.1")

**BAREBONES 286-12 COMPUTER $49.00 (2 FOR $79.00)**
Slimline desktop case, 100 watt supply, math co-processor support. On board IDE, & Floppy controllers. 2 COM ports and 1 parallel port with software setup. Supports up to 8 Megs using standard 30 PIN SIMMs. Internal room for (1) 3 1/2 inch IDE hard drive and (2) 3 1/2 inch floppies. Four 16 BIT ISA slots, accepts full length AT size cards. Keyboard can be set to no test at boot. Case size is 15.5"W x 16"D x 4"H.
**(Motherboard can be purchased separately: $29.00 or 2 for $49.00)**

**.6" COMPOSITE MINIATURE COLOR DISPLAY $149.00**
Fully encased. Dim: 1.3" x 1.3" x 4". 12 Volts DC power. NTSC signal. 250 H x 300 V resolution. Focus adjustable eyepiece. Applications include camcorder viewfinder, helmet mounted display, etc... Original cost over $600.00

**23605 Telo Ave., Torrance, CA 90505**
Order desk only: **USA: (800) 872-8878 CA: (800) 223-9977**
L.A. & Technical Info: **(310) 784-5488** Fax: **(310) 784-7590**
**OEM INQUIRIES WELCOME**

Minimum Order: $20.00. Minimum shipping and handling charge $5.00. We accept cashiers checks, MC or VISA. No personal checks or COD's. CA residents add 8.25% sales tax. We are not responsible for typographical errors. All merchandise subject to prior sale. Phone orders welcome. Foreign orders require special handling. Prices subject to change without notice. 20% restocking fee for returned orders.

CIRCLE 275 ON FREE INFORMATION CARD

# MCM ELECTRONICS®

**ELECTRONICS NOW READERS ONLY!**
**Save up to 50% on select items!**
**Take advantage of this tremendous offer.**
**Call today, time is limited!**
**To take advantage of this offer, you must supply this special price code:**

20th Anniversary 1996

**CODE: ENS28**

## Value And Selection From One Source...

- Test Equipment from Tenma, Fluke, Hitachi, Leader, B+K
- Name Brand and Low Cost Generic Technician's Tools
- OEM and Generic TV/VCR repair parts
- Over 10,000 American and Original Japanese Semiconductors

**MCM offers a comprehensive line of tools and test equipment engineered for the repair of computers, TVs, VCRs and more. In addition, you will find a wide variety of OEM and low cost generic TV/VCR parts, passive components and semiconductors, over 25,000 items in all, stocked and ready to ship.**

RITE OFF

SAVE 20%

### Projection Television (PTV) Coolant

Popular fluid is used by many large screen TV manufacturers and is a must when replacing CRTs in projection televisions. Direct replacement for Magnavox #4835-310-57233 and RCA 212072. 7.5 oz. can, 24 cans per case.

**#20-2040** Reg. ~~$4.99~~ Sale **$3.99**

SAVE 50%

#22-1145

#22-1150

### Security Bit Drivers For Nintendo and Sega

Driver bits allow easy removal of security screws found on many home video games, cartridges and accessories. ¼" hex size fits standard ¼" nut driver (MCM #22-1620) and most rechargeable screwdrivers. Available in two sizes.

**#22-1145 3.8mm** Reg. ~~$7.99~~ Sale **$3.99**
**#22-1150 4.5mm** Reg. ~~$7.99~~ Sale **$3.99**

SAVE 23%

### IR Remote Control A/B Switch

Allows wireless switching between two 75ohm inputs. Ideal for cable, antenna, dish or dual cable systems. Requires 12VDC, 100mA, AC adaptor included. Remote requires two "AA" batteries, not included. UL listed.

**#32-4425** Reg. ~~$25.75~~ Sale **$19.75**

**Prices effective October 3 through November 16, 1996**

**Hours: M–F 7 a.m.–9 p.m., Sat. 9 a.m.–6 p.m., EST.**

**For Complete Information On the items listed, or a FREE catalog, Call...**

# 1-800-543-4330

MCM ELECTRONICS®
650 CONGRESS PARK DR.
CENTERVILLE, OH 45459-4072
*A PREMIER Company*

FREE Catalog

RCA/GE Premier Distributor

Authorized Panasonic Quasar/Technics Original Parts Distributor

**Fast Delivery From Distribution Centers Near Reno, NV and Dayton, OH.** **CODE: ENS28**

CIRCLE 327 ON FREE INFORMATION CARD

# ALFA ELECTRONICS

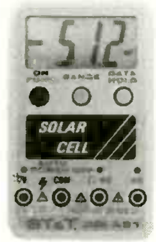
*HIGH QUALITY TEST EQUIPMENT*
*BEST PRICE*

## DMM 89 $179.00

***Most Advanced DMM***

*All Purpose & Communication*

- -80.7 to 81.4 dBm with 4Ω -1200Ω 20 reference impedances
- True RMS
- Frequency counter: 0.01Hz-10MHz
- Capacitance: 1pF-50,000μF
- Measure AC volt to 20kHz
- 5000 counts, 0.1% accuracy
- Auto/manual range, fast bar graph
- Min/Max/Ave/DH/Relative/Zoom
- Auto power off
- Input warning
- Splash proof
- Volt, amp, ohm, logic, diode, continuity
- Ruggerdized case
- Rubber holster included



## DMM A91

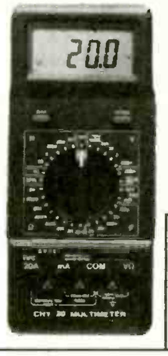
~~$49.95~~

**NOW $45.00**

***Plus Free Case***

*Solar Cell Powered*
*Large Display*

- Diode, Continuity
- Volt, Amp, Ohm
- Data Hold
- Auto power off
- 7 functions, 19 ranges
- 3.5 Digit, 0.6% accuracy
- Auto/Manual ranging
- Energy saver
- Student & hobbyist's favor



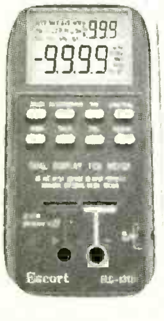
## DMM 20 $74.95

- Inductance: 1μH-40H
- Capacitance: 1pF-200μF
- Frequency: 1Hz-20MHz
- Volt, amp, ohm, diode, 20 Amp AC/DC current
- Transistor HFE
- Continuity, duty %
- Peak hold/Max
- Ruggerdized case
- Rubber holster $8.00

Full line of DMMs, economy, compact, ruggerdized, solar cell, automotive, heavy duty, industrial, starts from $19.95

**Fluke Multimeter**

| | |
|---|---|
| Fluke 12 | $84.95 |
| Holster C-10 | $10 |
| Fluke 70 II | $75.95 |
| Fluke 73 II | $97.50 |
| Fluke 75 II | $129 |
| Holster C-70 | $16 |
| Fluke 77 II | $155 |
| Fluke 79 II | $175 |
| Fluke 29 II | $175 |
| Fluke 76 | $175 |
| Fluke 87 | $287 |
| Fluke 867 | $1199 |
| Fluke 97 Scope Meter | $1785 |
| Fluke 105 Scope Meter | $2799 |



## LCR Meter 131D $229.95

***Most Advanced LCR***

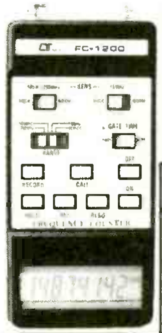
- Dual display:L/Q or C/D
- Inductance: 0.1μH-1000H
- Capacitance:0.1pF-10,000μF
- Impedance:1mΩ-10MΩ
- 0.7% basic accuracy
- Auto/manual range
- Dissipation factor & Q factor
- Serial & parallel mode
- Relative mode for comparison and to remove parasitics
- Statistics, tolerance,
- Best for design, incoming testing & production
- SMD and chip component test probe $25.00

## LCR Meter 814 $189.95

***Best Resolution LCR***

- Inductance: 0.1μH-200H
- Capacitance: 0.1pF-20,000μF
- Resistance: 1mΩ-20MΩ
- 1% basic accuracy
- Dissipation factor indicates leakage in capacitor and Q factor in inductor
- Zero adjustment to reduce parasitics
- Best for high frequency RF
- SMD and chip component test probe $25.00

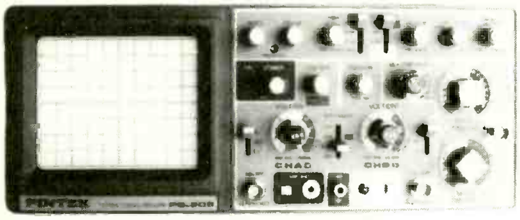
*LIMITED QUANTITY SPECIAL*
**DIGITAL LCR 680 $74.95**
0.1pF, 1μH, 10mΩ resolution



## Frequency Counter FC-1200 $129.95

- Frequency:0.1Hz-1.25GHz
- Display: 8 digit LCD
- Period: 0.1μs-0.1s
- Records Max/Min/Average
- Data hold, relative mode
- Telescoping antenna $8.00
- Deluxe case $5.00

*Also Available:*
AC/DC clamp meter,Light meter, Thermometer, pH meter, High voltage probe, Digital caliper, Anemometer, Electronic scale, Force gauge,Tachometer, Stroboscope, Humidity & EMF adapter, Sound level meter, Frequency counter, SWR/field strength/power meter, Dip meter



## 20 MHz Oscilloscope with Delay Sweep PS-205 $429.95

Dual Trace, Component test, 6" CRT, X-Y Operation, TV Sync, Z-Modulation, CH2 Output, Graticule Illum, 2 probes each has x1,x10 switch. Best price with delay sweep.

| | | |
|---|---|---|
| PS-200 | 20 MHz DUAL TRACE | $339.95 |
| PS-400 | 40 MHz DUAL TRACE | $494.95 |
| PS-405 | 40 MHz DELAY SWEEP | $569.95 |
| PS-605 | 60 MHz DELAY SWEEP | $769.95 |
| PS-1000 | 100 MHz DUAL TRACE | $999.95 |

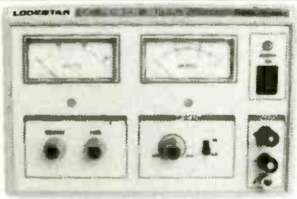
**Scope Probe:** 60MHz x1, x10 $15, 100MHz x1, x10 $22, 250MHz x1, x10 $29, 250MHz x100 $39

## Digital Storage Scope

**DS-303 30MHz, 20M Sample/sec $849.95**

**DS-303P with RS-232 interface $1,049.95**

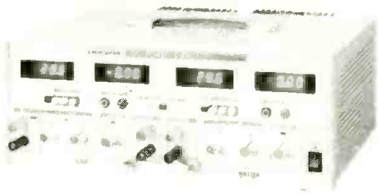
- Switchable between digital and analog modes
- 2 K word per channel storage
- 8 bit vertical resolution (25 Lerel/div)
- Expanded Timebase 10ms/div - 0.5 s/div
- Refresh, Roll, Save all , Save CH2, Pre-Trig
- Plotter control



## DC Power Supply PS-303 $159.00

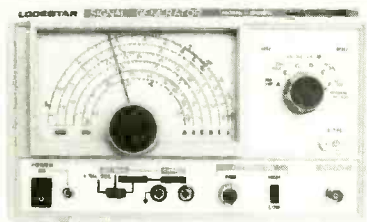
***0-30 VDC , 0-3A output***

- Constant voltage & constant current mode
- 0.02% + 2mV line regulation
- 0.02% + 3mV load regulation
- 1 mVrms noise and ripple
- Short circuit and overload protected
- PS-8200 with digital voltmeter $179.00
- Also available: 30V/5A, 60V/3A, 60V/5A 16V/10A, 30V/10A



## DC Power Supply Triple Output PS-8202 $499.95

- Two 0-30 VDC , 0-3A outputs
- One fixed 5VDC, 3A output
- Capable of independent or tracking operation
- Constant voltage and constant current mode
- Four digital meters for volt and current display
- Excellent regulation and low ripple
- Short circuit and overload protected
- Also available: 30V/5A triple output $549.95
- Dual tracking 30V/3A, 30V/5A, 60V/3A, 60V/5A



## RF SIGNAL GENERATOR SG-4160B $124.95

- 100 kHz-150MHz sinewave in 6 ranges
- RF Output 100mVrms to 35 MHz
- Internal 1kHz, External 50Hz-20kHz AM modulation
- Audio output 1 kHz, 1 Vrms

## RF SIGNAL GEN./COUNTER SG-4162 AD $229.95

Generates RF signal same as SG-4160B
6 digit frequency counter 1Hz - 150 MHz for internal and external source Sensitivity <50mV

## AUDIO GENERATOR AG-2601A $124.95

- 10Hz - 1MHz in 5 ranges
- Output: 0-8Vrms sinewave 0-10Vp-p squarewave
- Synchronization: ±3% of oscillation frequency per Vrms
- Output distortion: 0.05% 500Hz - 50kHz, 0.5 % 50Hz - 500kHz
- Output impedance: 600 ohm

## AUDIO GEN./COUNTER AG-2603AD $229.95

Generates audio signal same as AG-2601A
6 digit frequency counter 1Hz-150MHz for internal and external sources Sensitivity <50mV

## FUNCTION GENERATOR FG-2100A $169.95

- 0.2 Hz -2 MHz in 7 ranges
- Sine, square, triangle, pulse and ramp
- Output: 5mV-20Vp-p
- 1% distortion, DC offset ± 10V
- VCF: 0-10V control frequency to 1000:1

## FUNCTION GEN/COUNTER FG-2102AD $229.95

- Generates signal same as FG-2100A
- Frequency counter 4 digits
- Feature TTL and CMOS output

## SWEEP FUNCTION GEN./COUNTER $329.95

- 0.5Hz to 5 MHz in 7 ranges
- Sweep: Linear 10:1/Log 10:1 20ms to 2s
- AM Modulation
- Gated Burst, Voltage Control Generator
- Generator Control Voltage & 6 digit counter 1Hz-10MHz for internal & external sources

## ALFA ELECTRONICS

741 Alexander Rd., Princeton, NJ 08540

(800) 526-2532/(609) 520-2002
FAX:(609) 520-2007

15 DAY MONEY BACK GUARANTEE. 1 YEAR WARRANTY
CALL OR WRITE FOR FREE CATALOG

Visa, Master Card, American Express, COD, Purchase Order Welcome

CIRCLE 213 ON FREE INFORMATION CARD

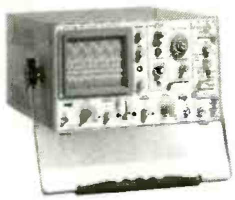
# instek® Test & Measuring Instruments

ISO 9002 CERT. #934163

## 100 MHz Cursor Readout Scope 4 ch, 8 traces OS-6101 $1,499.95

* 4 independent channels, 8 traces
* Time /Voltage cursor measurement
* ALT triggering function for 4 ch.
* Sweeps to 2ns/div, Delayed Sweep
* TV Sync., Ch. 1 output, Z-axis input
* 2 probes(x1, x10)

## 100 MHz Scope, 4ch. 8 traces Best value all purpose scope OS-6100B $1,329.95

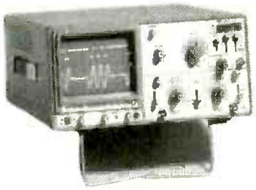


* 4 channels, 8 traces
* High sensitivity 500µV/div
* Sweeps to 2ns/div, Delayed sweep
* 20 kV accelerating voltage
* TV sync., Z-axis input
* A and B gate output
* Best price 100 MHz scope
* 2 probes(x1, x10)

## 50 MHz Triggering Oscilloscope OS-653 $699.95

* Dual Channel
* Hold Off Function
* Delayed Sweep
* Built-in Delay Line
* TV Sync
* ALT Triggering
* High sensitivity 1 mV/div
* Trigger level lock function
* Z-axis input, CH1 output
* 2 probes(x1, x10)

## 20 MHz Oscilloscope OS-622B $344.95



* Dual trace, X-Y operation
* TV Sync., Z-axis input,CH 1 output
* High sensitivity 1 mV/div
* Trigger level lock
* 2 probes (x1, x10)

OS-623B - 20 MHz w/Delayed Sweep.................$ 449.95
OS-935 - 5 MHz One channel..........................$ 209.95

## DC Linear Power Supplies Single Output

* Constant voltage and constant current mode
* Voltage regulation ≤0.01%
* Current regulation ≤0.2%
* Low ripple and noise
* Overload and reverse polarity protection
* Features 2 analog or 1 digital meter(PS series)
  2 analog or 2 digital meters(PR series)

PS-1830 : (0-18V, 0-3A)..............$209.95
PS-1830D : Digital Display..............$219.95
PS-1850 : (0-18V, 0-5A)..............$219.95
PS-1850D : Digital Display..............$244.95
PS-3030 : (0-30V, 0-3A)..............$224.95
PS-3030D : Digital display..............$254.95
PS-6010 : (0-60V, 0-1A)..............$209.95

PR-1810H : (0-18V, 0-10A)..............$349.95
PR-3060 : (0-30V, 0-6A)..............$314.95
PR-6030 : (0-60V, 0-3A)..............$314.95
PR-6030D : Digital Display..............$399.95

## Triple Output DC Power Supplies

* Two variable 0-30VDC, 0-3A outputs
* One fixed 5VDC, 3A output
* Auto tracking
* Auto serial and parallel operation
* Constant voltage and constant current mode
* Continuous/dynamic load can be selected
* Features 4 analog or 2 digital displays

PC-3030 (0-30V, 0-3Ax2)..............$499.95
PC-3030D : Digital display..............$549.95

## Programmable DC Power Supplies

* High stability , low drift, 4 digit display
* Front/rear output-sense switch selectable
* Auto step running w/timer settings
* 100 point programmability (PPS series)
* 50 point programmability (PPT series)
* Auto serial and parallel operation (PPT series)
* Auto tracking (PPT series), IEEE-488.2 and SCPI compatible command set (optional)

PPS-1860G: (0-18V, 0-6A)..............$1099.95
PPS-3635G: (0-36V, 0-3.5A)..............$1099.95
PPS-6020G: (0-60V, 0-2A)..............$1099.95
PPT-1830G: (0-18V, 0-3Ax2, 0-6V, 0-5A)..............$1399.95
PPT-3615G: (0-36V, 0-1.5Ax2, 0-6V, 0-3A)..............$1399.95

## Digital Display Function Generator FG-8016G $239.95

* Frequency Range: 0.02Hz to 2MHz
* Three Instruments in one: Function generator, Pulse generator & Frequency counter.
* Sine, Triangle, Square, TTL Pulse and CMOS output
* Built-in 6 digit counter with INT/EXT function
* 1000:1 tuning range
* Variable DC offset control

FG-8015 Function Generator
* 0.02Hz-2MHz (No Counter)..............$189.95

FC-8131 Intelligent Counter 1.3GHz..............$469.95
FC-8270 Intelligent Counter 2.7GHz..............$629.95
UC-2010G Universal Counter..............$294.95

## Digital Multimeter & C Meter DM-8034(3½ digits) $179.95

* 8 Function, AC/DC voltage, AC/DC current, resistance
* Built-in C meter, diode test and audible continuity check
* High voltage 1000V and 20A range
* 0.5% basic accuracy

DM-8040 (3¾ Digits, True RMS)
* Measures ACV to 50 kHz..............$339.95

DM-8055 (5½ Digits)..............$649.95
* 0.006% basic accuracy
* 1µV, 1mΩ, 1nA resolution
* dBm measurement
* Auto range, relative mode, Max/Min

DM-8055G(5½ Digits, GPIB)..............$889.95

## Model DM-392 (3¾ digits) $109.95

* Auto/Manual ranging(38 ranges)
* 42 Segment analog bar graph
* Data Hold/Min-Max memory /Relative mode
* Auto power off
* Overload protection
* Audible continuity check /diode test
* Capacitance: 1pF-40µF
* Frequency: 0.1Hz-1MHz
* 20 Amp range
* Double high energy fused (1A, 20A)
* 0.3% DCV accuracy

DM-351 : 3½ Digits w/Continuity, Auto Off..............$54.95
DM-352 : 3½ Digits, Cap. Freq. hFE, 20 Amp..............$79.95
DM-353 : 3½ Digits, Cap. Freq. Temp. hFE..............$84.95
DM-391 : 3¾ Digits, Auto, Cap. Freq. Min/Max..............$99.95
DM-392 : 3¾ Digits, Hold, Min/Max 20Amp..............$109.95
DM-393 : 3¾ Digits, Peak, Logic, hFE, Freq..............$119.95

**ALFA ELECTRONICS**

741 Alexander Rd., Princeton, NJ 08540

(800) 526-2532/(609) 520-2002 15 DAY MONEY BACK GUARANTEE. 2 YEAR WARRANTY

FAX:(609) 520-2007 CALL OR WRITE FOR FREE CATALOG AND QUANTITY DISCOUNT.

