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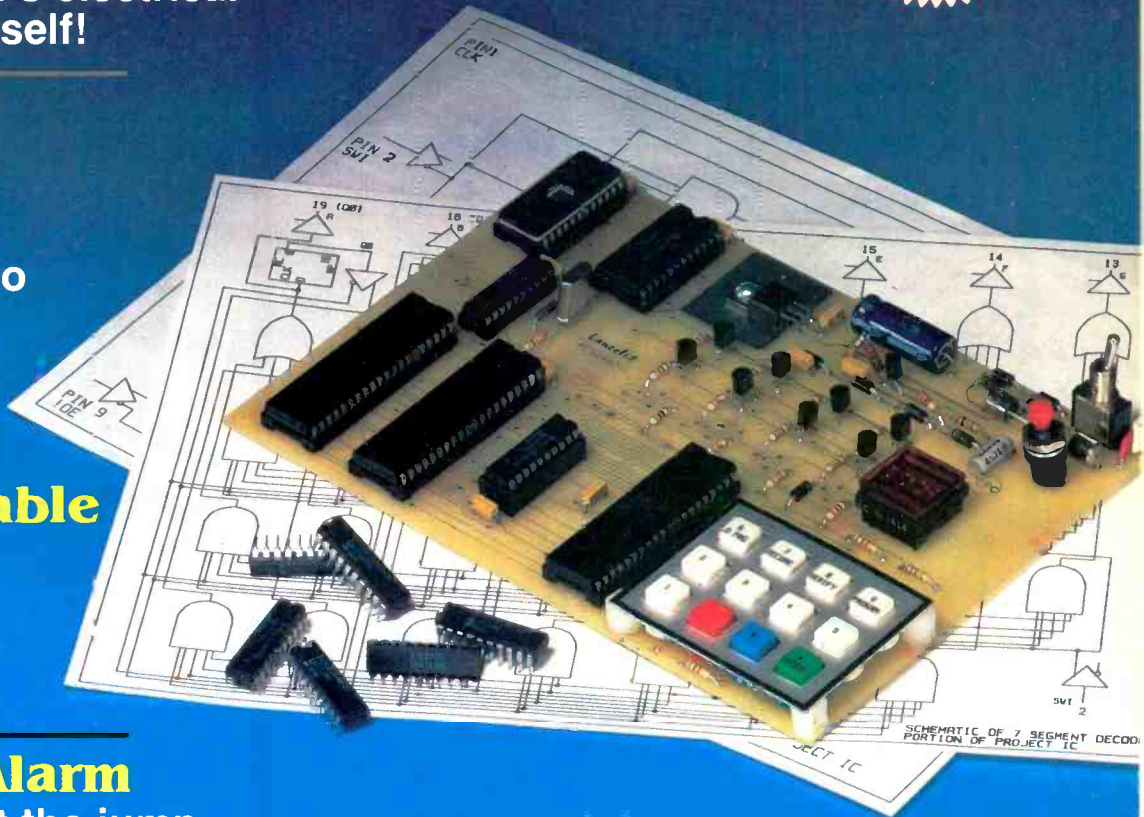
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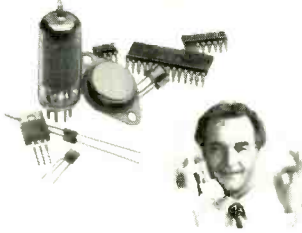
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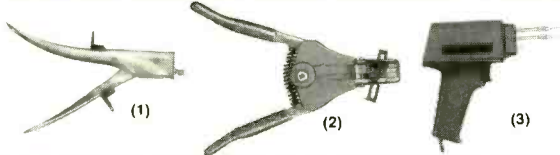
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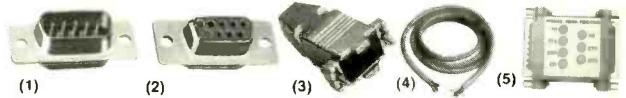