Visa, Master Card, American Express, COD, Purchase Order Welcome

CIRCLE 213 ON FREE INFORMATION CARD

# Keep your PCs up & running with the 100% accurate fix...

**Loop-back Plugs**—9-pin serial, 25-pin serial and 25-pin parallel plugs, used for external I/O port testing.

**Tri-State Logic Probe**—works with Post-Probe to enable testing down to individual chip level.

**Universally Compatible**
Works with any IBM or compatible computer and any operating system (DOS, Windows 95 & NT, OS/2, Unix, Novell, etc.


**Post-Probe™ Diagnostic Card**—when Post-Probe detects an error, a 2-digit BIOS code will display on the card telling you exactly what's wrong with your PC. 100% compatible with all ISA, EISA, Compaq and Micro-Channel PCs.

**Micro-Scope™ diagnostic diskettes**—containing the best PC diagnostic tools on the market. Comes with both 3.5" and 5.25" disks to work with any PC.

**Micro-Channel Adapter Card**—(behind Post-Probe card) allows Post-Probe to be used with Micro-Channel equipped computers.

**Durable Zip-up Leatherette Carrying Case**—all your tools in one organized, easy to carry toolkit.

**Complete Micro-Scope Manual**—easy to follow testing procedures and detailed error code descriptions. See the features list at left to view some of the incredible wealth of testing capabilities this program contains.

**Extensive Post-Probe Manual**—exhaustively complete, containing BIOS error codes for most PCs on the market. Look up the 2-digit error code in this manual and instantly diagnose your PC's problems. Also contains common chip diagrams, descriptions and complete troubleshooting tips.

## Micro-Scope™
UNIVERSAL DIAGNOSTIC SOFTWARE

## Fully O/S independent diagnostic software...

Call for Current Upgrade

*Call for upgrade pricing & complete new features list!*

Jerry **Pournelle** awarded MICRO-SCOPE & POST-PROBE the User's Choice Award in the May 1994 issue of Byte Magazine, stating: **"You name it, this tests it. If you maintain PCs you'll love it."**

◆ **LOW-LEVEL FORMAT**—Performs low-level format on all hard drives including IDE drives. ◆ **TRUE HARDWARE DIAGNOSTICS**—Accurate testing of CPU, IRQ's, DMA's, memory, hard drives, floppy drives, video cards, etc. ◆ **RELOCATES TRACK 0** on hard drives that support relocation. ◆ **IRQ CHECK**—Talks directly to hardware and shows I/O address and IRQ of devices that respond. ◆ **O/S INDEPENDENT**—Does not rely on O/S for diagnostics. Talks to PC at hardware level. All tests are full function regardless of O/S (i.e. Windows, Novell, UNIX, O/S2). ◆ **IRQ DISPLAY**—Show bits enabled in IRQ chip for finding cards that are software driven (Network, Sound Card, etc.). ◆ **MEMORY DISPLAY**—Displays any physical bit of memory under 1 MB. Very useful for determining memory conflicts and available memory space. ◆ **AND MUCH MORE...**We don't have enough space here for everything this software can do! Govt. Orders: NSN-7030-01-421-6459

## Post◆Probe™
First Ever Universal P.O.S.T. Card for All PCs!

## PC won't boot up? Find out why fast with our universal POST card...

Call for a FREE NEWSLETTER Subscription — Technician Newsletter

"This is the only card that will function in every system on the market. The documentation is extensive...covers the expected POST Codes for different BIOS versions...includes a detailed reference to the bus signals monitored by the card." **—Scott Mueller from *'Upgrading & Repairing PCs, 2nd Edition'***

◆ Includes pads for voltmeter to attach for actual voltage testing under load. ◆ 4 LEDs monitor +5vdc -5vdc +12vdc -12vdc. ◆ Monitors Hi & Lo clock and OSC cycles to distinguish between clock chip or crystal failure. ◆ Monitors I/O Write and I/O Read to distinguish between write and read errors. ◆ Accurately monitors progress of POST for computers *without* POST codes. ◆ Reads POST codes from any IBM or compatible that emits POST codes. ISA/EISA/MCA. ◆ Compatible with Micro Channel computers. ◆ Dip switch allows easy selection of I/O ports to read. ◆ Includes **TRI-STATE LOGIC PROBE** to determine actual chip failures. ◆ Manual includes chip layouts and detailed POST procedures for all major BIOSs. ◆ **AND MUCH MORE...**call for more details.
Govt. Orders: NSN-7025-01-421-6467

**Web Site: http://www.micro2000.com**

GSA Approved — PC UPGRADE Utility of the Month — Service News Product of the Month — Award Winning — 1993 BYTE Pournelle's User's Choice Award — Windows 95

*Professional Diagnostics from*
MICRO 2000™

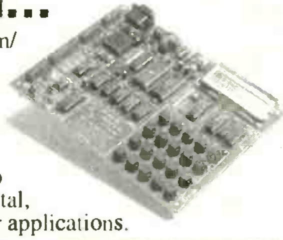
## Call Now for Latest Pricing
# 1-800-864-8008

VISA · MasterCard · American Express · Discover



CIRCLE 325 ON FREE INFORMATION CARD

# Learn MICROCONTROLLERS EMBEDDED SYSTEMS and PROGRAMMING...



...with the AES learning system/ embedded control system. Extensive manuals guide you through your development project. All programming and hardware details explained. Complete schematics. Learn to program the LCD, keypad digital, analog, and serial I/O. for your applications.

**THREE MODELS AVAILABLE. Choose from an Intel 8051, Intel 8088, or Motorola 68HC11 based system. All models come with:**

•32K Byte ROM, 32K Byte RAM • 2 by 16 Liquid Crystal Display • 4 by 5 Keypad • Digital, Analog, and Serial I/O • Interrupts,timers, chip-selects • 26 pin expansion connector • Built-in Logic Probe • Power Supply (can also be battery operated) • Powerful ROM MONITOR to help you program • Connects to your PC for programming or data logging (cable included) • Assembly,BASIC, and C programming(varies with model) • Program disks with Cross Assembler and many, well documented, program examples • User's Manuals: cover all details(over 500 pages) • Completely assembled and ready to use • Source code for all drivers and MONITOR • Optional Text Book

Everything you need. From $279.
Money Back Guarantee

Call for Free Info Pack, or see WEB at http://www.aesmicro.com
714-550-8094,FAX 714-550-9941

AES Advanced Educational Systems

**Call 1-800 -730-3232**

AES 970 W. 17TH STREET. SANTA ANA. CA 92706. USA

# DATA ACQUISITION

## and Control Hardware for PC's

**ANA100 Analog I/O .......... $ 99**

- 8 Channel 8-Bit
- 0 to 5 Volt Input
- 14 TTL I/O lines
- Analog Output
- 400KHz Sampling

**DIG100 Digital I/O ........... $ 39**

- 8255 PPI
- 24 or 48 TTL I/O Lines option
- Selectable Base Address

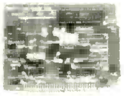
**ANA150 Analog/Counter... $ 89**

- 8 Channel 8-Bit 0 to 5 Volt input
- 3 16-Bit Counters
- 400KHz Sampling

**DIG200 Counter I/O ........ $ 79**

- 3 16-Bit Counters
- 8 TTL Input lines
- 8 TTL Output lines
- Selectable Clock Frequency input

**ANA200 Analog I/O .......... $ 79**



- 1 Channel 12-Bit 0 to 5 Volt input optional bi-polar
- 100KHz / 300KHz Sampling rate
- 24 TTL I/O lines

**ANA201 Analog .............. $ 129**

- 8 Channel 12-Bit
- x1, x5, x10, x50 Programmable Channel gain
- 100KHz/300KHz Sampling rate

## Engineering Software - PC/MSDOS

**Easy-PC Professional XM** - Integrated Electronics cad system, Schematic Capture, Circuit Analysis, and PCB Design in one software package ........................ $ 399.00

**PC-SCOPE** - Digital Storage Oscilloscope, 1, 2, 4, or 8 Channel Capture and Data Display. Works with ANA100, ANA150, and ANA201 Boards ........................$ 39.00

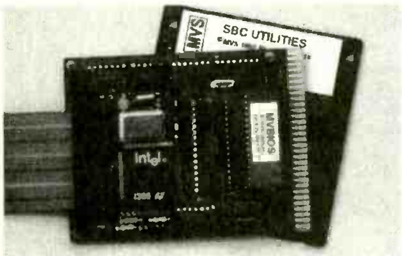
*MasterCard/Visa orders accepted*
*More hardware and software items available, Call for information or*
See our catalog on the internet: http://www.bsof.com
E-mail: sales@bsof.com

# BSOFT Software, Inc.

Phone 614-491-0832 * Fax 614-497-9971
444 Colton Road * Columbus, OH * 43207

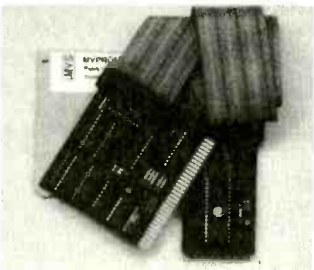
# 386 SBC $83

OEM (1K) PRICE INCLUDES:
- 5 SER (8250 USART)
- 3 PAR (32 BITS MAX)
- 32K RAM, EXP 64M
- STANDARD PC BUS
- LCD, KBD PORT
- BATT. BACK. RTC
- IRQ0-15 (8259 X2)
- 8237 DMA 8253 TMR
- BUILT-IN LED DISP
- UP TO 8 MEG ROM
- CMOS NVRAM




USE TURBO C, BASIC, MASM RUNS DOS AND WINDOWS
EVAL KIT $295

# $95 SINGLE PIECE PRICE UNIVERSAL PROGRAMMER



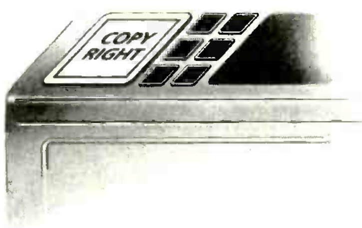

- DOES 8 MEG EPROMS
- CMOS, EE, FLASH, NVRAM
- EASIER TO USE THAN MOST
- POWERFUL SCRIPT ABILITY
- MICROCONT. ADAPTERS
- PLCC, MINI-DIP ADAPTERS
- SUPER FAST ALGORITHMS

OTHER PRODUCTS:

| | |
|---|---|
| 8088 SINGLE BOARD COMPUTER | .......OEM $27 ... *95 |
| PC FLASH/ROM DISKS (128K-16M) | ..................21 .....75 |
| 16 BIT 16 CHAN ADC-DAC CARD | ......................55 ...195 |
| WATCHDOG (REBOOTS PC ON HANGUP) | .....27 .....95 |

*EVAL KITS INCLUDE MANUAL BRACKET AND SOFTWARE.
5 YR LIMITED WARRANTY
FREE SHIPPING
HRS: MON-FRI 10AM-6PM EST

MVS
*MVS BOX 850*
*MERRIMACK, NH*
*(508) 792 9507*




The Most
~~AN~~ **IMPORTANT PART OF YOUR PHOTOCOPIER ISN'T PART OF YOUR PHOTOCOPIER**

Having a machine may not permit you to photocopy books, journals, newsletters and magazines.
The Copyright Clearance Center CAN.
Contact us to find out
how you too can COPY RIGHT!SM

**COPYRIGHT CLEARANCE CENTER**

222 Rosewood Drive, Danvers, MA 01923 ☐ Tel. (508) 744-3350 ☐ Fax (508) 741-2318

# EARN MORE MONEY!

## Be an FCC LICENSED ELECTRONIC TECHNICIAN!


No costly school. No commuting to class. The Original Home-Study course prepares you for the "FCC Commercial Radiotelephone License." This valuable license is your professional "ticket" to thousands of exciting jobs in Communications, Radio-TV, Microwave, Maritime, Radar, Avionics and more...even start your own business! You don't need a college degree to qualify, but you do need an FCC License.

**No Need to Quit Your Job or Go To School**
This proven course is easy, fast and low cost! GUARANTEED PASS—You get your FCC License or money refunded. **Send for FREE facts now. MAIL COUPON TODAY!**

Or, Call 1-800-932-4268 Ext. 210

**COMMAND PRODUCTIONS**
FCC LICENSE TRAINING, Dept. 210
P.O. Box 2824, San Francisco, CA 94126
Please rush FREE details immediately!

NAME ______________________
ADDRESS ______________________
CITY ____________ STATE ______ ZIP ______

# ONLY COOL-AMP SILVERPLATES ON THE JOB.

From a customer testimonial:

"Ok, your edge connectors don't connect. Or you want to plate your own PC creations, but you don't want to bother with electro-plate solutions. The plating on the socket...has worn off and no longer makes reliable contact...what are you going to do now?

"Give the people at Cool-Amp a call. They have a silver plating compound I have used for the past couple of years that solves all of the above problems and more. This white powder has an infinite shelf life...and is easy to use.

"It will actually put a permanent silver plate on copper, brass or bronze...There are no messy or dangerous chemicals. Application could not be easier. Use a clean rag and a little bit of water and just rub it on a clean surface. In minutes you can permanently silver plate a circuit board or replate a power amp tube or socket.

"It has saved me time, money and my sanity."

**Cool amp has even outperformed electroplating in recent tests. It is time-proven since 1944.**

COOL-AMP

# AND CONDUCTO-LUBE. *THE* SILVER-BASED CONDUCTIVE LUBRICANT.

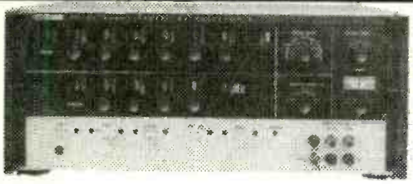
The upstart, since 1952. Developed for switches, uses continue to expand to all applications needing a conductive lubricant.

Conducto-Lube

**ORDER FACTORY DIRECT:**
**503-624-6426 or FAX 503-624-6436**

CIRCLE 228 ON FREE INFORMATION CARD

# Quality Reconditioned Test Equipment from Danbar



## Fluke 5200A
Programmable ac calibrator, outputs from 100 μV rms to 120 V rms at 50 mA. Frequency range 10 Hz to 1 MHz, amplitude range is 1 mV to 1000 V.

**Special $1500.00**

## Fluke 5215A
Power Amplifier, output voltages to 1100 Vrms, max output of 200 W, frequency from 10 Hz to 100 kHz.

**Special $1500.00**

## Fluke 5220A
Transconductance Amplifier, lets you calibrate meters and shunts, 20 amps output dc or rms ac, 0.25% basic dc accuracy.

**$2800.00**

## Fluke 720A
Kelvin-Varley Voltage Divider, 0.1 ppm resolution, 0.1 ppm of input absolute linearity.

**Special $1000.00**

## Fluke 5100B Calibrator
Calibrator for analog and digital multimeters up to 4.5 digits, five functions: direct or alternating voltage or current plus resistance. Opt 03, 05.

**$4350.00**

## Fluke 5101B Calibrator
Similar to 5100B but has procedure storage feature. Opt Y5000 Interface buffer for 5205A, 5215A and 5220A.

**$5000.00**

## Fluke 335D
Dc Standard Null Detector, 1 μV to 1000 Vdc with .001% accuracy.

**$750.00**

## ESI RV622A Dekavider
Decade voltage divider, 6 dial, 10,000 Ω.

**$199.00**

WANTED USED TEST EQUIPMENT

## Fluke 5440B
Direct Voltage Calibrator, 0 to 1100V range, completely automatic internal calibration, procedure storage module for single button set-up, completely programmable through the GPIB/ IEEE-488 interface.

**$5600.00**

## Fluke 931B
True RMS Voltmeter, measures .01 to 1100 V in 5 ranges over 2 Hz to 1 MHz frequency range.

**$450.00**

## Fluke 5450A
Resistance Calibrator, 17 standard resistors in 1 box, decade values from 1.0Ω to 100 MΩ, 1.9 multiples from 1.9Ω to 19 MΩ, GPIB/IEEE-488 programmable.

**$1250.00**

## Fluke 343A
Dc Voltage Calibrator, 7 decade instrument with a basic accuracy of 20 ppm and a resolution of 1 μV on the 10 μV range, 0 to 1100V output, 0 to 25 mA, 0.1 ppm resolution.

**$1000.00**

## Fluke 752A
Reference Divider, 10:1 and 100:1 division ratios, ratio accuracy of 0.2 ppm on 10:1 ratio, ratio accuracy of 0.5 ppm on 100:1 ratio, built-in calibration bridge.

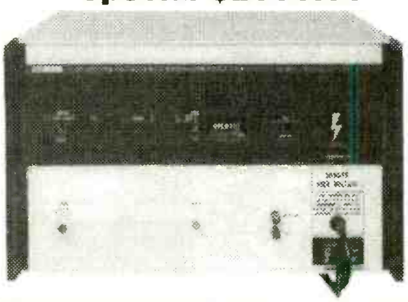
**$1750.00**

## Fluke 332D
DC Voltage Calibrator, output voltage ranges from 0 to 1111.1110 Vdc and is set by 7 in-line decade switches.

**$149.00**

## Fluke 5205A
Precision Power Amplifier, extends the range of 5700A, 5100B series, 5200A or 5400B calibrators, output voltages to 1100V rms, ±1500V dc, max output power 220 watts, dc to 100 kHz.

**Special $2000.00**



## Fluke 540B
Transfer Standard, this is a thermal instrument used for precise measurement and calibration of ac voltage and current, voltage transfers from 0.25 to 1000 Vrms in 14 ranges with a frequency from 5 Hz to 1 MHz.

**$550.00**

## ESI DB62
Variable Resistor, 6 decades, 11,111,100Ω, 10 MΩ max in .01Ω steps.

**$199.00**

## Fluke 515A
Portable Calibrator provides dc voltage, ac voltage and resistance standards in a compact unit. 0 to 100 Vdc, 2 μV resolution, 0 to 100 Vac, 0 to 10 mA rms.

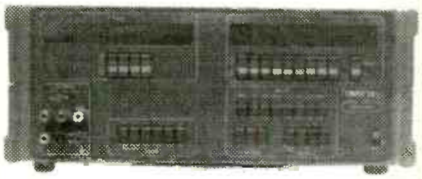
**$1500.00**

## Fluke 845AR
Voltmeter/ Null Detector, high input impedance, 1 μV to 1000V in 19 ranges, input resistance 100 MΩ on 300 mV and above, 10 MΩ on 100 mV and below.

**Special $300.00**

## Datron 4000A
Autocal Standard, high-precision calibrator with exceptionally high stability and full system capability. Provides dc voltage calibration facilities in 8 decade ranges from ± 100 μV to 1000 V, 7.5 digit, IEEE 488.