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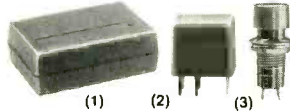
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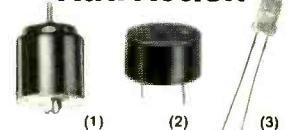
9⁹⁵



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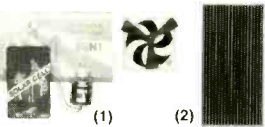
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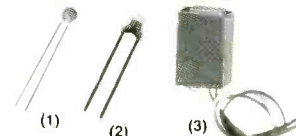
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DECADE OF THE MICROPROCESSOR

Hard as it is to believe, another decade has come to a close. And just like every other decade in the last half of the 20th Century, the 1980's were a time of explosive changes in electronics technology.

I used the word "explosive" advisedly, for even "revolutionary" seems too gentle to describe the havoc the microprocessor has caused. Love 'em or hate 'em, there's no denying that the microprocessor has altered our hobby, and our society.

Few had any inkling of what was brewing as this decade opened; microprocessors and personal computers were still the province of a small cadre of experimenters. What's more, the devices were relatively "primitive;" some of the today's pocket organizers have more computational capabilities than even the most advanced hobbyist/consumer computers of January, 1980. Today, microprocessors are everywhere you turn. They're in our cars, our telephones, our entertainment gear, our ham gear, our cameras, you name it.

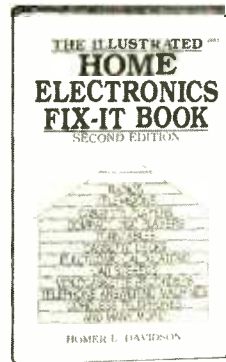
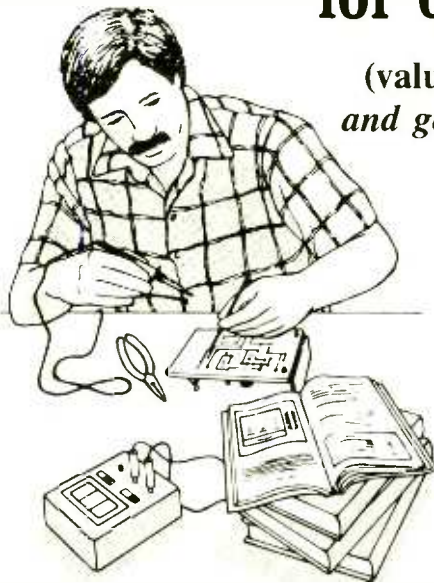
Have the changes brought about by the microprocessor been good ones? The answer must be a resounding yes! Now, before I am buried by the avalanche of mail that this comment is sure to generate, consider all of the advances that would be impossible without the microprocessor. Yes, microprocessors have shoved some important segments of the electronics hobby into the background. And, yes, the over-use of microprocessors have made some facets of our lives more difficult than they need be. But if you stop and rationally think about all the ways our lives might suffer if microprocessors never existed, I think you'll come to the same conclusion.

Now, as we look ahead to the 1990's, I wonder what technology or technologies will change our lives during the next decade. Will it be superconductivity, robotics, "cold fusion," or something still to come? Whatever it is, it will really have to be something special to outdo the decade of the microprocessor.

Carl Laron
Managing Editor

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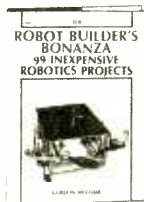
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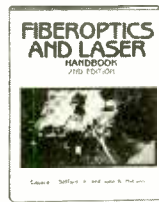
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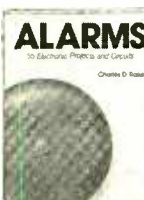
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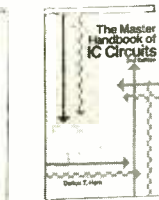
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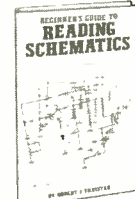
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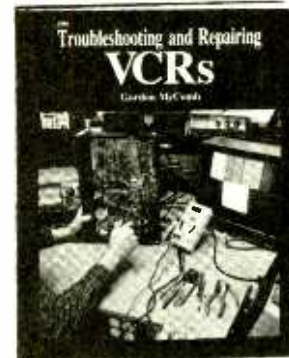
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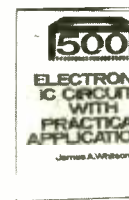
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Letters