**$5000.00**



## Fluke 8922A
True RMS Voltmeter, 2 mV to 700V ranges, 4 digit display, relative dB, 2 Hz to 11 MHz.

**$700.00**

## Fluke A55 Set of 9
High Frequency Thermal Converters, set of 9 pieces.

**$1500.00**

*Please call for our Free 1996 Catalog*

14455 NORTH 79TH STREET • UNIT C • SCOTTSDALE • ARIZONA 85260
(602) 483-6202 • FAX (602) 483-6403

DANBAR SALES COMPANY

CIRCLE 235 ON FREE INFORMATION CARD

## Electronic Soldering System

Here's the ideal solution when **Temperature Control** is required. Easy to use slide control allows user to set system from 300°F to 840°F. Voltage to iron from control unit is 24V Iron heating power is 48W. Replaceable 5.3mm tip is standard. Replacement irons and tips are available.

AS LOW AS $50.00

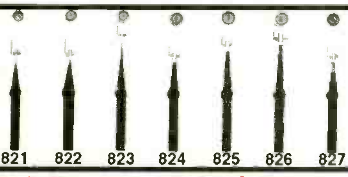
| CAT NO | DESCRIPTION | PRICE EACH 1 | 5 |
|---|---|---|---|
| SL10 | Temp Controlled Soldering Iron | $56.00 | $50.00 |
| SL24V | Spare 24V Soldering Iron | 10.50 | 7.50 |

## Electronic Soldering System with LED Display

Deluxe temperature controlled system with LED display for maximum accuracy. Temperature is adjustable from 160°-480°C (320°-900°F). Iron heating power is 48 Watts. Runs on 24V from controller unit. Replacement irons and tips are available. Tip size is 5.3mm.

| CAT NO | DESCRIPTION | PRICE EACH 1 | 5 |
|---|---|---|---|
| SL30 | Deluxe Soldering System w/LED | $86.00 | $75.00 |
| SL24V | Spare 24V Soldering Iron for SL10 or SL30 | 10.50 | 7.50 |

AS LOW AS $75




## Replacement Tips for SL10/SL30

We now offer a variety of replacement tips for the SL10/SL30 soldering stations.

| CAT NO | DESCRIPTION | PRICE EACH 1 | 5 |
|---|---|---|---|
| 821 | 1/32" Pencil Tip | $1.39 | $1.19 |
| 822 | 1/32" Pencil Tip | 1.39 | 1.19 |
| 823 | 1/64" Pencil Tip | 1.39 | 1.19 |
| 824 | 1/16" Chisel Tip | 1.49 | 1.29 |
| 825 | 1/8" Chisel Tip | $1.49 | $1.29 |
| 826 | 3/64" Chisel Tip | 1.49 | 1.29 |
| 827 | 3/64" Pencil Tip | 1.59 | 1.39 |

## Ball Bearing 12V DC Fans

These High Quality Fans feature Ball Bearings and Brushless DC Motors. All of them are designed to meet UL, CSA & VDE Standards. Design these fans into power supplies, computers or other equipment requiring additional air flows for heat removal. These fans are regular Circuit Specialists stock items — they are not surplus.

**INDUSTRY BEST PRICING!**

| CAT NO | PRICE EACH 1 | 10 | 25 | 100 |
|---|---|---|---|---|
| CSD 4010-12 | $ 9.88 | $ 6.38 | $5.48 | $4.87 |
| CSD 6025-12 | 9.38 | 5.91 | 5.41 | 4.71 |
| CSD 8025-12 | 8.88 | 5.85 | 5.19 | 4.49 |
| CSD 9225-12 | 8.95 | 6.14 | 5.29 | 4.59 |
| CSD 1225-12 | 11.45 | 8.96 | 7.82 | 6.85 |

### Specifications

| CAT NO | DIMENSIONS (MM) | RATED VOLTAGE (V) | START VOLTAGE (V) | INPUT CURRENT (A) | AIR FLOW (CFM) | STATIC PRESSURE (INCH-$H_2O$) | SPEED (RPM) | NOISE LEVEL (dB) | WEIGHT (g) |
|---|---|---|---|---|---|---|---|---|---|
| CSD 4010-12 | 40x40x10mm | 12 | 7 | 0.06 | 5.1 | 0.19 | 5,500 | 26 | 20 |
| CSD 6025-12 | 60x60x25mm | 12 | 5 | 0.13 | 13.7 | 0.165 | 4,500 | 28 | 65 |
| CSD 8025-12 | 80x80x25mm | 12 | 5 | 0.16 | 37.8 | 0.177 | 3,000 | 31 | 80 |
| CSD 9225-12 | 92x92x25mm | 12 | 5 | 0.32 | 42 | 0.18 | 2,800 | 37 | 95 |
| CSD 1225-12 | 120x120x25mm | 12 | 5 | 0.35 | 62 | 0.180 | 2,500 | 42 | 135 |

## • SOLDER • SOLDER • SOLDER • SOLDER • SOLDER • SOLDER •

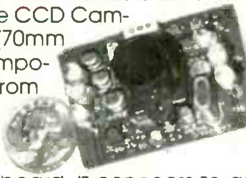

We stock high quality 60/40(Sn%/Pb%), .031" and 63/37, .031" diameter. This is prime JIS certified solder that we maintain as a regular stock item (It is not "Left-overs, Rejects or Surplus") and you can buy it from us at a fraction of the price that you are used to.

***Tired of Paying Inflated Prices for Solder?***

| CAT NO | DESCRIPTION | PRICE EACH 1 | 10 | 25 |
|---|---|---|---|---|
| RH60-1 | 1-lb. Spool, .031", 60/40 | $ 6.90 | $ 5.96 | $ 5.30 |
| RH63-1 | 1-lb. Spool, .031", 63/37 | 6.95 | 6.10 | 5.41 |
| RH60-4 | 4.4-lb. Spool, .031", 60/40 | 24.00 | 21.90 | 17.92 |
| RH60-TUBE | 6-oz. Tube, .031", 60/40 | .99 | .89 | .79 |

## CCD Camera - IR Responsive

***As Low As $109!!***



This black and white monochrome CCD Camera is totally contained on a PCB (70mm x 46mm). The lens is the tallest component on the board (27mm high from the back of the PCB) and it works with light as low as 0.1 lux. It is IR Responsive for use in total darkness. It comes with six IR LED's on board. It connects to any standard monitor, AUX or video input on a VCR or through a video modulator to a TV. Works with a REGULATED 12V power supply (11V-13V). Hooks up by connectiong three wires: red to 12V, black to ground (power & video) and brown to video signal output.

| CAT NO | DESCRIPTION | PRICE EACH 1 | 5 |
|---|---|---|---|
| CA-H34A | PCB Mounted IRCCD Camera | $125.00 | $109.00 |

## !!!!!!! SEE OUR ON-LINE CATALOG AT http://www.cir.com !!!!!!!

# CIRCUIT SPECIALISTS, INC.

***SINCE 1971***

**800-811-5203**
**602-464-2485**
**602-464-5824(FAX)**

**WE ACCEPT:** VISA MasterCard NOVUS

## RECEIVE OUR LATEST 132 PAGE CATALOG!


It's chock full of all types of electronic equipment and supplies. We've got I.C.'s, capacitors, resistors, pots, inductors, test equipment, breadboarding supplies, PC supplies, industrial computers, data acquisition products, personal computers and computer parts, plus much, much more. FAX us your name and address or call 800-811-5203, ext. 5, to leave a message on our catalog request line.

CIRCLE 312 ON FREE INFORMATION CARD

# BRIGAR ELECTRONICS

7-9 ALICE ST.-BINGHAMTON, NY 13904

PHONE: (607) 723-3111
FAX: (607) 723-5202
E-MAIL: BRIGAR2@aol.com

SEND FOR FREE CATALOGUE

WAREHOUSE SALE

CREDIT CARD DISCOUNT

| | | |
|---|---|---|
| $ 0.00 | - $ 99.99 | NET |
| $100.00 | - $249.99 | LESS 10% |
| $250.00 | - $499.99 | LESS 15% |
| $500.00 | - $999.99 | LESS 20% |
| $1000.00 | AND UP | LESS 25% |

WHY PAY MORE ?

SERVING: ■INDUSTRY ■SCHOOLS ■HOBBYISTS ■EXPERIMENTORS ■CONSUMERS

OPEN: MONDAY THRU FRIDAY 7:30AM TO 4:30 PM, SATURDAY 7:30AM TO NOON

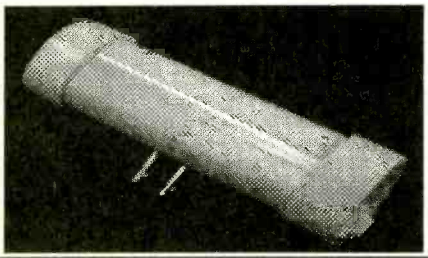
## PORTABLE FLUORESCENT - MINI LIGHT

**Plug in anywhere - No Wiring - as bright as a 20-Watt Bulb.**

- ■Energy efficient fluorescent bulb costs only pennies a day.
- ■Plugs into any standard outlet
- ■Convenient ON/OFF switch
- ■Completely portable -plugs into any standard outlet.
- ■Lasts up to 3 years with normal use.
- ■UL Listed. - 3.5watt - 120vac
- ■Size: 5-1/4"Long x 1-1/4"H x 1-3/4"deep
- ■Color: White

Use at Home: kitchen,hallway,stairway,bedroom etc.
Use away: RV,Boat,Motel room,Camp

**BRAND NEW - DISPLAY PACKED.**



*SNAPIT*
A LEVITON DIVISION

**SALE.... $4.95 EA.**

## OPTREX #DMF50140NF-SEW INTELLIGENT GRAPHIC LCD MODULE

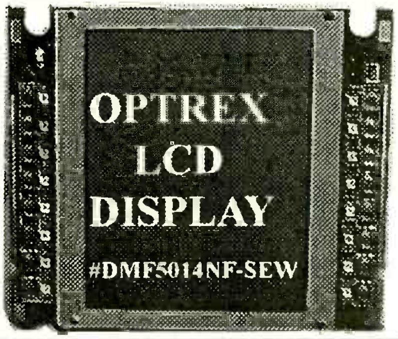
"SUPERTWIST" Modules utilize surface mount technology. Displays Blue pixels on White backruond. Modules have E-L Backlighting - Graphic Figure Character Display. Unit comes complete with built in drivers & 8 bit tti interface.

- •CONTROL LSI T6963C TOSHIBA
- •VIEW ANGLE: 6:00 •DOT SIZE: .44(W) x .57(H) mm
- •DIT PIXELS 143(W) x 153(H) mm •VIEW AREA 74.8(W) x 98.4(H) mm
- •DC VOLTAGE: 5VDC •GRAPHIC, FIGURE & CHARACTER DISPLAY
- •HIGH CONTRAST & WIDE VIEW ANGLE •FILM TYPE BACKROUND

Using this information, one should be able to interface the LCD to any microcontroller or a microprocessor.

PROGRAM DISKETTES contains list of all commands, a file that contains list of initialization steps, and a text file that has the 68hc11 program

LIST PRICE... $119.95 ***BRIGAR SPECIAL $59.95***




DISPLAYS COMES COMPLETE WITH 3.5" DISKETTE. FILES CONTAIN 68HC11 PROGRAM, LIST OF COMMANDS AND Initialization steps, Schematic, and pin out

## ULTRASONIC LIGHT SWITCH MFG: LITRONIC

REPLACES EXISTING WALL SWITCH - OPERATES FROM 120VAC POWER. GREAT FOR HOME ALARM SYSTEMS OR CONTROLLING LIGHTS & SMALL APPLIANCES - ADJUSTABLE TIME & SENSITIVITY, ON-OFF SWITCH - LED TRIP INDICATOR - COLOR: WHITE

**SIZE: 5"W x 5"H X 1-3/8"D**

CAN BE USED WITH SINGLE OR DOUBLE SWITCHES.

ON/AUTO SWITCH TURNS LIGHTS OFF MANUALLY WHEN NECESSARY OR LEAVES LIGHTS IN UTOMATIC CONTROL MODE.

- ●**VOLTAGE** 120 OR 277VAC 50/60HZ
- ●**MIN LOAD** 80 WATT 120V
- ●**MAX LOAD** 1000W 120V

SENSOR LOW POWER ULTRASONIC 25KHZ

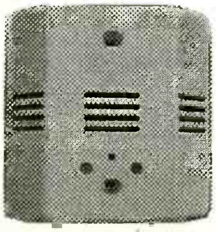
- ●**SENSOR COVERAGE:** 250 SQ. FT. WITH 180 DEG. DETECTION FIELD
- ●**ADJUSTMENT:** SENSITIVITY & TIME OUT (0 TO 25 MINUTES)
- ●**DOCUMENTATION & SCHEMATIC INCLUDED.**

**ENERGY SAVINGS 30 TO 60%**

ORIGINAL PRICE $100.00

***SPECIAL SALE PRICE***
***..... $12.95 EA.***
***5 FOR $60.00***

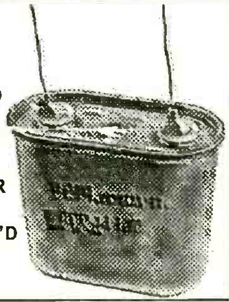
**MOTION SENSING AUTOMATIC SWITCH**



## *AEROVOX*

**# P2066601YR**
**1.9 UF @ 660V 50/60 HZ**
SIZE: 2-1/4"H x 2"W x 1"D
**PRICE..... .90 EA.**

***AEROVOX* # N20R7001YR**
**1.6 UF @ 700V 60HZ**
**SIZE: 2-1/16"H x 2"W x 1"D**
**PRICE.... $1.00 EA.**

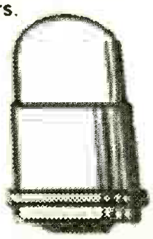


## CHICAGO MINIATURE LAMPS

**# CM385** - Base Style: midget flanged
Brand New - Packed 100 pcs./card
28 volts .04 amp - 50,000 life Hours
Bulb style: T-1 3/4 - Same as 387 Lamps except has twice the life hours.

**Regular Price .. 60¢ ea.**
**BRIGAR SPECIAL**
**SALE 20¢ EA.**

GET MORE *for Less*



## COMPUTER PRODUCTS POWER CONVERSION

**5 - 9 WATT DC/DC CONVERTER**
**PART # EM951S**
**OUTPUT: ± 12 VDC ± 375 MA**
**INPUT: 5 VOLT DC**
PC MOUNTABLE
500V ISOLATION
REGULATED LINE: 1.2%
REGULATED LOAD: 8%
REFLECTED RIPPLE: 75MA P-P
Size: 2" square x .4" thick
REGULAR PRICE ... $20.00
**PRICE SLASHED ....$4.95**

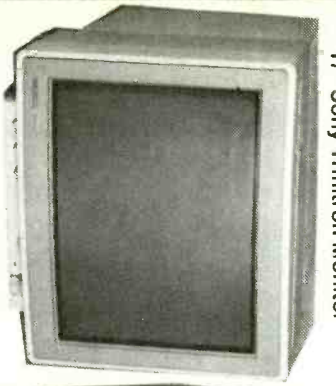



CIRCLE 336 ON FREE INFORMATION CARD


Unbeatable Discount Prices
1 YEAR WARRANTY
15 DAY MONEY BACK GUARANTEE
POWER SUPPLY
FREQ. COUNTER
SWEEP FUNCTION GENERATOR
MULTI-METER
MT-100
Reg. $599.
$419.00
Four Instruments in One Instrument
1 Function Generator
• Sine, Square, Triangle, Pulse, Skewed Sine, Ramp, TTL
• 0.2 Hz ~ 2MHz
2 Frequency Counter
• 8 Digit LED
• 1 Hz ~ 100MHz
• ± (1 Hz + 1 dgt. + Time Base Error)
3 Power Supply
• 3-1/2 Digit LCD
• Triple output: #1. 0~50V, 0.5A MAX #2, 15V, 1A #3. 5V, 2A
4 Digital Multimeter
• 3-1/2 Digit LCD
• DCV, ACV, Ω, DCA, ACA
• ± (0.5% + 2 dgts)
FG-140
2MHz Function Generator
Reg. $249. $149.00
• 0.2 Hz ~ 2.0 MHz, 7 Decades
• Sine, Square, Triangle, Pulse, Ramp, Skewed Sine
• VCF, Symmetry
• Variable DC Offset Control
2MHz Sweep Function Gen. w/Freq. Counter
FG-150
Reg. $399. $229.00
• 4 Digit LED Display
• Sine, Square, Triangle, TTL, Pulse, Ramp, Skewed Sine
• Linear/Logarithmic Sweep
• 10 MHz Freq. Counter
1.0GHz Frequency Counter, High Resolution
FC-200
Reg. $399. $219.00
• 1.0 Hz ~ 1.0 GHz
• 8 Digit LED Display
• Auto & Manual Range
• 4 Selectable Gate Times
• 1MΩ & 50Ω Input Impedance
Oscilloscope Probe Set
Switch Selectable X1/X10
HP-9060, 60MHz
Reg. $29. $17.00
HP-9150, 150MHz
Reg. $49. $27.00
HP-9250, 250MHz
Reg. $59. $37.00
PS-500 DC Power Supply
Reg. $249. $159.00
• 0-30VDC
• 0.1 ~ 3A
• Short & Overload Protection
PS-540 DC Power Supply
Reg. $399. $249.00
• 0 - 16 VDC
• 0.1 ~ 10A
• Short & Overload Protection
Deluxe O'scopes w/Phillips CRT. "BEST BUY!"
OS-3304
Reg. $499.
$349.00
OS-3324
Reg. $599.
$429.00
OS-3344
Reg. $899.
$649.00
OS-3304 25MHz, Dual Trace
1 • DC to 25 MHz. Dual Channel
• 6" Rectangular CRT with Internal Graticule 10x8cm (Phillips P31)
• Uncalibration LED.
• High Sensitivity 1 mV/div to 2mV/div X-Y modes, Z Axis (intensity modulation)
• Rise time 14n Sec. or less.
• Full TV Trigger for TV-V & TV-H
• Acceleration Potential 2kV
• 60MHz (X1.X10) Probe Kit: 2 sets
• Power: 115/230V AC
OS-3324, 3 Function
1 • OS-3304
2 • Dual Component Tester/Comparator
3 • Triple DC Power Supply 5VDC, +12 VDC, -12VDC
OS-3344, 5 Function
1 + 2 + 3 • OS-3324
4 • Frequency Counter 100MHz, 7 Digit LED Display
5 • Function Generator 0.02 Hz to 2.0 MHz
OS-3315
40MHz, Dual Trace
Sweep Delayed
Reg. $799. $549.00
• DC to 40 MHz. Dual Channel
• Delayed Sweep 100nS to 1.0S 7 decade
• 6" Rectangular CRT with Internal Graticule 10x8cm (Phillips P31)
• Uncalibration LED.
• High Sensitivity 1 mV/div to 2mV/div X-Y modes, Z Axis (intensity modulation)
• Rise time 8.5nS or less.
• Full TV Trigger for TV-V & TV-H
• Acceleration Potential 12kV
• Variable Hold Off
• 16ns ~ 1.0s Time Base
• 60MHz (X1.X10) Probe Kit: 2 sets
• Power: 115/230V AC
Bel MERIT
DM5050C
DM5100
Reg. $149.
$89.00
Including Deluxe Holster
Features (DM5050C/DM5100)
• Basic DCV Accuracy: ± 0.25%
• AC/DC Volt & Amp, Ohm
• Diode, Continuity Beeper
• Alligator Clip Test-Leads
• Lead Holders/Velcro Strap Holster
DM5050C, DMM + Capacitance
• 9 Function / 42 Range
• Multimeter
Ohm: Up to 2000MΩ
Amp: AC/DC 2 Amp
• Extended Capacitance Meter (9 Range) 0.1pF - 20,000µF
Zero Adjust Knob
• Trig Lamp
DM5100, Wide Range w/Logic
• 11 Function / 45 Range
• Auto Power Off
• Data Hold & Peak Hold
• Freq: Up to 20MHz
• Amp: Up to 20A AC/DC
• Ohm: Up to 200MΩ
• Capacitance: 1p - 200µF
• Logic: TTL, TR hFE
Digital Engine Analyzer
Reg. $119. $69.00
DM230
• 3 1/2 Digit LCD
• Engine Analyzer Taco, Dwell, Duty Cycle
• DMM DCV, DCA, Ω
• Temperature 0 ~ 1,999°F
• Diode
• Continuity
• Holster, Temp. Probe, Clip Leads
Capacitance Meter
Reg. $79. $49.00
CM210
• 3 1/2 Digit LCD
• 0.1p-20,000µF 9 Ranges
• 0.5% basic Accu.
• Zero Adjust Knob
• Test Leads & Built in Socket
Pen-Type DMM w/Logic
Reg. $79. $59.00
DM150
• 3 1/2 Digit
• Dual Display
• Auto & Manual
• DCV, ACV, ACA, DCA, Ω
• Logic CMOS/TTL
• Data Hold
• Diode
• Continuity
Multifunction DMM
Reg. $99. $64.00
DM4050
• 3 1/2 Digit
• Basic Accuracy: 0.25%
• Heavy Duty, 20A AC/DC Resistance 20MΩ
• Capacitance
• Freq. up to 20MHz
• TR-hFE
• Diode
• Continuity
• Deluxe Holster
BMC Your Best Source for High Standard Electronics
P.O. Box 744, Lake Forest, CA 92630-0744
Order & Free Catalog
800-532-3221
(714) 586-2310 Fax (714) 586-3399
VISA
MasterCard
CIRCLE 335 ON FREE INFORMATION CARD

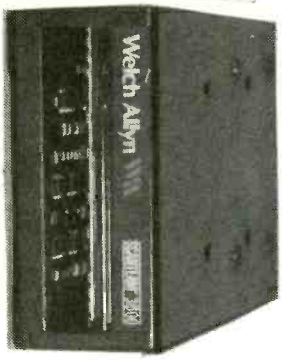
CIRCLE 305 ON FREE INFORMATION CARD

## 17" Sony Trinitron Monitor



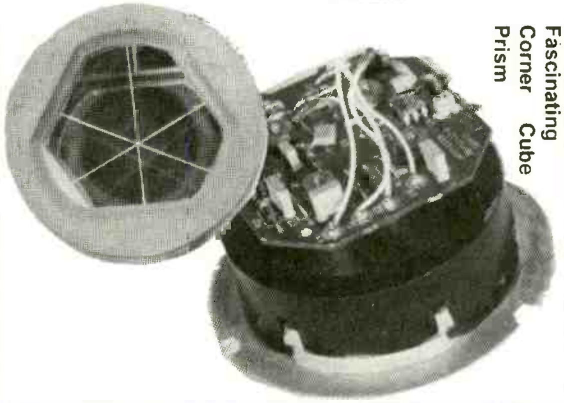
This is our most popular item. In good condition, they meet new unit specs. Not a multisync, works fine with Macintosh, or on IBM with Photon video card Tuned, with cables for Mac **$225.00**. With Photon video **$375.00**. Basic monitor **$175.00** 52 Lbs Shipping.

## Welch Allyn Bar Code Reader




**Dreaming about using bar code? Here is your big chance.** this late model bar code reader is the Welch Allyn Scanteam 3600. Uses standard product barcode, easy to use, requires only 5 VDC. With full technical manual, works with standard bar code software. **$49.00** Postpaid. Unused.

## Fascinating Corner Cube Prism



**One of the most fascinating optical components,** the corner cube directs light back to its source. Used by surveyors, planted on the moon by Apollo astronauts, these beautiful gem-like prisms are usually quite expensive. We have two types available:

1. 60 mm dia. 5 sec accuracy. surveyors type mounted 20mm offset.
2. Military assembly with corner truncated and electronic unit with IR filter, similiar specs. If you know what these were used for, please tell me.

Either type .....**49.00** Postpaid. Unused.

Dear Readers,

Ordering from V&M Surplus is easy. No minimum order, no hidden charges, most items postpaid. Your satisfaction guaranteed, or your money back. I am an avid collector, and right now I am looking for the following items: Norden Bombsight, M209 Converter (crypto-machine), K9 Ball Turret Sight. Cash or trade. *Franklin B. Fink CEO, CE&BW*

Vision and Motion Surplus
50 Main Street (Rear)
Ashland MA 01721
1-800-471-0747, 1-508-881-4900

---

# *MEMBRANE SWITCH KITS!*

**FLAT PANEL KEYPADS ASSEMBLE IN MINUTES WITH YOUR LEGEND**

***AVAILABLE IN 4, 12, 16, 24 & 40 KEY TYPES***


**INDUSTRIAL TYPES AVAILABLE**

MORE THAN 30 LAYOUTS TO FIT MOST APPLICATIONS

CALL FOR FREE BROCHURE

## SIL-WALKER

**880 CALLE PLANO, UNIT N
CAMARILLO, CA
93012**

**PHONE: (805) 389-8100**
**FAX: (805) 484-3311**

VISA / MASTERCARD

---

## *BROADCAST TRANSMITTER*

The FMS2 studio quality transmitter is FULLY crystal controlled and programmable to any FM broadcast frequency.

**Unit features:** ALC, 2:1 compressor, audio buffer / amplifier, pre-emphasis, roll off filter, stereo generator, digital PLL tuning 75 MHz-125MHz bandwidth, 500mW power output and a special introductory price of only $295.00 US

*SCHEMATICS FOR UNIT $27* *CATALOG 800-504-1178*
*FAX POLL INFO 416-243-1067* *TEK LINE 416-243-2260*

wavemach

---

## Robot Explorer Newsletter

Nano-ants, flying robots, Martian explorers.
Explore an entire universe of exciting robots.
8 information-packed issues for only $14.95.
Call now! MasterCard/Visa Accepted.

1-(800) GO-ROBOT or 1-(800)467-6268

---

## !!! BROADCAST FARTHER !!!

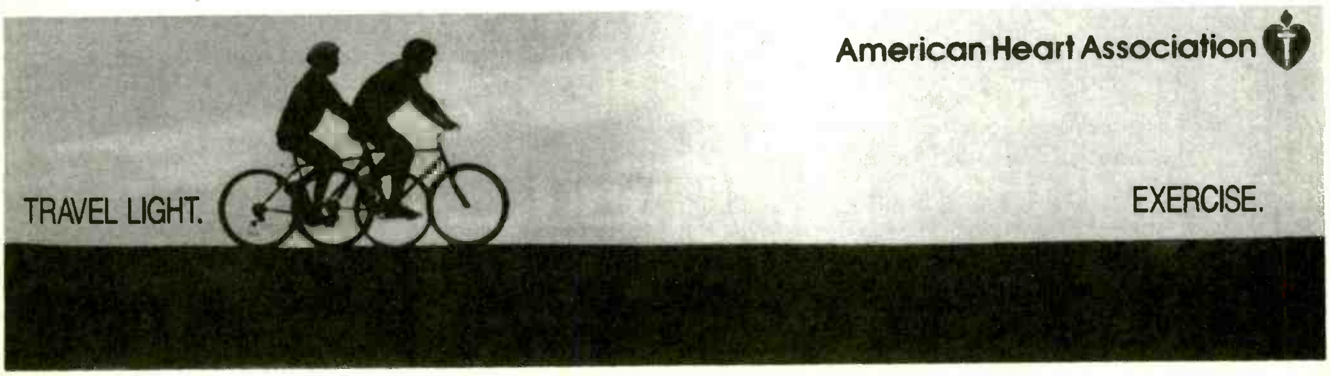
The model 1525 is a 75-110MHz RF amplifier that connects to mono or stereo FM transmitters and produces a *powerful* 15-20 watt signal which could broadcast up to 5 miles or more! Requires 75-250 mW drive.

Step by step plans complete with part source information and antenna designs . . . ONLY **$14** PLUS $2 S&H NO C.O.D.S

*Progressive Concepts*
BOX 586 STREAMWOOD, IL 60107
(708)736-9822 FAX: (708)736-0353

VISA MasterCard

---




AMAZING ELECTRONIC & SCIENTIFIC DEVICES
Lasers, Tesla, Ions, Anti-Gravity, Magnetics & More!
Plans • Ready-to-Use • Easy-to-Build Kits
Laser Ray Gun
Handheld, battery operated. Produces an intense burst of light capable of burning holes.
LAGUN2 Plans ............ $20.00
LAGUN2K Kit / Plans ........ Price on Req
250KV Tesla Coil
10-14" of Explosive Bolts of Lightning!
• Transmit Wireless Energy
• Ion Motors
• Anti-Gravity
• Strange and bizarre pyrotechnical effects
• Many other experiments shown in detail
• Award winning science project!
BTC3 Plans ............ $15.00
BTC3K Kit/Plans with coil ........... $299.50
BTC30 Assbld Ready to Use ....... $399.50
BTC4 Plans, 500KV unit ............ $20.00
ATTENTION: Experimenters & Researchers!
Anti-Gravity, Rail & Coil Guns, Mass Warping, Levitation Research, Exploding Water, Propulsion Drivers, Lattice Snapping, EMP etc. Loss-less Energy Charger with triggered spark switch. • Adjustable 500 to 3KV out • Charges up to 25KJ • Programmable Output
HEP1 Plans ............ $15.00
HEP1K Kit/Plans with 500J ....... $399.50
HEP10 Lab Assembled - to your spec's. Write, call or fax for price & delivery
HEP10 -> ...shown connected to potential rail gun system
Visible Beam Gas Lasers
Millions degree temp equiv. Illuminates low level clouds
• Light Shows
• Window Listener
• Optical Projects
• 12/115V
• Science Project
LAS1KM 1 mw, low cost Kit .......... $69.50
LGU6K 2-3mw Kit ............ $119.50
HNE70 5-7mw, ready to use ....... $299.50
Gravity Generator
Levitate an object! Great science fair project!
GRA1 Plans ............ $15.00
GRA1K Power Supply Kit/Plans ... $99.50
GRA10 Assbld Kit/Plans ............ $149.50
Includes text book on Anti-Gravity theory!
Solid State Tesla Coil
• Generate fiery electrical plasma discharge
• Powers light and objects without contact
• Experiment with electrical and mechanical fields.
TCL5 Plans ............ $8.00
TCL5K Kit/Plans 12VDC ............ $49.50
Pioneer a Futuristic Weapon!
Electric Gun - prototype designed in our lab - Join the research!
• Ballistic Velocities
• Handheld • Battery Operated
• Labelled as DANGEROUS Product
Experiment now before it is classified as a firearm! EGUN1 Plans ............ $20.00
(Must be 21 for purchase of hardware)
Ion Ray Gun
Project Energy! Star Wars technology demonstrates weapons potential. IOG7K Kit/Plans $99.50
"Talking" Plasma Globe
Spectacular color. Pulsates to music, sounds!. 8-9", with intensity and sound controls. PLASMA1 Ready to Use . $79.50
Electronic Hynotizer
Caution Required
Control their minds! Programmable audible and visual stimuli induces hypnotic trances. HYP2K Kit with Book ....... $39.95
EH2 Hypnosis Book & Plans ......... $14.95
We can design and build high voltage systems - to your spec's!
Call or fax us with your requirements!
4000 Volts 10ma High Voltage Module - Ready to use - for many projects from hoverboards to pyrotechnics.
MINMAX4 While they last! ............ $19.50
TACTICAL ELECTRONICS
Cybernetic Ear!
Enhances normal hearing 3-4 times! Adjustable volume control, fits easily into either ear. Many, many uses. Ready to Use!
CYBEREAR .... $19.95
Telephone Line Grabber Infinity Transmitter
ALL NEW
Use any Tone phone to monitor a premises, access other calls or control up to 8 devices! TELCON3K PlansKit $99.50
TELCON30 Ready to Use ........... $149.50
Long Range Microphone
Parabolic dish to BUG Mother Nature and more!
24" dish focuses signals to an ultra-high gain amplifier.
PM5K Kit/Plans ............ $149.50
• Optional wireless module transmits captured sounds to an FM radio.
WM5K Kit for Wireless Option .... $29.50
Phasor Sonic Blast Pistol
Rids areas of unwanted pests. Trains and conditions wild and domestic animals. Great for barns, attics, cellars, gardens.
PPP1K Kit/Plans ....... $39.50
3 Mi Telephone Xmitter
• Tune-able 80-130 Mhz • Undetectable
• Only transmits when phone is used
VWPM7K Kit/Plans ............ $39.50
3 Mi Voice Transmitter
• Ultra-Sensitive Mike
• Crystal Clear
• Tunes 80-130 MHz.
FMV1K Kit/Plans ............ $39.50
FireBall Gun
Shoots flaming ball - two shot capacity. Great for special effects and remote fire starting. CAUTION REQUIRED!
FIREBALL Plans (dangerous product) . $10.00
Shocker Force Field/ Vehicle Electrifier
Make hand and shock balls, shock wands and electrify objects. Great payback for those wiseguys!
SHK1K Easy to Assemble Kit ...... $19.50
Extended Play Telephone Taping System
• Tapes Phone Conversation • Extends Tape X4 • Check Local Laws before using!
TAP30X Ready to Use ............ $84.50
Invisible Pain Field Intruder Deterrent
System detects intrusions and turns on a sonic field of pain, causing disorientation, acute paranoia, nausea and more. The perpetrator - man or animal - soon vacates! Protects 4 individual areas up to 5000 sq ft. Non hazardous when used as instructed.
PPG4K Kit/Plans ............ $129.50
PPG40 Ready to Use ............ $199.50
See In Total DARKNESS!
• High Quality IR Night Vision Scope with IR Illuminator.
SD10 Ready to Use ............ $199.50
Electric Charge Gun
Life is Precious - PROTECT IT!
Stuns & immobilizes attackers 15 feet away! Check your state laws for legality. More knockdown power than most handguns. No permanent injury. ID coded.
ECG1 Data (Creditable to purch) ....... $10.00
ECG10 Charge Gun, Ready to Use, includes FREE Stun Gun! ......... $249.50
STUN GUNS - sold separately:
STUN100 100,000 Volts ............ $34.50
STUN200 200,000 Volts ............ $49.50
3 Mi Tracker Transmitter
• Tunable Output
• Uses FM Radio
• Excellent Signal Beacon
HOD1K Kit/Plans ............ $39.50
FANTASTIC BRIGHTNESS!
High Quality Laser Pointer
LAPN64 15mw equv, 2000' ........... $39.50
LAPN61 50mw equv, 4000' .......... $84.50
Window Bounce Laser Listener
Aim at window and listen to sounds from reflected light. CAUTION - Not for illegal use. LWB3 Plans ............ $10.00
LWB3K Kit/Plans (req's vid tripod) ...... $149.50
MIND CONTROL!
Places subjects under your control. Programmable audible & visual stimuli with biofeedback, Induces strange & bizarre halucinations without drugs. Caution - not FDA approved.
MIND2 Plans ............ $15..00
MIND2K Kit and Plans ............ $49.50
MIND20 Assembled Unit ............ $69.50
1000' Potato Cannon
Not a Toy! Uses electronic or piezo ignition. CAUTION REQUIRED!
POT1 Plans (dangerous product) ... $10.00
VISIT US ON THE WEB!
http://www.amazing1.com
INFORMATION UNLIMITED
Dept ENS-6, Box 716, Amherst, NH 03031
Phone: 603-673-4730 FAX: 603-672-5406
MC, VISA, COD, Checks accepted Please add $5.00 S & H
CATALOG! FREE with Order or send $1 P&H
24 Hour Phone 800-221-1705 Orders Only Please!

# Toronto Surplus & Scientific Inc

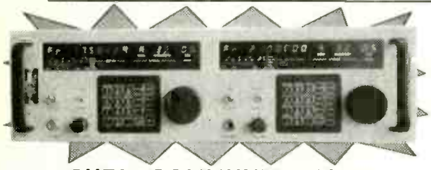
608 Gordon Baker Rd. Willowdale,
Ontario Canada zip: M2H-3B4
TEL: (416) 490-8865

VISA

AMERICAN EXPRESS

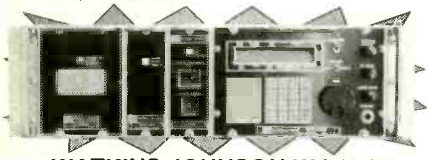
OFFICE:(905) 887-0007 FAX: (905) 887-0006

***SHIPPING IS NOT INCLUDED IN THESE PRICES, PLEASE CALL FOR RATES***



## CUBIC COMMUNICATIONS DUAL VLF/HF RECEIVER

This High-Tech surveillance receiver features two fully independent high performance radios in one rack cabinet. Covers 5kHz-30MHz with a full compliment of filters incl. USB/LSB plus RS-232 remote control. The units we have in stock are in very nice condition.
**Price: $2395.00 ea.**

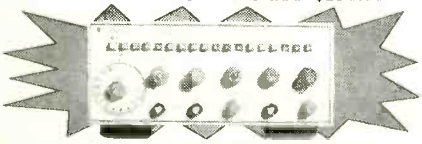


## WATKINS JOHNSON WJ-9040 SERIES RECEIVER

This awesome radio covers 200Hz-1400MHz in 13 bandwidths of AM, AM Slideback, FM, CW and SSB demodulation modes. Contains lots of features and you can bet this is a super-rare find in the used market. **Price: $5450.00 CALL for DETAILS!!!**

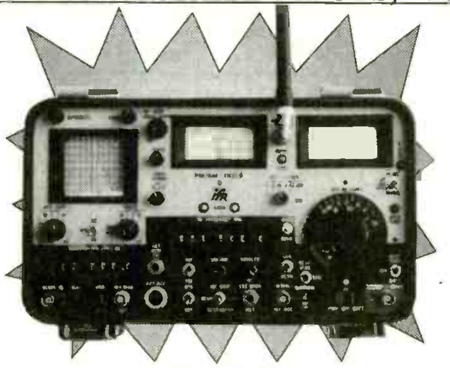
## HEWLETT PACKARD 8640B SIGNAL GENERATOR

Industry Standard sig-gen 500Khz-512Mhz features internal phase lock/synchronizer and digital freq. readout. +19 to -145 dBm output. AM, FM, Ext and Pulse modulation.
**Price: $1695.00 OPT 001 add $100.00**
**OPT 003 add $150.00**



## HEWLETT PACKARD HP3312 SWEEP/FUNCTION GENERATOR

Well designed and easy to use, this function generator combines economy and quality in one compact unit. Freq range is 0.1Hz-13MHz output is 10.0VP-P into 50 ohms. Sweep, CW, AM, FM, or tone burst. This unit features-sync. out, trig. phase, symmetry, offset and more. **Price: $935.00 ea. Fully checked.**



## IFR 1100S COMMUNICATIONS MONITOR

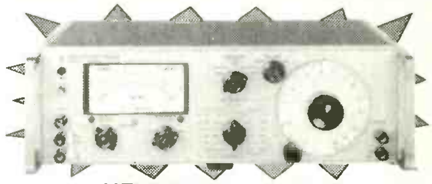
FM/AM-1100S is a synthesized AM/FM/SSB receiver/signal generator. Frequency range is 300Khz-1Ghz, it contains a 60 watt RF power meter, deviation/modulation meter, oscilloscope, spectrum analyzer, tone generator and internal high stability freq.-standard. It's a radio repair shop in one cabinet.
**Price: $4250.00 Fully Checked.**
IFR 1000SA as above except without spectrum analyzer. **Price: $2750.00 Fully Checked.**
**-NEW IFR 1000 Instrument covers with sinad meter and scope probe (new unused). $275.00**

## PRC 25 - MILITARY TACTICAL TRANSCEIVER

Fabulous quality and design are standard in this 30Mhz-75.95 Mhz tactical transceiver.
Output power level from 1.1-2 watts 150Hz squelch. The units we just received are reconditioned (newly painted) .ready for issue and include the battery box. **Price: $245.00**

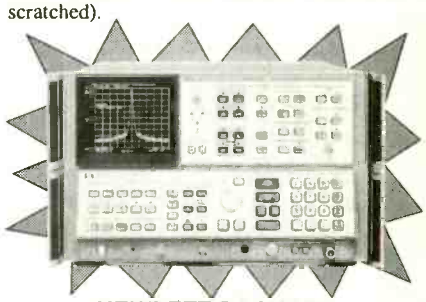
**All Prices in U.S. $**
**Please include telephone/fax # with mail-in orders. Orders must be prepaid by guaranteed instrument.**
**Prices do not include shipping.**
**Please call us if you have any questions**

*Manuals available at extra cost*



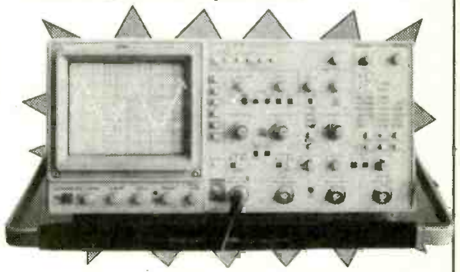
## HEWLETT PACKARD HP 331A DISTORTION ANALYZER

Industry Standard unit covers 5Hz-600kHz & measures total harmonic distortion down to .1% full scale. We are blowing these out as-is, untested but, most we've shipped in the past have worked. **Price: $99.00** (units are scratched).