THINK AGAIN

It has come to our attention that two errors crept into the October, 1989 installment of "Think Tank." In Fig. 6, the schematic drawing of the Power Inverter, transistor Q2 is shown inverted; its emitter should be connected to the emitter of Q1.

Also, in the LED Light Chaser, a dot is missing in the schematic of Fig. 8. That dot should appear at the junction of the line between R9 and IC1 pins 12 and 14, and the line between IC1 pin 1 and IC4 pin 6

— Editor

TOUCH-CONTROL DIMMER SWITCH

In my article "Touch-Control Dimmer Switch," (*Popular Electronics*, November 1989) I found a problem with the printed-circuit patterns. In the process of printing the magazine, the patterns blurred somewhat and some of the pins appear to be touching at TR1 and IC1. None of the adjacent Triac or IC pads should touch in either the round or the rectangular pattern. Pin 1 and pin 2 on IC1 may be soldered together if you wish to select the O-mode. I also recommend regulating the size of the bulb being controlled by the heat dissipated by TR1 or amperage rating of TR1 or L1. If controlling 150 watts or less, Radio Shack's 276-1000 and 273-102A may be used. At no time should the bulb be more than 400 watts.

Another option for the touch-control dimmer switch would be to install an LS7232 variable dimmer IC. It plugs right in place of the LS7237, but pin 1 must be tied to pin 2 of IC 1 or the LS7232 may be damaged.

I am offering iron-on PC patterns to save time for those who are making their own boards. The round patterns are \$1.00 each, and the rectangular patterns are \$1.00 for two. Please send a self-addressed stamped envelope with your order to Touch, 7330 Duce Road, Yale, MI 48097.

Mike Giamportone

WHICH WIEN?

Don't feel too bad about having called a Wien bridge a "Wein" bridge. The reference books I looked at were split 50-50 on the spelling. Knowing German doesn't help, because both Wien and Wein are German names.

I finally traced the Wien bridge to its origin—a paper by Max Wien (pronounced "Veen")

in the *Annalen der Physik und Chemie*, 1891. Wien built a primitive oscilloscope by reflecting a light beam off a telephone receiver; he was one of the first people ever to see waveforms. With that gadget for a signal detector, he then built a bridge to compare capacitors or inductors.

Michael A. Covington

CONVERTER CAPACITORS

I built the "High-Performance Shortwave Converter" (*Popular Electronics*, October 1989), and I found that it lives up to the author's claims, and more. Having built many SW converters over the years, I am going to give that one a gold star.

There was one problem I must point out, however. Three of the capacitors were transposed in the parts-placement diagram (Fig. 3). When completing the project, C2 should be installed in the position marked C3, C3 should be installed in the position marked C4, and C4 should be installed in the position marked C2.

Incidentally, anyone who's having trouble finding the NE602 can order it from DC Electronics (P.O. Box 3203, Scottsdale, AZ 85271-3203) for \$2.00 plus \$3.00 shipping. I have found that company to be a good source of materials for building home-made equipment.

G.T.
Peoria, IL

LEARNING BY DOING

I would like to compliment you on an outstanding periodical. Almost everything that I know about electronics is from reading *Popular Electronics*. When I first became interested in electronics, I purchased the book *Getting Started in Electronics* from Radio Shack. However, I still couldn't understand enough to have a practical aptitude. So I gave up for a while, until I decided to subscribe to *Popular Electronics*. Even if I couldn't understand the circuits, I could have fun building projects.