## HEWLETT PACKARD 8568B SPECTRUM ANALYZER OPT-E96

This High Performance instrument features 3 Hz video bandwidth over the 1kHz - 1.5Ghz freqency range. Automatic zoom, signal track, multiple store/recall are only a few of the very powerful functions you will find coupled with a high performance sythesized LO and built in freq counter.
**Price: $16995.00 Fully Checked**



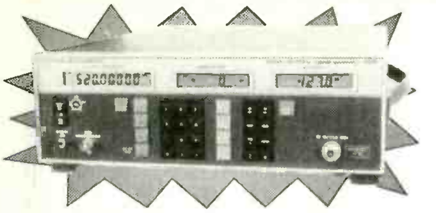
## TEK 2246 OSCILLOSCOPE

This user friendly oscilloscope features, 100MHz bandwidth on four channels, on screen scale factors, versatile triggering, 2mV/Div vert sensitivity, delayed sweep. hands-off voltmeter and smart cursors.
Looks very clean. **Price: $1950.00**

(No catalog available yet!)

Nov. 96

CIRCLE 317 ON FREE INFORMATION CARD



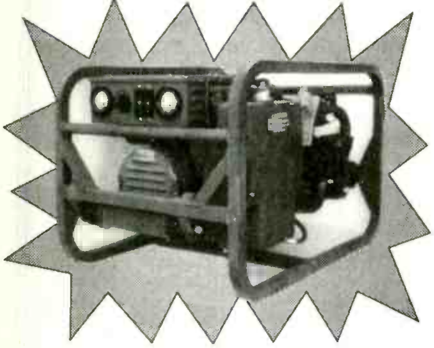
## MARCONI SYNTHESIZED SIGNAL GENERATOR Model 2018

Freq range 80Khz-520Mhz with calibrated output levels from -127 dBm to +13dBm. Resolution 10Hz. It can be freq, phase or amplitude modulated from ext or int modulation sources. RF output resolution is 0.1dB. reversepower protection of up to 50W is possible without damage to the instrument. This instrument is microprocessor controlled and very easy to use, a must for any serious repair or development lab. **Price : $1750.00 Checked**


# "CAL" ASTRONAUTICS MOBILE SATELITE COMMUNICATIONS STATION

This is a box chock full of "***current***" high-end communications technology. These units were designed so that mobile land based vehicles could keep in touch (via Geostationary Inmarsat satellite network) with home base using an intellegent data terminal. The terminal features a back-lit 4 line LCD display and illuminated keys; one of the transciever's most impressive features is an "L" Band 1.2-1.55GHz 60 watt amplifier. The fabulous helix antenna (with LNA built-in) is an amazing design with all kinds of active and passive devices surface-mounted on to the antenna reflector. We consider this the "ultimate gadgeteers goodie pack" with all kinds of up-to-date RF satellite ground technology. These systems come complete in their original shipping container with all cables and mounting bracket. Best of all they operate on 12 VDC. Operators manual supplied (but, there isn't any subscriber data).

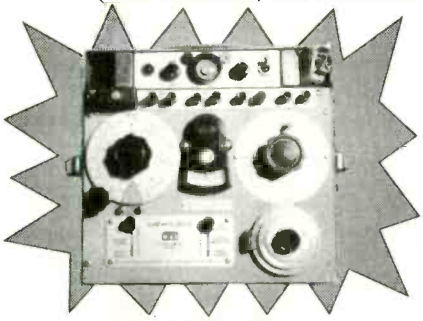
**(NOT TESTED) IN GOOD CONDITION............$345.00**



## MILITARY STANDARD D.C. GENERATOR

Superior QUALITY plus rugged design are features of this deluxe 2 cylinder 4 stroke gasoline generator. The control panel contains meters for voltage & current indication, main circuit breaker and voltage adjustment. Shielded wires and plugs comprise the RFI suppression ignition system eliminating most radio noise. These units are "new" in the original carton complete with operators manual and only require fuel and oil for operation; output voltage is adjustable approx. 10-32v (28v nom) @ 53.3A (1.5Kw) continuous duty load.

**Price: $379.00 New in Orig. Carton.**
**You will be impressed!!!**



## ESI MODEL 250 DA IMPEDANCE BRIDGE

Resistance range- 0.1 milliohms - 11megohms, capacitance 0.1pf-1100mf, inductance 0.1 µH to 1100 Hy. Dissipation factor (R/X or D) 0.001 to 1000. Internal oscillator 1 KHz.

**Used, not functionally checked.............$95.00**
**Functionally checked..........................$165.00**

## PDR-63 PORTABLE RADIAC METER

This portable radiac set is loaded with all kinds of extras featuring six ranges of sensitivity for both Gamma or Beta radiation measurements. The 1st scale 0-1 rad/hr up to 0-5000 rad/hr. The unit comes supplied with headset & bat/charger. Req's only 4 AA Batteries. **Price: $149.95**

COLLECTOR ALERT - $39.00
8-DAY AIRCRAFT CLOCK
1-7/8" dial

**Great collectors item for the ham shack, fifties vintage funct/chkd.**

-CROWN MODEL 7560 1KW PWR AMP. DC - 40KHz . $1.800.00
-DATRON 4000A DC & OHMS CALIBRATOR ............ $4,500.00
-EATON NM-17/27A EMI FIELD INT. METER ............ $1.500.00
-ENI MOD 310L 250KHz-110MHz @ 50db GAIN .......... $ 365.00
-ENI MOD 406L 150 KHz-250MHz @ 40db GAIN .......... $ 350.00
-FLUKE 5100A CALIBRATOR .......................... $3,800.00
-FLUKE 7261A FREQ. COUNTER 520mHz .................. $ 475.00
-GOULD 220 CHART RECORDER .......................... $ 450.00
-GOULD RS 3800 PROGRAMABLE CHART RECORDER/w MOD 5900 SIG CONDITIONER & DC AMPS (NEW) $3,500.00
-HI- ENERGY CORP. DISCHARGE CAP. 1µF@ 20KV $ 300.00
140µF@ 6KV .......................... $1,000.00
-HP 204D LOW DIST. OSCILLATOR .......................... $ 350.00
-HP 3551A TRANSMISSION TEST SET .......................... $ 950.00
-HP 3581A WAVE ANALYZER .......................... $ 850.00
-HP 4260A LCR BRIDGE .......................... $ 385.00
-HP 4948A IN-SERVICE TIMS (brand new) .................. $2,995.00
-HP 5006A SIGNATURE ANALYZER .......................... $ 650.00
-HP 5315AUNIVERSAL COUNTER (1 GHz) .................. $ 875.00
-HP 6472C POWER SUPPLY 0-64V @ 0-150A .................. $1,800.00
-HP 8505 NETWORK ANALYZER SYSTEM .................. $4,980.00
-HP 8558B SPECTRUM ANALYZER .01-1.5GHz .......... $2,350.00
-HP 8559A SPEC-ANALYZER .01-22GHz .................. $3,995.00
-MARCONI 2018 SYNTHESIZED SIGNAL GENERATOR 80KHz - 520MHz .......................... $1,750.00
-ROHDE & SCHWARZ SIG GENERATOR .4-484MHz . $ 750.00
-TEK FG504 FUNCTION GENERATOR (40MHz) ........ $ 875.00
-TEK 1502 TDR w/CHART REC .......................... $2,200.00
-TEK 465 OPT 5 TV-TRIG .......................... $ 849.00
-TEK 465B 100mHz OSCILLOSCOPE .......................... $ 895.00
-TEK 465M 100mHz OSCILLOSCOPE .......................... $ 695.00
-TEK 485 350 MHz OSCILLOSCOPE .......................... $ 1195.00
- TEK 1750 WAVEFORM/VECTOR MONITOR ............ $1,850.00
- SENCORE VA62 VIDEO TEST SYSTEM .................. $1,995.00
- BOONTON 82AD AM/FM MOD-METER .................. $1,275.00
- COLLINS 651S-1 RECEIVER .......................... $1,250.00
- GRT-22 UHF POWER AMPLIFER .......................... $ 200.00
- R392 RECEIVER .5-30MHz .......................... $ 165.00
- T195 100w COMPANION XMTR TO 392 .................. $ 85.00
- WATKINS JOHNSON 8626A-4 with WJ8626-1 & SPN 108 5KHz-30 MHz MIL-SPEC communications reciever ....... $3,950.00
- WAVETEK 3002 RF SIG. GENERATOR .................. $ 795.00

*****ATTENTION DIVERS-GAS DRIVEN COMPRESSORS*****

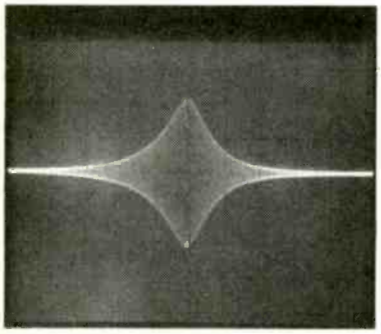
- BAUER 11CFM 3500 PSI COMPRESSOR SYSTEM combines a four stage compressor and 4 cyl wisconsin engine on a cart with storage tanks and controls or electric version avail .......... $3,500.00
- BAUER K14 3500 PSI COMPRESSOR SYSTEM same as above except uses briggs & straton 8hp motor .......................... $2,750.00

Nov. 96

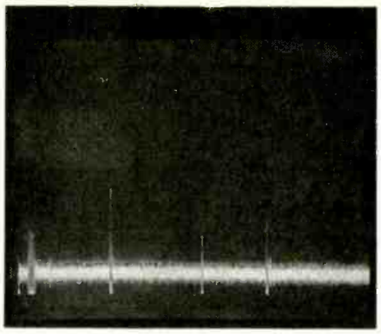
CIRCLE 317 ON FREE INFORMATION CARD

## SPECTRUM ANALYZER

(Continued from page 52)



*THE OSCILLOSCOPE'S VIEW of the bubble sampled from the preamplifier assembly's test point after the 145-MHz IF filter alignment. The oscilloscope's 10× time-base magnifier is switched on. You should be able to see the zero beat at the center of the bubble.*



*THE OSCILLOSCOPE'S DISPLAY of the HSA output when a short-wire antenna is connected to the BNC connector. The extreme left burst is an unknown signal. Local radio-control signals from left to right are at 27.995 MHz, 53.4 MHz, and 72.280 MHz.*

For example, EMI on cables might be best observed by passing the cable through a toroid ferrite. Wrap a few turns of finer wire as a secondary and connect to the HSA. This allows examination of what is on a suspect cable but avoids electrostatic pickup.

It is also possible to extend the reach of the HSA with a length of coax cable with a one or two turn sniffer loop on the pickup end. In all cases, be careful when working around power lines or line-powered equipment.

**Parts and Supplies Hints.** All parts and supplies for the Hobby Spectrum Analyzer came from electronics parts mail-order suppliers listed in the sidebar and from local hardware, model hobby, craft, and RadioShack stores. No single parts source can supply everything needed. A very few parts such as slide switches and beads came only from Digi-Key. The NE602 IC came from Ocean State Electronics and DC Electronics. The MV209 varactor comes from DC Electronics or Hosfelt. Many catalogs list ceramic disc capacitors; however, the RadioShack capacitor assortment #272-806 has all the smaller picafarad values on the RF circuit module. Consider using cut-to-length plastic ball pen handles for spacers. Metal and plastic tubing of many sizes as well as brass, aluminum, tin plate, and copper sheet is available at model hobby shops. Ω

# Printed Circuits in Minutes Direct From LaserPrint!

8 1/2" x 11"
* Or Photocopy
**Use standard household iron or P-n-P Press.

1. LaserPrint*
2. Press On**
3. Peel Off
4. Etch


Use Standard Copper Clad Board
20 Shts $30/ 40 Shts $50/ 100 Shts $100
Visa/MC/PO/Ck/MO $4 S&H
Techniks Inc.
P.O. Box 463
Ringoes NJ 08551
ph. 908.788.8249 fax 908.788.8837
http:\\chelsea.ios.com\~techniks
Retail Dealer Inquires Invited

# "WE PURCHASE"
## $$ TOP PRICES $$ PAID

**JERROLD™**
DPV7
FPBB7
CFT

**TOCOM™**
5503 VIP
5507

**PIONEER™**
5135
6110
6300

**ATLANTIC SCIENTIFIC™**
8570
8580
8590
8600

**Midwest's Largest Brokers**
*We Buy Quantities of Ten To A Thousand Units*
**NATIONAL CABLE BROKERS**
**(219) 935-4128**

# UPGRADE YOUR COMPUTER!

VISA/MC Welcome!

*TECHNOLOGY ASSOCIATES*
*959 W. 5th St. • Reno, NV 89503*
*(702) 322-6875 • Fax (702) 324-3900*
www.techass.com • sales@hoopsware.com

**Memory**

| | |
|---|---|
| 1Mb (1x8-70 ns) | $9 |
| 4Mb (4x8-70 ns) | $27 |
| 4Mb (1x32-60 ns) | $25 |
| 8Mb (2x32-60 ns) | $52 |
| 16Mb (4x32-60 ns) | $98 |
| 32Mb (8x32-60ns) | $188 |

**Hard Drives**

| | |
|---|---|
| WD 540 Mb IDE | $160 |
| WD 850Mb IDE | $175 |
| WD 1.2Gb IDE | $230 |
| WD 1.6Gb IDE | $250 |
| WD 2.1Gb IDE | $340 |

**Modems**

| | |
|---|---|
| 14.4 Int Fax/Modem | $38 |
| 28.8 Int Fax/Modem w/Voice | $97 |
| 28.8 Int Supra PNP Fax/Modem | $102 |
| 28.8 Int USR Fax/Modem for Windows | $115 |
| 33.6 Int Fax/Modem | $89 |

**CPU's**

| | |
|---|---|
| AMD 486DX4-100 | $33 |
| AMD 5x86-133 | $42 |
| Cyrix 5x86-120 | $65 |
| Cyrix 686-110 | $140 |
| Intel Pentium 100 | $142 |
| Cyrix 686-120 | $179 |
| Intel Pentium 133 | $250 |
| Cyrix 686-133 | $299 |
| Intel Pentium 150 | $425 |
| Intel Pentium 166 | $499 |

**Video Cards**

| | |
|---|---|
| 256K ISA VGA | $23 |
| Trident 8900 1Mb ISA SVGA | $38 |
| Trident 9440 1Mb VLB SVGA | $38 |
| SIS 1Mb PCI SVGA | $38 |
| Trident 9680 1Mb PCI SVGA w/MPEG | $45 |

**Sound Cards**

| | |
|---|---|
| 16-bit Sound Blaster Pro compatible | $40 |
| 16-bit SB Pro PNP | $80 |
| Sound Blaster 32 PNP | $141 |

**Motherboards**

| | |
|---|---|
| 486xxx VLB, 256K | $72 |
| 486xxx PCI, 256K | $99 |
| Pentium Intel Triton2 VX, 256K pipeline | $128 |
| Pentium Intel Triton2 HX, 512K pipeline | $162 |
| Pentium Pro | $310 |

**Miscellaneous**

| | |
|---|---|
| 1.44Mb FDD | $29 |
| 1.2Mb FDD | $60 |
| 6X CD-ROM IDE | $80 |
| 8X CD-ROM IDE | $95 |
| Colorado Traven T1000 850Mb tape drive | $185 |
| 3-button serial mouse | $9 |
| Spill-resist 101-key | $20 |

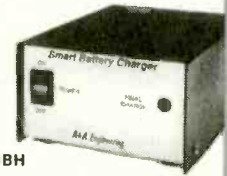
**Controller Cards**

| | |
|---|---|
| ISA Multi I/O IDE, FDC, 2S/1P/1G | $12 |
| VLB Multi I/O, EIDE FDC, 2S(16550), 1P(ECP, EPP)/1G | $18 |

*NOTE: Prices are projections based on advertising lead times.*

Prices and availability subject to change without notice.
**CALL FOR DAILY LOW PRICES!**

# Smart Battery Charger




JUN 87 QST
BY WARREN DION N1BBH

**FOR GEL-CELLS or LEAD ACID BATTERIES.** Features: Precision temperature tracking voltage reference & three mode charging sequence. Standard kit is for 12V @ 1/2 or 1 Amp, user selectable. Can be connected to the battery indefinately, will not overcharge. Weighs 2 pounds and measures 4"W x 5½"D x 2½"H. Finished enclosure included in kit.

**Complete Kit Only** ............ **$59.95**
**Assembled & Tested** ........... **$79.95**

*CA Residents add 7.75% sales tax. S&H: $5.00 (Insured). Foreign orders add 20%. For more info or price list; send legal size SASE (52¢) to:*

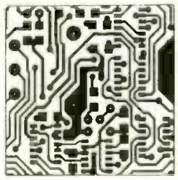
**A&A Engineering**
2521 W. La Palma #K • Anaheim, CA 92801
(714) 952-2114 • FAX: (714) 952-3280

# NEW EASY PC

BRITISH DESIGN AWARD

SCHEMATIC and PCB C.A.D

ONLY **$135**



Includes

- MGA, CGA, EGA & VGA compatible.
- Design large multi layer boards.
- One level pull down menu and quick keys for fast layout.
- Dot matrix, laser, plotter, Gerber & N.C. drill output.
- 6 Month Free update
Free Demo

OHIO AUTOMATION Inc.
7840 ANGEL RIDGE ROAD
ATHENS, OHIO 45701
(614) 592-1810
*Visa & MasterCard Accepted*

# Timid about getting on the. . . World Wide Web?

You've heard about the *Information Superhighway* and all the hype that goes with it! Sort of makes you feel timid about getting on the Web. Put your fears aside! A new book, ***The Internet and World Wide Web Explained***, eliminates all the mystery and presents clear, concise information to build your confidence. The jargon used is explained in simple English. Once the tech-talk is understood, and with an hour or two of Web time under your belt, your friends will believe you are an Internet guru!