After my first three issues, I had a large enough collection of circuits that I could look for similarities in the schematics and descriptions that unlocked the mysteries that frustrated me earlier. After nine issues and a lot of experimentation, I'm pretty good at designing circuits of my own. Now that I have the skill, I can never think of anything practical and challenging to design. You should include, each month, a few ideas that readers would like to see worked out. Unfortunately, my school does not have an electronics class, so I'll have to wait until college to get a firm foundation on the principles I might have missed. In the mean time, I can still learn on my own with books and *Popular Electronics*.

E.Y.
Villanova, PA

OVER-SENSITIVE SECURITY SYSTEM

I found that the article "Servicing Security

Systems" (*Popular Electronics*, September 1989) contained a lot of good information. It also reminded me of a problem that I helped a friend of mine work out several years ago.

My friend lives in an apartment building in the Bronx. The windows are old and loose, and if you hit one (or even if there was a thunderstorm) it would trigger the alarm. Since, as the author pointed out, the detector is kept from activating the alarm by current, I gave my friend a small handful of capacitors ranging from 0.01 to 1 μ F. I told him to connect a capacitor across the terminals of the normally closed circuit in the alarm box, and to try banging on the window. As it turned out, a 0.01- μ F capacitor was effective in eliminating his false-alarm problem.

The reason the trick worked is that when an interruption of the loop occurs, the voltage source starts to charge the capacitor. Current is drawn for a period determined by the time constant ($R \times C$). The idea is to select the smallest capacitor that does the job. If and when the "swinger" becomes a steady open circuit, it will be no trouble to isolate and repair.

A.R.
South Hackensack, NJ

BALANCING ACT

In reading the October 1989 issue of *Popular Electronics*, I was struck by the interesting diversity of articles. I particularly enjoyed "Electronic Quackery"—it was a well-written and -researched historical piece.

I believe you have achieved a good balance, and I enjoy the wide range of interests you cover.

M.M.G.
Huntington Beach, CA

"BRAIN" RADIO

I enjoyed Stanley A. Czarnik's articles on crystal radios and electrotherapy in the October issue of *Popular Electronics*. Keep it up.

Mr. Czarnik asked for additional information on Archie F. Collin's work on "brain" radio. Anyone who's interested in reading more about the subject should also see *Scientific American Supplement*, Vol. 54, page 2225 (Aug. 2, 1902); and *London Electrical Review*, Vol. 50, pages 844-847 (May 23, 1902). The latter is an update on *Electrical World* and has various morbid and disgusting photos. You can also check bibliography source: *Articles by A. Frederick Collins*, 22 pages, circa 1909, for a list of his wireless articles in various journals—it's quite rare. Finally, Collins may have patented some of his work; check between 1901 and 1905.

R.A. Ford
Lindsay Publications
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WHAT-METER?

Regarding the "In-Line AC Wattmeter" in the October issue: That is a handy and worth-

while device, but it is *not* a wattmeter! A true wattmeter requires both voltage and current inputs. That current-only instrument is simply an ammeter. With it, you can calculate watts for a strictly resistive load, like a light bulb or a toaster. Notice I say "calculate," because you must also know the voltage to complete the Ohm's law equation.

The author evidently intends to use his instrument only for 117 VAC house current, and has marked the scale directly in "watts." However, that scale will not be accurate for reactive loads, such as refrigerator compressors or fluorescent lights. It's all a matter of power factor, the phase relationship between voltage and current. An ideal capacitor will draw lots of current from an AC voltage, but no power is consumed!

W.L.J.
North Hollywood, CA

WATTMETER WARNING!

The staff here at shortwave station WCSN, from entry-level apprentices to graduate engineers, all enjoy reading **Popular Electronics**. However, I must comment on the article, "In-line AC Wattmeter," by Gregory R. McIntire, that appeared in the October 1989 issue.