To order Book #403 send $6.95 plus $3.00 for shipping in the U.S. and Canada only to Electronics Technology Today Inc., P.O. Box 240, Massapequa Park, NY 11762-0240. Payment in U.S. funds by U.S. bank check or International Money Order. Please allow 6-8 weeks for delivery.

# GIANT! SPY ELECTRONICS CATALOG

ENTHUSIASTS

**Just Like In The Movies!**
Fiber-optics• IR Detectors•UV Powder
Covert TV Cameras• Phone Transmitters
Laser/Parabolic Mic's•Nightvision• Wrist Watch
Cameras•Time Lapse VCR's, Surveillance-Counter
Surveillance•Homing Xmitters•Fiberscopes• Police
Electronics•Micro-TV's• Phone Bug's• TV Xmitters
Transmitters• Books/Video's and Much, Much More!

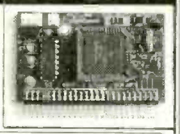
**SECRET EVIDENCE LOCATER**
Just whistle your secret code and it whistles back
**$7.77+2.00 S&H**

**MODULAR JACK PHONE XMITTER**
**$25.95 +2.00 S&H**

***Subscription!*** $5.00 to CIAssociates
4101-267EN11 Green Oaks.
Arlington. TX 76016

# ADAPT-11
## 68HC11 Module for Solderless Breadboards

- miniature 2.0" by 2.8" module
- plugs vertically into solderless breadboard
- reset circuit, button, & mode select switch
- RS-232 int., 5V reg & ext. pwr. conn.
- all I/O lines on dual row connector
- programs 68HC811E2 & '711E9 chips



Starter Package comes with ADAPT-11 module, 68HC811E2 microcontroller with 2K EEPROM on-chip (re-programmable in circuit 1000s of times; no EPROM programmer or eraser required), PC serial cable for downloading code, Motorola Programming Reference Guide, ADAPT-11 User Manual, freely distributable 68HC11 software, and demo program. #AD11-SP $74.95 + $5 shipping & handling.

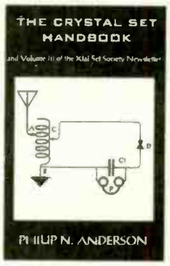
**Use PLCCs in your Solderless Breadboard!**
- Solderless breadboard socket adapters for all popular PLCC sizes.
- Vertical design saves space on breadboard.

**Also available:**
Solderless breadboard adapters for DB9 & DB25, and IDC (ribbon cable) connectors, from $5.

Visa, MasterCard, AmEx, Discover

**TECHNOLOGICAL ARTS**
309 Aragona Blvd., Suite 102, Box 418, Va. Beach, VA 23462
1644 Bayview Avenue, Box 1704, Toronto, ON M4G 3C2
voice/fax: (416) 963-8996 www.io.org/~techart

# INSIDE CRYSTAL SETS




An easy-to-read book on crystal set theory and construction opens vistas for novices and pros alike. Build radios like Grandpa did, do it better, and know what you are doing. *The Crystal Set Handbook*, published by The Crystal Set Society, is an authentic guide on the topic.

To order *The Crystal Set Handbook*, send $10.95 plus $4.00 for shipping in the U.S. and Canada only to **Electronics Technology Today Inc.**, P.O. Box 240, Massapequa Park, NY 11762-0240. Payment in U.S. funds by U.S. bank check or International Money Order. Please allow 6-8 weeks for delivery.

FREE PROBES WITH ALL SCOPES

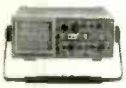
# OSCILLOSCOPES

**Lowest Prices of the Year!**

**CALL OR WRITE FOR A FREE 60 PAGE CATALOG! (800) 445-3201**

## B&K Precision Scopes

**60MHz ANALOG WITH DIGITAL STORAGE**
**Model 2560**



- Cursors and readouts
- RS-232 port
- 20MS/s real time sampling
- 1GHz equivalent time sampling (at 0.1µs/div.)
- Prints via RS-232 port to any HP-GL plotter

**$1995**

**20MHz ANALOG WITH DIGITAL STORAGE**
**Model 2522A**

- 20MHz analog bandwidth
- 20MS/s sampling rate
- 2K memory per channel
- 300MHz equivalent time sampling
- Pre-trigger capture

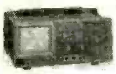
**$869.95**

**100MHz THREE-TRACE**
**Model 2190A**

- 1mV/division sensitivity
- Sweeps to 5ns/division
- Dual time base
- Signal delay line
- 15KV accelerating voltage

**$1379.95**

**60MHz DUAL-TRACE**
**Model 2160A**



- 1mV/division sensitivity
- Sweeps to 5ns/division
- Dual time base
- Signal delay line
- V mode-displays two signals unrelated in frequency.
- Component tester

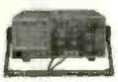
**$949.95**

**40MHz DUAL-TRACE**
**Model 1541C**

- 1mV/division sensitivity
- Video sync separators
- Z-axis input
- Single Sweep
- V mode displays two signals unrelated in frequency
- Component tester

**$695**

**60MHz, CURSORS & READOUTS, DUAL TIME BASE**
**Model 2260**



- Cursors and readouts
- 1mV/div sensitivity
- 23 calibrated ranges - main time base
- 19 calibrated ranges - delayed time base
- Signal delay time
- V-mode - displays 2 signals unrelated in frequency.
- Component tester
- Z-axis input
- Single sweep

**$1225**

**20MHz DUAL-TRACE**
**Model 2120 - 2 Year Warranty**
**Special $389.95**

**Model 2125 with delayed sweep**
**$539.95**

- 1mV/division sensitivity
- AUTO/NORM triggered sweep operation
- AC, TVH, TVV and line coupling
- Calibrated 19 step time-base with x10 magnifier
- Compact low-profile design

## Quality Scopes by Elenco

### 60MHz

**DS-603 $1350**
- Analog / Digital Storage
- 20MS/s Sampling Rate

**S-1360 $749**
- Analog with Delayed Sweep

### 40MHz

**S-1345 $569**
- Analog with Delayed Sweep

**S-1340 $475**
- Analog

**2 Year Warranty**

### 25/30MHz

**DS-303 $1095**
- Analog / Digital Storage

**S-1330 $439**
- 25MHz Analog
- Delayed Sweep

**S-1325 $325**
- 25MHz Analog

**OSCILLOSCOPE SELECTION CHART**

ANALOG

| Model | Bandwidth MHz | Sensitivity (max) | No. of Channels | Sweep Rate Max ns/div | Delayed Sweep | Video Sync | Component Tester | Beam Find | Time Base |
|---|---|---|---|---|---|---|---|---|---|
| S-1360 | 60 | 1mV/div | 2 | 10ns/div | Yes | Yes | Yes | Yes | 2 |
| S-1345 | 40 | 1mV/div | 2 | 10ns/div | Yes | Yes | Yes | Yes | 2 |
| S-1340 | 40 | 1mV/div | 2 | 10ns/div | No | Yes | No | No | 1 |
| S-1330 | 25 | 1mV/div | 2 | 10ns/div | Yes | Yes | Yes | Yes | 2 |
| S-1325 | 25 | 1mV/div | 2 | 10ns/div | No | Yes | No | No | 1 |

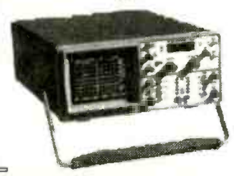
DIGITAL STORAGE

| Model | Bandwidth MHz | Analog Sen (max) | No. of Channels | Sampling Rate | Memory Channel | Internally Backed Up | Pretrigger % | Output |
|---|---|---|---|---|---|---|---|---|
| DS-303 | 30 | 1mV/div | 2 | 20MS/S | 2K | Yes | 0, 25, 50, 75 | RS232 |
| DS-603 | 60 | 1mV/div | 2 | 20MS/S | 2K | Yes | 0, 25, 50, 75 | RS232 |

## Affordable Spectrum Analyzers by B&K

**500MHz Series**
Model 2615 - $1595
Model 2620 w/ tracking generator - $1895

**1.05GHz Series**
Model 2625 - $2395
Model 2630 w/ tracking generator - $2995



HURRY... AT PRICES THIS LOW THEY'LL BE GONE FAST!

## HITACHI SCOPES

**Inventory Reduction Sale**
**Lowest Prices of the Decade!**

V-209 - 20MHz Battery Operated
Was $1505, NOW **$1095 Save $410**

V-422 - 40MHz Was $965,
NOW **$765 Save $200**

V-525 - 10MHz w/ Cursors
Was $1355, NOW **$955 Save $400**

V-552 - 50MHz Was $1195,
NOW **$850 Save $345**

V-555 - 50MHz w/ Cursors
Was $1375, NOW **$975 Save $400**

V-695 - 60MHz w/ Cursors
Was $1815, NOW **$1395 Save $420**

V-1065A - 100MHz w/ Cursors
Was $2139, NOW **$1565 Save $574**

V-1560 - 100MHz Was $1790,
NOW **$1490 Save $300**

V-1565 - 100MHz w/ Cursors
Was $1960, NOW **$1595 Save $365**

V-252 - 20MHz **$419**

## Fluke Scopemeters

| | |
|---|---|
| 91 | $1225 |
| 92B | $1445 |
| 96B | $1695 |
| 97 | $1795 |
| 97A | $2945 |
| 99B | $2095 |

Call or write for complete specs.

**WE WILL NOT BE UNDERSOLD**

UPS SHIPPING: 48 STATES 5%
OTHERS CALL FOR DETAILS
IL Residents Add 8% Tax

**C&S SALES, INC.**
150 W. CARPENTER AVENUE
WHEELING, IL 60090
FAX: (847) 520-9904 (847) 541-0710
http://www.elenco.com/cs_sales/

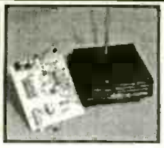
VISA MasterCard

**15 DAY MONEY BACK GUARANTEE**
**FULL FACTORY WARRANTY**
PRICES SUBJECT TO CHANGE WITHOUT NOTICE

CIRCLE 308 ON FREE INFORMATION CARD

# RAMSEY

## Synthesized FM Stereo Transmitter



Microprocessor controlled for easy freq programming using DIP switches, no drift, your signal is rock solid all the time - just like the commercial stations. Audio quality is excellent, connect to the line output of any CD player, tape deck or mike mixer and you're on-the-air. Foreign buyers will appreciate the high power output capability of the FM-25; many Caribbean folks use a single FM-25 to cover the whole island! New, improved, clean and hum-free runs on either 12 VDC or 120 VAC. Kit comes complete with case set, whip antenna, 120 VAC power adapter - easy one evening assembly.

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

## Tunable FM Stereo Transmitter

A lower cost alternative to our high performance transmitters. Offers great value, tunable over the 88-108 MHz FM broadcast band, plenty of power and our manual goes into great detail outlining aspects of antennas, transmitting range and the FCC rules and regulations. Connects to any cassette deck, CD player or mixer and you're on-the-air, you'll be amazed at the exceptional audio quality! Runs on internal 9V battery or external power from 5 to 15 VDC, or optional 120 VAC adapter. Add our matching case and whip antenna set for a nice finished look.

**FM-10A, Tunable FM Stereo Transmitter Kit . . . . . . . . . . . . $34.95**
**CFM, Matching Case and Antenna Set. . . . . . . . . . . . . . . . $14.95**

## RF Power Booster Amplifier

Add some serious muscle to your signal, boost power up to 1 watt over a frequency 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 Stereo transmitters, providing radio service through an entire town. Power required: 12 to 15 volts DC at 250mA, gain of 38dB at 10 MHz, 10 dB at 1000 MHz. For a neat, professionally finished look, add the optional 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**

## Micro FM Wireless Mike

World's smallest FM transmitter. Size of a sugar cube! Uses SMT (Surface Mount Technology) devices and mini electret condenser microphone, even the battery is included. We give you two complete sets of SMT parts to allow for any errors or mishaps-build it carefully and you've got extra SMT parts to build another! Audio quality and pick-up is unbelievable, transmission range up to 300 feet, tunable to anywhere in standard FM band 88 to108 MHz. 7/8"w x 3/8"h x 3/4"h.

**FM-5 Micro FM Wireless Mike Kit. . . . . . . . . . . . . . . . . . . $19.95**

## Crystal Controlled Wireless Mike

Super stable, drift free, not affected by temperature, metal or your body! Frequency is set by a crystal in the 2 meter Ham band of 146.535 MHz, easily picked up on any scanner radio or 2 meter rig. Changing the crystal to put frequency anywhere in the 140 to 160 MHz range-crystals cost only five or six dollars. Sensitive electret condensor mike picks up whispers anywhere in a room and transmit up to 1/4 mile. Powered by 3 volt Lithium or pair of watch batteries which are included. Uses the latest in SMT surface mount parts and we even include a few extras in case you sneeze and loose a part!

**FM-6, Crystal Controlled FM Wireless Mike Kit . . . . . . . . . $39.95**
**FM-6WT Fully Wired FM-6 . . . . . . . . . . . . . . . . . . . . . . . . . $69.95**

**Call for our Free Catalog !**

## Super Pro FM Stereo Radio Transmitter

A truly professional frequency synthesized FM Stereo transmitter station in one 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 frequency easily with the Up/Down freq buttons and the big LED digital display. Plus there's input low pass filtering that gives great sound no matter what the source (no more squeals or swishing sounds from cheap CD player inputs!) Peak limiters for maximum 'punch' in your audio - without over modulation, LED bargraph meters for easy setting of audio levels and a built-in mixer with mike and line level inputs. Churches, drive-ins, schools and colleges find the FM-100 to be the answer to their transmitting needs, you will too. No one offers all these features at this price! Kit includes sharp looking metal cabinet, whip antenna and 120 volt AC adapter. Also runs on 12 volts DC.

*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, Professional FM Stereo Transmitter Kit . . . . . . . $299.95**
**FM-100WT, Fully Wired High Power FM-100. . . . . . . . . . $429.95**

## Speech Descrambler Scrambler

Decode all that gibberish! This is the popular descrambler / scrambler that you've read about in all the Scanner and Electronic magazines. The technology used is known as speech inversion which is compatible with most cordless phones and many police department systems, hook it up to 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, RCA phono type jacks. Our matching case set adds a super nice professional look to your kit.

**SS-70A, Speech Descrambler/Scrambler Kit . . . . . . . . . . $39.95**
**CSS, Custom Matching Case and Knob Set . . . . . . . . . . $14.95**
**SS-70AWT, Fully Wired SS-70A with Case. . . . . . . . . . . . $79.95**
**AC12-5, 12 Volt DC Wall Plug Adapter . . . . . . . . . . . . . . . . $9.95**

## Tone-Grabber Touch Tone Decoder / Reader

Dialed phone numbers, repeater codes, control codes, anywhere touch-tones are used, your TG-1 will decode and store any number it hears. A simple hook-up to any radio speaker or phone line is all that is required, and since the TG-1 uses a central office quality decoder and microprocessor, it will decode digits at virtually any speed! A 256 digit non-volatile memory stores numbers for 100 years - even with the power turned off, and an 8 digit LED display allows you to scroll through anywhere in memory. To make it easy to pick out numbers and codes, a dash is inserted between any group or set of numbers that were decoded more than 2 seconds apart. The TG-1 runs from any 7 to 15 volt DC power source and is both voltage regulated and crystal controlled for the ultimate in stability. For stand-alone use add our matching case set for a clean, professionally finished project. We have a TG-1 connected up here at the Ramsey factory on the FM radio. It's fun to see the phone numbers that are dialed on the morning radio show! Although the TG-1 requires less than an evening to assemble (and is fun to build, too!), we offer the TG-1 fully wired and tested in matching case for a special price.

**TG-1, Tone Grabber Kit. . . . . . . . . . . . . . . . . . . . . . . . . . . $99.95**
**CTG, Matching Case Set for TG-1 Kit. . . . . . . . . . . . . . . $14.95**
**TG-1WT, Fully Wired Tone Grabber with Case . . . . . . . . $149.95**
**AC12-5, 12 Volt DC Wall Plug Adapter . . . . . . . . . . . . . . . . $9.95**

## Mini-Peeper Micro Video Camera

Super small, high quality fully assembled B & W CCD TV camera the size of an ice cube! Provides excellent pictures in low light (2 lux), or use our IR-1 Infra-Red light source to invisibly illuminate an entire room on a pitch black night! Imagine the possibilities... build it into a smoke detector, wall clock, lamp, book, radio. Exact same camera that's in big buck detective catalogues and stores. Kit includes: fully assembled CCD camera module, connectors, interface PC board kit with proper voltage regulation and filtering, hook-up details, even a mini microphone for sensitive sound! Two models available: Wide Angle Lens 3.6mm/f2, adjustable focus lens, 92 degree view; Pinhole Lens 5.5mm/f4.5, 60 degree view. The Pinhole Lens is physically much flatter and provides even greater depth of focus. The camera itself is 1.2" square. The Wide Angle Lens is about 1" long, Pinhole Lens about 1/2", interface PC board is 1" x 2" and uses RCA jacks for easy hook-up to VCRs, TVs or cable runs. Power required is 9 to 14 VDC @ 150 mA. Resolution: 380 x 350 lines. Instruction manual contains ideas on mounting and disguising the Mini-Peeper along with info on adding one of our TV Transmitter kits (such as the MTV-7 unit below) for wireless transmission!

**MP-1, Wide Angle Lens CCD TV Camera Outfit. . . . . . . . $169.95**
**MP-1PH, Pin-Hole Lens CCD TV Camera Outfit. . . . . . . . $189.95**

## MicroStation Synthesized UHF TV Transmitter

Now you can be in the same league as James Bond. This transmitter is so small that it can fit into a pack of cigarettes - even including a CCD TV camera and battery! Model airplane enthusiasts put the MTV-7A into airplanes for a dynamite view from the cockpit, and the MTV-7A is the transmitter of choice for balloon launches. Transmitter features synthesized, crystal controlled operation for drift-free transmission of both audio and video on your choice of frequencies: Standard UHF TV Channel 52 (which should only be used outside of the USA to avoid violating FCC rules), and 439.25 MHz or 911.25 MHz which are in the amateur ham bands. The 439.25 MHz unit has the nifty advantage of being able to be received on a regular 'cable-ready' TV set tuned to Cable channel 68, or use our ATV-74 converter and receive it on regular TV channel 3. The 911.25 MHz unit is suited for applications where reception on a regular TV is not desired, an ATV-79 must be used for operation. The MTV-7A's output power is almost 100 mW, so transmitting range is pretty much 'line-of-sight' which can mean many miles! The MTV-7A accepts standard black and white or color video and has its own, on-board, sensitive electret micorphone. The MTV-7A is available in kit form or fully wired and tested. Since the latest in SMT (Surface Mount Technology) is used to provide for the smallest possible size, the kit version is recommended for experienced builders only. Runs on 12 VDC @ 150 mA and includes a regulated power source for a CCD camera.

**MTV-7A, UHF TV Channel 52 Transmitter Kit . . . . . . . . . $159.95**
**MTV-7AWT, Fully Wired Channel 52 Transmitter . . . . . . . $249.95**
**MTV-7A4, 439.25 MHz TV Transmitter Kit . . . . . . . . . . . . $159.95**
**MTV-7A4WT, Fully Wired 439.25 MHz Transmitter . . . . . . $249.95**
**MTV-7A9, 911.25 MHz TV Transmitter Kit. . . . . . . . . . . . . $179.95**
**MTV-7A9WT, Fully Wired 911.25 MHz Transmitter . . . . . . $269.95**
**ATV-74, 439.25 MHz Converter Kit . . . . . . . . . . . . . . . . . $159.95**
**ATV-74WT, Fully Wired 439.25 MHz Converter. . . . . . . . . $249.95**
**ATV-79, 911.25 MHz Converter Kit . . . . . . . . . . . . . . . . . $179.95**
**ATV-79WT, Fully Wired 911.25 MHz Converter. . . . . . . . . $269.95**

**RAMSEY ELECTRONICS, INC.**
793 Canning Parkway
Victor, NY 14564

***Order Toll-free: 1-800-446-2295***
Sorry, no tech info or order status at this number

***Technical Info, Order Status***
***Call Factory direct: (716) 924-4560***

VISA MasterCard DISCOVER

*ORDERING INFO:* Satisfaction Guaranteed. Examine for 10 days, if not pleased, return in original form for refund. Add $4.95 for shipping, handling and insurance. Orders under $20, add $3.00. NY residents add 7% sales tax. Sorry, no CODs. Foreign orders, add 20% for surface mail or use credit card and specify shipping method.

CIRCLE 266 ON FREE INFORMATION CARD

CIRCLE 322 ON FREE INFORMATION CARD

# PC-Based 6MHz Sweep/Function Generator $549

- Wide frequency range from 0.2Hz to 6 MHz
- Sine, square. triangular output waveforms plus sweep function
- 3 operating modes: sweep, gated burst and voltage control frequency
- Designed and made in USA

*Turn your PC into a test station with :*

| | |
|---|---|
| Dual 100 MHz Universal Counter | $399 |
| 60 MHz Digital Storage Scope | $749 |
| 100 MHz Digital Storage Scope | $999 |

TC INSTRUMENTS INC.®

Tel: (909) 622-2006
Fax:(909) 622-7778
http://www.tcinst.com

We do OEM
Distributors wanted

# Cable TV Descramblers

**Converters * Filters * Accessories**

30 day Free Trial - *NO RISK!*
Unbeatable wholesale prices!
Affordable extended warranty
1 Year Warranty on *all* products

**Free Catalog**

*Call the cable professionals!*

Credit Cards Welcome!

**1-800-379-3976**

Orion Electronics

Prices starting as low as **$99!**

# New Surveillance Devices !

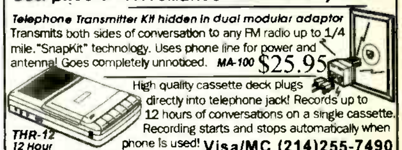
*Smoke Alarm and Table Clock Video Cameras*

Ultra miniature video cameras hidden in smoke alarm or alarm clock - your choice. Wide field of view and super .1 lux low light sensitivity! Undetectable!

*SC-600* *TC-70* High quality B/W with 420 lines of resolution for ultra sharp images. Direct output of video and audio. $219.95 ea.

***Best price on surveillance cameras anywhere!***

***Telephone Transmitter Kit hidden in dual modular adaptor***
Transmits both sides of conversation to any FM radio up to 1/4 mile."SnapKit" technology. Uses phone line for power and antenna! Goes completely unnoticed. *MA-100* $25.95



High quality cassette deck plugs directly into telephone jack! Records up to 12 hours of conversations on a single cassette. Recording starts and stops automatically when phone is used!

*THR-12 12 Hour Telephone Recorder* $99.95

**Visa/MC (214)255-7490**
Free shipping! Check/Money orders also accepted
**Seymor-Radix Inc. Box 166055-N Irving,TX 75016**
Now you can visit us on the internet at http://www.why.net/home/sr/

# ABC ELECTRONICS 315 7TH AVE N. MPLS. MN. 55401
## (612)332-2378 FAX (612)332-8481 30 DAY WARRANTY
## WE BUY TEST EQUIPMENT AND COMPONENTS.

| | | | |
|---|---|---|---|
| TEK 7A13 DIFFERENTIAL COMPARATOR | $150.00 | TEK 7B15 1 GHZ DELAYING TIME BASE | $250.00 |
| TEK 7A16P PROG.200MHZ VERT.AMPLIFIER | $75.00 | TEK 7B50A 150 MHZ TIME BASE | $75.00 |
| TEK 7A17 150 MHZ SINGLE TRACE AMPLIFIER | $50.00 | TEK 7B52 DUAL TIME BASE | $75.00 |
| TEK 7A18 75 MHZ DUAL TRACE AMPLIFIER | $50.00 | TEK 7B53 100 MHZ DUAL TIME BASE | $75.00 |
| TEK 7A19 600 MHZ SINGLE TRACE AMPLIFIER | $150.00 | TEK 7B70 200 MHZ TIME BASE | $75.00 |
| TEK 7A22 DIFFERENTIAL AMPLIFIER | $200.00 | TEK 7B71 DELAYING TIME BASE | $75.00 |
| TEK 7A24 400 MHZ DUAL TRACE AMPLIFIER | $200.00 | TEK 7B80 400 MHZ DELAYED TIME BASE | $100.00 |
| TEK 7A26 200 MHZ DUAL TRACE AMPLIFIER | $75.00 | TEK 7B85 400 MHZ DELAYING TIME BASE | $125.00 |
| TEK 7D11 DIGITAL DELAY UNIT | $50.00 | TEK 7B90P PROGAMABLE TIME BASE | $200.00 |
| TEK 7D12 A/D CONVERTER MAINFRAME | $50.00 | TEK 7B92A 500 MHZ DELAYING TIME BASE | $125.00 |
| TEK 7D13 DIGITAL MULTIMETER | $50.00 | TEK AM502 DIFFERENTIAL AMPLIFIER | $75.00 |
| TEK 7M11 DUAL 50 OHM DELAY LINE | $100.00 | TEK MX5010 MULTIFUNC.INTERFACE EXTEN. | $200.00 |
| TEK 7M13 | $50.00 | TEK 7834 400 MHZ STORAGE MAIN FRAME | $400.00 |
| TEK 7S11 SAMPLING PLUG IN | $200.00 | TEK 7844 400 MHZ MAIN FRAME | $400.00 |
| TEK 7S12 GENERAL PURPOSE SAMPLER | $350.00 | TEK 7854 400 MHZ DIGITAL STORAGE FRAME | $500.00 |
| TEK 7S14 1 GHZ SAMPLING PLUG IN | $350.00 | TEK 7904 500 MHZ MAIN FRAME | $250.00 |
| TEK PS5010 PROG.TRIPLE POWER SUPPLY | $250.00 | TEK 7104 1GHZ FRAME WITH- (7A29,7A29,7B10,7B15) | $2750.00 |
| TEK 485 350 MHZ PORTABLE SCOPE | $600.00 | | |
| KEITHLEY 480 PICOAMMETER | $300.00 | TEK 2235 100MHZ OSCILLOSCOPE | $650.00 |
| LEADER LBO516 100MHZ OSCILLOSCOPE | $300.00 | TEK 2246 100MHZ OSCILLOSCOPE | $1200.00 |
| GENRAD 1657 RLC BRIDGE | $750.00 | GENRAD 1658 RLC BRIDGE | $900.00 |
| SENCOR LC53 CAP-IND. METER | $400.00 | TEK 608 MONITOR | $650.00 |
| FLUKE 8505A 6.5 DIGIT DMM | $250.00 | TEK 577 D1/177 CURVE TRACER | $1500.00 |
| TEK DAS9100 WITH PROBES | $750.00 | HP 1651 LOGIC ANALYZER | $1200.00 |
| TEK 7D20 PROGRAMABLE DIGITZER | $500.00 | HP 8012A PULSE GENERATOR | $400.00 |
| FLUKE 343A DC VOLTAGE CALIBRATOR | $750.00 | BRADLEY 192 O-SCOPE CALIBRATOR | $750.00 |
| TEK 453 50 MHZ OSCILLOSCOPE | $200.00 | TEK 475 200 MHZ OSCILLOSCOPE | $500.00 |
| AVCOM PSA-35A SPECTRUM ANALYZER | $1000.00 | LEADER LBO516 100 MHZ OSCILLOSCOPE | $300.00 |
| SENCORE LC53 CAP-IND. METER | $400.00 | RACAL-DANA 1991 160 MHZ COUNTER | $300.00 |
| EMI SCR300-3 POWER SUPPLY | $300.00 | TEK 608 MONITOR | $650.00 |
| HP 141T/8553B/8552B SPECTRUM ANALYZER | $1500.00 | HP 8601 110 MHZ SWEEP/SIGNAL GEN. | $350.00 |

NEW **MULTI FREQUENCY CUBES!**

WIRELESS CABLE BOX TESTER
EXTERNAL AND INTERNAL MULTI-FREQUENCY
WORKS ON ALL MODELS: J****,SA,PIONEER, ALSO FOR CFT 2200!
WORKS EVERYWHERE.
**AUTOMATIC FREQUENCY FINDER!**
*60 DAYS WARRANTY*
QUANTITY DISCOUNT AVAILABLE
***DEALERS WELCOME!***
**PH: 718-575-1474 718-768-4963**
**Fax: 718-369-3989**
**E MAIL: 104170.3043@COMPUSERVE.COM**
AMEX MO & COD
Pocket cube is a test generator only

# CABLE TV CONVERTERS

*Equipment & Accessories*
*Wholesalers Welcome*

**Call C&D ELECTRONICS**
**1-800-310-1153 M-F 10a-8p**

# SURVEILLANCE

**The Latest High Tech Professional Electronic Devices**

Our latest catalog offers a **HUGE** selection of surveillance, privacy devices including: hidden video equipment, electronic kits, telephone recording systems, touch tone decoders, scanners, telephone tap detectors, bug detectors, voice disguisers, telephone scramblers,locksmithing tools, and more. **Catalog $5.00.**

**SPY OUTLET**
**P.O. Box 337, Buffalo, NY 14226**
**(716) 691-3476/(716) 695-8660**

# Invest a stamp...Save a bundle

For the price of a stamp, you can get the latest edition of the federal government's free **Consumer Information Catalog**. It lists more than 200 free or low-cost publications on federal benefits, jobs, health, housing, education, cars, and more.
So stamp out ignorance with our free **Catalog**. Send your name and address to:
**Consumer Information Center, Department SB, Pueblo, Colorado 81009**

# Fix It Yourself!


- Hands-on, detailed, troubleshooting instructions
- "How to" primer for test equipment: oscilloscopes, frequency counters, video analyzers, etc.
- Schematic diagrams
- Trouble analysis flowcharts
- Preventive maintenance techniques
- Safety precaution checklists
- Comprehensive replacement parts list
- Directory of manufacturers

**It's easy, fast, and rewarding to repair it yourself with the Electronics Repair Manual!**

**Leading Manufacturers Represented...**

| | | | |
|---|---|---|---|
| • Emerson | • Nintendo | • RCA | • Technics |
| • Hitachi | • Panasonic | • Sanyo | • Toshiba |
| • IBM | • Pioneer | • Sharp | • Zenith |
| • NEC | • Quasar | • Sony | and others! |

**30-Day Free Trial!**

**Dozens of Fix-It-Yourself Projects for...**

- ☐ CD Players
- ☐ VCRs
- ☐ Televisions
- ☐ Camcorders
- ☐ Computer Equipment
- ☐ Fax Machines
- ☐ Telephones
- ☐ Amplifiers
- ☐ Car Radios
- ☐ Home Appliances
- ☐ AM/FM Tuners
- ☐ Thermostats

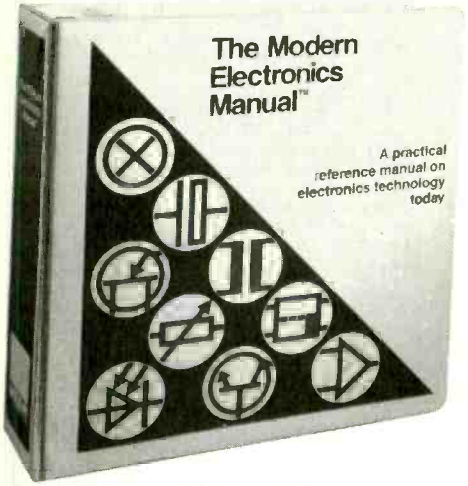
**...and more!**

***Keep Your Skills Up-to-Date!***

*The Electronics Repair Manual and the Modern Manual Electronics Manual will be a valuable reference for years to come. Supplements, each containing over 125 pages, add new repair projects, valuable insights into new technologies, diagnostic and repair techniques, electronics projects, and more schematic diagrams into your manual. Just $35 each for Electronics Repair and $49.50 each for Modern Electronics plus shipping and handling. Supplements are sent 4-5 times a year and are fully guaranteed. Return any supplements you don't want within 30-days and owe nothing. Cancel anytime.*

CIRCLE 311 ON FREE INFORMATION CARD

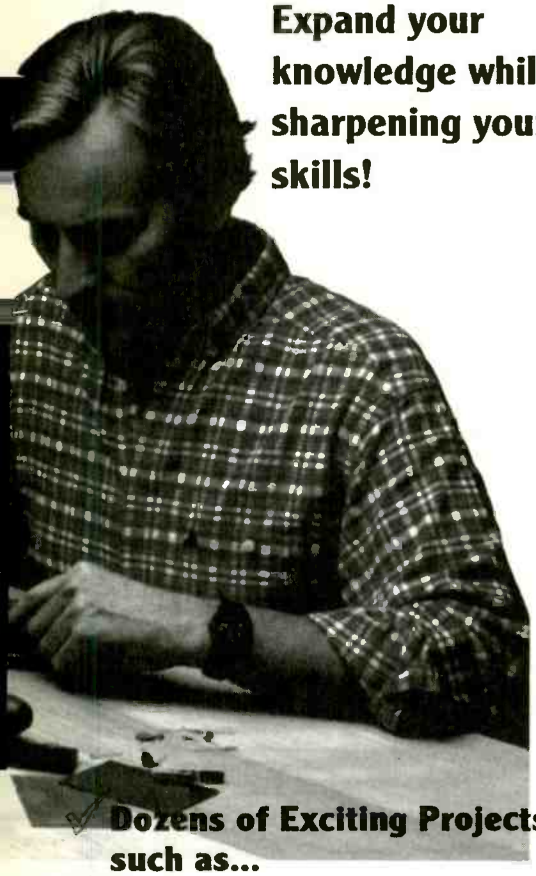
# Build It Yourself!




- A lifetime of exciting electronics projects
- Complete project plans
- Step-by-step instructions, flow charts, schematics, and photos
- Troubleshoot and repair
- Make your own printed circuit board (acetate board layouts provided)
- Component suppliers' addresses
- Handy 3-ring workbench binder

**Electronics Fundamentals...**
- Electronic Components and their Characteristics
- The Op-Amp Explained
- General Diagnostic Techniques

**...plus much more!**



**Expand your knowledge while sharpening your skills!**

**Dozens of Exciting Projects such as...**

☐ Simple Logic Probe
☐ Multi-Purpose Gas Detector
☐ Digital Combination Lock
☐ Radiation Detector
☐ Portable Frequency Counter

...and many other projects!

## 30 Day Free Trial Order Form

☐ Yes! Please rush me my copy of:
☐ Electronics Repair Manual for only $59.95 32856
☐ Modern Electronics Manual for only $59.95 32857
☐ Both Manuals for just $99.95. 32858

*I may take $10 off the total price when I enclose my check or credit card authorization by 12/31/96.Plus, I get free shipping and handling! I understand that if I am not satisfied, I may return the book(s) within 30 days for a full 100% refund of the purchase price.*

☐ My payment is enclosed. I've deducted $10 if I am ordering by 12/31/96.
☐ VISA ☐ MasterCard No. ______________ Exp. ______
☐ Check Enclosed.
☐ Optional express delivery (available in U.S. only).
Enclose an additional $10 and we'll guarantee delivery within 5 business days from receipt of your order (prepaid orders only; no P.O. Boxes).
☐ Bill me later including $6.50 shipping and handling per book, subject to credit approval. *Signature and phone number required to process your order. P.O. Box addresses must be prepaid.*

Signature (required) ______________________

Daytime phone (     ) ______________________

Mr./Mrs./Ms. ______________________

Company ______________________

Street Address ______________________

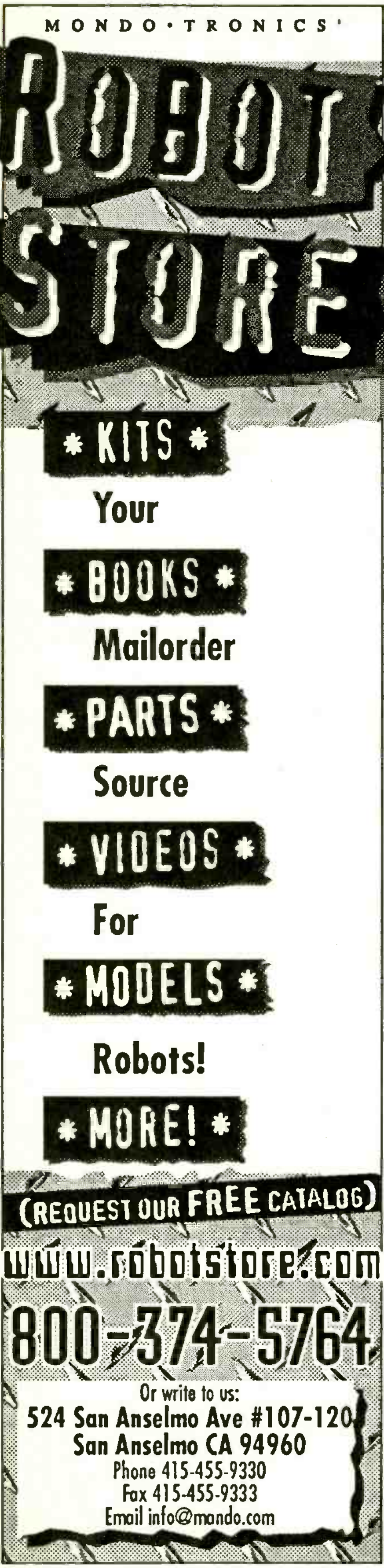
City ______________ State ________ Zip ________

Shipping and handling to Canada, $10 (U.S. Currency); Overseas, $15 (foreign orders must be prepaid); CT residents add 6% sales tax. Supplements will be sent 4-5 times a year on a fully guaranteed, 30-day trial basis. They may be cancelled at any time.

MAIL TO: WEKA Publishing, Inc.
1077 Bridgeport Avenue, P.O. Box 886, Shelton, CT 06484

**Call 1-800-222-WEKA or fax to 1-800-256-5915 for fast service!**

CIRCLE 311 ON FREE INFORMATION CARD




# CLASSIFIED

## SATELLITE EQUIPMENT

**FREE catalog** of big dish systems, upgrades, and accessories. Warranties, satisfaction guaranteed. **SKYVISION, 800-334-6455.** 1012 Frontier Drive, Fergus Falls, MN 56537. www.skyvision.com. See full page ad in the Shopper Section.

**THE** best television comes on a **DISH**$^{sm}$. Digital 18" satellite systems, mobile satellite systems, home entertainment accessories, and more. **SKYVISION 800-500-9264;** 1018 Frontier Drive, Fergus Falls, MN 56537. www.skyvision.com. See our full page ad in the Shopper Section.

**VIDEOCYPHER II** descrambling manual. Schematics, video and audio. Explains DES, EPROM, CloneMaster, Pay-per-view (HBO, Cinemax, Showtime, Adult, etc.) $16.95, $2.00 postage. Schematics for Videocypher II Plus, $20.00. Schematics for Videocypher II 032, $15.00. Software to copy and alter EPROM codes, $25.00. VCII Plus EPROM, binary and source code, $30.00. **CABLETRONICS,** Box 30502R, Bethesda, MD 20824.

**OBTAINING sound** for your **VCII** and **VCII Plus** is **easy.** No codes needed. **Details 1 (800) 211-5635.**

**DSS reverse engineering package.** Software, schematics, chip programmer plans, reviews & more! $49.95. VISA/MC. **TELECODE,** 1-(520) 726-2833.

**SOUND** for Videocypher-11 and plus without codes. Free details. SASE. **NASSIRIAN,** Box 382-E, Rio Linda, CA 95673.

## PLANS-KITS-SCHEMATICS

**CRYSTAL** set Handbook — Visit antiquity by building the radios your grandfather built. Assemble a "Quaker Oats" rig, wind coils that work and make it look like the 1920's! Only $10.95 plus $4.00 for shipping and handling. **CLAGGK INC.**, PO Box 4099, Farmingdale, NY 11735. US funds only! USA and Canada — no foreign orders.

**FREE Catalog.** 100 Leading-Edge kits. K1, PIC. Full instructions, source code. 1 (800) 875-3214. **SCIENCE FIRST,** 95 Botsford Place, Buffalo, NY 14216.

**BUILD** your own DC motor control. 1 to 480 amps w/surplus parts. **BEYOND ELECTRONICS,** 1 (800) 747-2861. Free catalog.

**AWESOME kits:** Voice changer, levitator, laser, gas sensor and more! Catalog $1.00. **LNS TECHNOLOGIES,** 20993 Foothill Blvd., Suite 307R, Hayward, CA 94541.

**ELECTRONIC** Project Kits. www.qkits.com 1-888-GO-4-KITS. 292 Queen St., Kingston, ON., K7K 1B8. **QUALITY KITS.**

**HACKERS** Catalog. **Hard-to-find** kits and assembled equipment **(Red box, spy, cable, etc.) Low prices.** $1.00. **SMITH-04,** Box 371, Cedar Grove, NJ 07009.

## EDUCATION & INSTRUCTION

**ELECTRONIC engineering.** 8 volumes complete. $109.95. No prior knowledge required. Free brochure. **BANNER TECHNICAL BOOKS,** 1203 Grant Avenue, Rockford, IL 61103.

**LEARN** VCR repair. Great profits. Home study. **P.C.D.I.,** Atlanta, Georgia. Free literature. (800) 362-7070 Dept. VRM342.

**LEARN** PC repair-troubleshooting, servicing. Home study. Free literature. **P.C.D.I.,** Atlanta, Georgia. (800) 362-7070 Dept. JJM342.

**BASIC mechanics for electronic technicians.** Send S.A.S.E. to **RM COMPANY,** PO Box 2124, Pomona, CA 91768.

## SECURITY

**SURVEILLANCE** Privacy security protection. Catalog $5.00. **SPY EMPORIUM,** 6065 Hillcroft, Suite 413, Houston, TX 77081. (713) 774-1000.

## TEST EQUIPMENT

**TEST Equipment** pre-owned now at affordable prices. Signal generators from $50.00, oscilloscopes from $50.00. Other equipment including manuals available. Send $2.00 US for catalog. Refunded on first order. **J.B. Electronics,** 3446 Dempster, Skokie, IL 60076. (847) 982-1973.

**TECHNICIANS:** Electronic component tester for use with oscilloscope. Satisfaction guaranteed. $29.95 plus S&H. Info: **ELECTROHM,** 529 Brentwood, Lawrence, KS, 66049. Fax: (913) 832-2481.

## MISCELLANEOUS ELECTRONICS FOR SALE

**TUBES:** "oldest", "latest". Parts and schematics. SASE for lists. **STEINMETZ,** 7519 Maplewood Ave., EN, Hammond, IN 46324.

**FIBER-Optic Projects** — Swing into the new technology by assembling tried and true projects recently published. "Practical Fiber-Optic Projects" - BP374 is only $9.95. (price includes shipping) **ELECTRONIC TECHNOLOGY TODAY INC.,** PO Box 240, Massapequa Park, NY 11762-0240.

**GREEN Thumb Alert**— Electronics enters the Garden! New exciting book points out how gardeners can build simple gadgets to pomote sucess where the elements work against you. Some of the projects are: over/under temperature monitoring, dusk/dawn switching, automatic plant watering, warming cables, etc. "Electronic Projects for the Garden" only $9.95 (price includes shipping) **ELECTRONIC TECHNOLOGY TODAY INC.,** PO Box 240 Massapequa Park, NY 11762-0240.

**CBers** Order new CB Trick III CB book. Shows CB tune ups, amplifiers, and expert CB info! Send $19.95 to **MEDICINE MAN** CB, PO Box 37, Clarksville, AR 72830.

**RESISTORS** 20 for $1.00. LEDs 4 for $1.00. Catalog $1.00. **ZIPFAST,** Box 12238, Lexington, KY 40581-2238.

**POOR** reception on your A.M. radio? Our Signal Booster will help. Guaranteed! Send $2.00 for details (refundable with order). **FALA ELECTRONICS,** PO Box 1376, Dept. 4, Milwaukee, WI 53201.

**POWERIZE yourself!** New **"easy use"**, low cost, personal computer peripheral **for non-computer experts.** Connects serial port. **Measure/log** physical conditions. **Control** machines, mechanical-electrical devices, processes. Can send data/control/alarms via modem. Time interval controller, too. **Convenience, productivity, profit!** Includes **detailed training manual; tells how!** lots of **free software!** Information: **CYBER BOX,** Box 53743, Lubbock, TX 79453, **1 (800) 299-6971.**

**CONVERTER-** descramblers: Examples, Zenith Ztac $225.00, Scientific Atlanta 85XX $185.00, 8580 compatible $215.00, 8600 $335.00, DPV-7212 compatible $215.00, Jerrold 400 $115.00. **All Pioneer test generator** $150.00. Most makes in stock, COD ok. **MOUNT HOOD ELECTRONICS,** (503) 543-7239.

**BUY BONDS**

# CLASSIFIED

## INVENTORS

**REGISTERED Patent Attorney.** Free handbook/advice. Patent/trademark protection for your ideas. 1 (800) 876-6670. **J.P. HALVONIK.**

## CABLE TV TURN-ON CHIPS

**SUPER Cable TV "Test Chips".** Provides full service activation. Excellent; Instructions & illustrations. **Jerrold Starcom:** DP(V)5..DP(V)7..DPBB7..CFT-2000..CFT-2200 Series. **Pioneer:** BA-5000 thru BA-6700. **Pioneer: Custom Programmer** (Clears E2 & rewrites new I.D. codes). **Scientific Atlanta: 8500 thru 8600. Tocom:** 5503-VIP..5507. **Zenith:** ST-1000 thru ST-5612. **Call Now!! MASTER COMPONENTS. 1 (800) 233-0570.**

## THE CABLE TV SUPER CUBE

**THE Mobilizer!!** External **"Test Cube"** activator. Easy **plug-n-play** operation. Excellent instructions & illustrations. Supports all DP(V)7..DPBB7..CFT-2000..CFT-2200 series converters. **New enhanced performance features:** Locked box revitalizer! Restore command! Plus much more! **Dealers wanted! Call Now!! MASTER COMPONENTS 1 (800) 233-0570.**

## CABLE TV

**ATTN, cable** box owners. Order your ID signal and bullet stopper before it's too late. Send $23.00 to **R.R. ENTERPRISE,** Box 3532, Easton, PA 18043.

**CABLE Descrambling** New secret manual. Build your own descramblers for cable and subscription TV. Instructions, schematics for **SSAVI,** Gated Sync, Sinewave, (HBO, Cinemax, Showtime, UHF, Adult) $12.95, $2 postage. **CABLETRONICS,** Box 30502R, Bethesda, MD 20824.

**CABLE TV Equipment & Accessories** Wholesalers welcome! 30 day moneyback guarantee! Free catalog! **PROFORMANCE ELECTRONICS INC., 1 (800) 815-1512.**

**CABLE TV Test Chips** for Jerrold, Tocom, Pioneer, Scientific Atlanta, etc... **Quick Installation!** New Multi-Mode modules available. Prices from $5.00 each. **1 (800) 786-9025.**

**CABLE-safe.** Guarantee cable privacy. The one-way valve for your cable TV signal. Cable signals come in, but they don't go out! $29.95 + $3.00 S&H. VISA/MC/AMEX. **ELECTROMAN,** Box 24474, New Orleans, LA 70184. (504) 482-3017.

**"CABLE Unscrambled.** Everything you want to know about cable, but are afraid to ask. $10.00. **"Descrambler Schematics Revealed."** A powerful guide to descrambling schemes. $10.00. **"Baseband Video Explained."** Discover what a Baseband Signal is and how it's constructed. $10.00. Special offer. Get all three for only $25.00! VISA/MC/AMEX. **ELECTROMAN,** Box 24474, New Orleans, LA 70184. (504) 482-3017.

**UNIVERSAL Descrambler.** Unscramble signals using your VCR as the tuner. Works with virtually any system, this is the only one you need. Declare cable box independence! Fully assembled. $129.95 + $5.00 S&H. VISA/MC/AMEX. **ELECTROMAN,** Box 24474, New Orleans, LA 70184. (504) 482-3017.

**"BULLET Buster".** Protect your cable box against the infamous cable "bullet". The "Bullet" Buster acts as an electronic shield. Installs in-line in seconds. Don't wait until it's too late! $19.95 + $3.00 S&H. VISA/MC/AMEX. **ELECTROMAN,** Box 24474, New Orleans, LA 70184. (504) 482-3017.

**CABLE Descrambler! Anyone can build** in **seven steps** with **Radio Shack** parts. **Plans/Kit** from **$5.00 plus free bonus!! 1 (800) 818-9103.**

**DESCRAMBLER Cable** using **simple circuit. E-Z to follow instructions** $10.00. **Complete kit** with **free "Bullet Stopper".** $20.00. **1 (800) 522-8053.**

**CABLE Bullet "Terminator/I.D. Blocker."** Electronically shields yourself and your box. Factory direct. **Lifetime Guarantee $14.95. 1 (800) 820-9024.**

**CABLE TV notch filters.** Request our free brochure by calling our voicemail at 1 (800) 433-6319 or write to **STAR CIRCUITS** PO Box 94917, Las Vegas, NV 89193. Visit our web site at http://ourworld.compuserve.com/homepages/starcircuits

**CABLE** test modules/cubes. Pioneers, S/A, Tocoms, Jerrolds. Latest technology. Quantity discounts. Voice/Fax (718) 426-8515.

**CABLE** TV testers/descramblers. All makes/models. Best prices guaranteed! 1 Yr. warr. http://www.concentric.net/rmvideo1 or call (602) 581-1496.

**CABLE** TV, descramblers, converters. Quantity discounts. 30 day free trial. Competitive prices. Call now! 1 (800) 322-0921 **REGAL SALES, INC.**

**DESCRAMBLE** cable with simple circuit added to Radio Shack RF modulator and using VCR as tuner. Instructions $10.00. **TELCOM,** Box 832 E11, Brusly, LA 70719.

**25+ Master test chip files.** Jerrold, Scientific-Atlanta, Tocom, Pioneer, Zenith. Software & book. $79.95. **TELECODE** 1 (520) 726-2833.

**CARL'S Electronics-** The Cable Hacker's Guide, stopping power meters, and electronic plans now available on-line. http://www.ultranet.com/~carlton. Call for a free catalog (508) 534-3228.

**WIRELESS** cubes for any box $150.00. Instruction, plans, parts list - $7.00. Call (718) 545-5146. 1 Year warranty.

**JERROLD** - RFT's, FTG's. Lowest prices. Minimum order 5. 4pm to 8pm Eastern 1 (607) 734-2262.

**R.F.T.'s $58.00!,** Diagnostic cubes, F.T.G.'s with filter **$58.00!** (JER.-PIO.-S.A.). 1 (800) 688-0097. Testers for educational only.

## COMPUTER SOFTWARE

**JOYSTICK-To-Mouse.** Now run Windows with any joystick! "Fly" the internet! 3.x/95 compatible. Only $29.95! "www.IMGPresents.com" 1 (818) 346-3581, 1 (800) 889-0987.

## COMPONENTS

**RARE blue LEDs** 12 for $18.00, includes $4.00 S&H. CA residents add $1.44 tax. Hurry, quantities limited. **DIGITON,** 18620 Hatteras Street, #254, Tarzana, CA 91356-1827.

**TRANSFORMERS** - TOROIDAL: 37&52VA, 120V- 30VCT & 7.5V RMS. Simple, compact and cost effective solution to supplying +5V and ±15V for digital/analog projects. Dealers welcome. **OMEGATRON,** (418) 831-1749.

# ADVERTISING INDEX

**Electronics Now does not assume any responsibility for errors that may appear in the index below.**



# ADVERTISING SALES OFFICES


**Gernsback Publications, Inc.**
**500 Bi-County Blvd.**
**Farmingdale, NY 11735-3931**
**1-(516) 293-3000**
**Fax 1-(516) 293-3115**

**Larry Steckler**
publisher (ext. 201)

**Christina Estrada**
assistant to the publisher (ext. 209)

**Arline Fishman**
advertising director (ext. 206)

**Michele Torrillo**
advertising assistant (ext. 211)

**Adria Coren**
credit manager (ext. 208)

**For Advertising ONLY**

**EAST/SOUTHEAST**
**Stanley Levitan**
Eastern Advertising
1 Overlook Ave.
Great Neck, NY 11021-3750
1-516-487-9357
Fax 1-516-487-8402

**MIDWEST/Texas/Arkansas/Okla.**
**Ralph Bergen**
Midwest Advertising
One Northfield Plaza, Suite 300
Northfield, IL 60093-1214
1-847-559-0555
Fax 1-847-559-0562
bergenrj@aol.com

**PACIFIC COAST**
**Janice Woods**
Pacific Advertising
Hutch Looney & Associates, Inc.
6310 San Vicente Blvd.
Suite 360
Los Angeles, CA 90048-5426
1-213-931-3444 (ext. 228)
Fax 1-213-931-7309

**Electronic Shopper**
**Joe Shere**
National Representative
P.O. Box 169
Idyllwild, CA 92549-0169
1-909-659-9743
Fax 1-909-659-2469

**Megan Mitchell**
National Representative
1201 N. Rainbow Blvd., #50
Las Vegas, NV 89108-6819
1-702-259-7043
Fax 1-702-259-7043

**Customer Service**
1-800-999-7139
7:00 AM - 6:00 PM M-F MST

# The scope can be held with one hand. The awards can't.

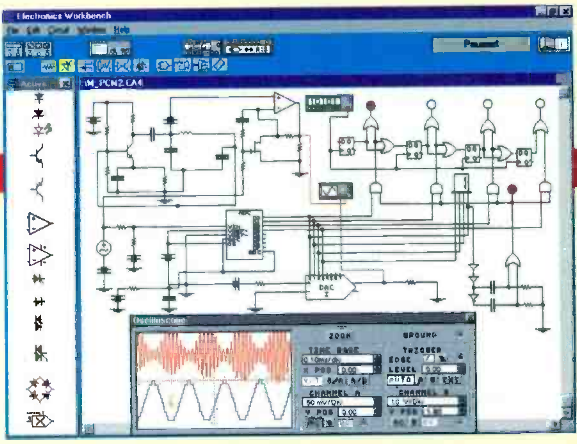


The TekScope® Handheld Digital Oscilloscope has won virtually every major award a handheld scope or DMM can. Because it allows you to sample at 500 MS/s on both of its channels simultaneously. Because it comes with Isolated Channel™ Architecture. Because it has a True RMS DMM. All surrounded by an intuitive, rugged package that will rest comfortably in the palm of your hand. For these reasons and more, TekScope has repeatedly been voted number one by customers like yourself.

Awards can be a handful, sure. But we're not complaining. For more information, call 1-800-479-4490, Action Code 722, or visit us at www.tek.com.

**Tektronix**

# Better Designs –Faster



## Guaranteed with Electronics Workbench!

Just click and drag to create and edit schematics. Mix analog and digital devices in any combination with full control over values, models and behavior. Try 'what if' scenarios and fine tune effortlessly. And on-screen waveforms always match actual circuit response. You'll create better designs faster—*Guaranteed!*

### Guaranteed Satisfaction

Join over 70,000 customers and experience the power, flexibility and value that only Electronics Workbench offers. Receive unequaled service and free, unlimited technical support by phone, fax, e-mail, WWW, CompuServe and BBS. You'll be delighted. *We guarantee it.**

### True Mixed-Mode Power

Connect any analog or digital device to any other device without limit. Only Electronics Workbench offers this professional power for under $2,000.

### Real-World Digital

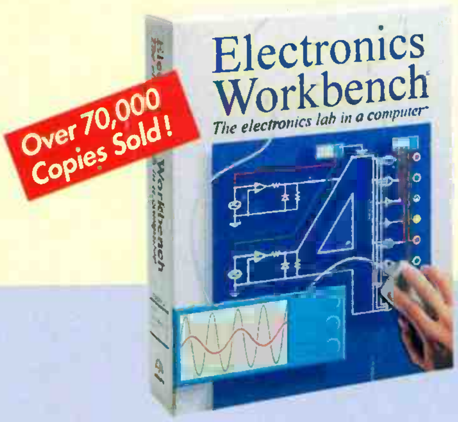
Real-world TTL and CMOS, complete with propagation delays and fanout. Unique at this price.

### 32-Bit Speed

Integrated SPICE analog and native-mode digital simulation in full 32-bit. Unique at this price.

### Real-World Results

Unlimited supply of over 200 components and ICs and 350 real-world models—all perform as real devices.




# Electronics Workbench®

**$299**

***30-DAY MONEY-BACK GUARANTEE**

VERSION 4.1 FOR WINDOWS 95/NT/3.1, DOS AND MACINTOSH.

*Ask about our Engineer's Pack with thousands of additional models and more. Version 4.0 users call for your free upgrade.*

**800-263-5552**

INTERACTIVE

**Fax: 416-977-1818 Internet: http://www.interactiv.com**

CompuServe: 71333,3435/BBS: 416-977-3540/E-mail: ewb@interactiv.com

INTERACTIVE IMAGE TECHNOLOGIES LTD., 908 Niagara Falls Boulevard, #068, North Tonawanda, New York 14120-2060/Telephone 416-977-5550

TRADEMARKS ARE PROPERTY OF THEIR RESPECTIVE HOLDERS. OFFER IS IN U.S. DOLLARS AND VALID ONLY IN THE UNITED STATES AND CANADA. ALL ORDERS SUBJECT TO $15 SHIPPING AND HANDLING CHARGE

Australia: 2-519-3933 • Belgium: 2-384-73-09 • Brazil: 11-453-5588 • Canada: 416-977-5550 • Chile: 2-236-0300 • Cyprus: 9-641-801 • Czech Republic: 4-823-454 • Denmark: 33-25-0109 • Finland: 0-297-5033 France: 1-49-08-90-00 • Germany: 711-62-7740 • Greece: 1-524-9981 • Hungary: 1-215-0082 • India: 11-578-7055 • Indonesia: 21-470-0815 • Israel: 3-647-5613 • Italy: 11-437-5549 • Japan: 3-5395-2126 Malaysia: 3-774-2189 • Mexico: 5-593-5260 • Netherlands: 10-450-4949 • New Zealand: 9-267-1756 • Norway: 22-16-70-45 • Philippines: 973-27-0118 • Portugal: 1-814-6609 • Singapore: 777-2303 • Slovenia: 61-317-830 South Africa: 331-6-8309 • South Korea: 2-3452-9757 • Spain: 1-383-8335 • Sweden: 8-740-5500 • Taiwan: 2-366-0080 • Thailand: 2-398-6952 • UAE: 4-453505 • UK: 203-23-3216 • USA: 416-977-5550

CIRCLE 126 ON FREE INFORMATION CARD