Current transformers (CT's) can be extremely dangerous if the secondary looks into an open circuit!

For those who aren't familiar with current transformers, follow through the math:

Assume 1-amp primary current:
Secondary current = 1 amp × 5 (primary turns)/400 (secondary turns) = 0.0125 amp.

Now assume that the maximum resistance of 50K ohms is in circuit:

Secondary voltage = I × R = 0.0125 amp × 50K ohm = 625 volts.

The secondary resistance will probably limit the voltage to a lower value, but the danger is still there.

Now consider the case if the meter was disconnected with current flowing in the primary:

Secondary voltage = I × R = 0.0125 × infinity = infinity!

Although infinite voltage is not practically possible, an open-secondary current transformer can have unexpectedly high voltages. What frequently happens with commercial CT's is that the transformer or the associated secondary wiring will break down if no protective devices, such as Metal Oxide Varistors (MOV's), are installed.

In short, current transformers can be dangerous if not handled with care.

R.S.
Greenbush, ME

shortwave capability. It was manufactured by Hazeltine Corporation and was sold by Coast-to-Coast stores as the "Musicaire." The model number is 681 TB and it uses a 6-volt battery for power. I'd appreciate any information your readers could provide to help me restore the set.

Christopher Misterek
1122 North Central
Pierre, SD 57501

I have two antique radios that I hope to restore, with some help from other **Popular Electronics** readers. Does anyone know where I can obtain the schematics for a Westinghouse console model #754 (110 volts, 80 watts, 25/60 cycles) and a General Electric table model #K.L. 53 (serial #953, 80 watts)? I would be willing to pay for copies of them. Thank you.

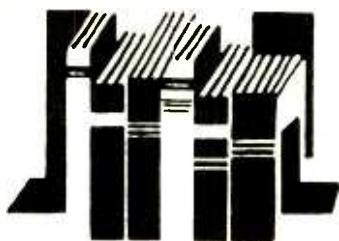
Joseph L. Hall
P.O. Box 3400
Mission, BC
Canada V2V 4J5

I need a circuit for a battery-generated, linear, meter-driven remote thermometer of 0° - 100°F, for distances up to 100 feet. I have numerous thermometer circuits in my library, but nothing that fits that description.

Steven Garren
Route 5, Box 452
Winder, GA 30680 ■

		EMINENCE 					
3-WAY 100W CROSSOVER 12 dB/octave rolloff. 800Hz, 5000Hz crossover points. 8 ohm. 100 watts RMS. 		WALNUT SPEAKER CABINET KIT Super quality, genuine walnut veneer cabinet. Kit includes: routed and mitred top, sides, and bottom in unfinished 3/4" walnut veneer. Cut your own custom holes in the front and rear to match your drivers. 15" x 24" x 11". Volume: 1.9 cubic feet. 		12" SUB WOOFER Dual voice coil sub woofer. 30 oz. magnet, 2" voice coils. 100 watts RMS, 145 watts max. fs = 25 Hz. 6 ohm (4 and 8 ohm compatible). SPL = 89 dB 1W/1M. Response: 25-700 Hz. QTS = .31, VAS = 10.3 cu. ft. Pioneer #A30GU30-55D. Net weight: 6 lbs. 		18" EMINENCE WOOFER MADE IN USA 100 oz. magnet, 3" voice coil. 250 watts RMS, 350 watts max. 8 ohm, 30 Hz resonant frequency. 22-2700 Hz response. Efficiency: 95 dB 1W/1M. Paper cone, treated accordion surround. Net weight: 29 lbs. 	
SPEAKER CONTROL PANEL Panel with 50 watt L-pads for tweeter and midrange and built-in LED power meter. 5" x 2 1/2" 100 watt version available. 	12" POLY WOOFER Super duty, 40 oz. magnet. 100 watts RMS, 145 watts max. 4 and 8 ohm compatible (6 ohm). 2" voice coil. fs = 25 Hz. QTS = .166, VAS = 10.8 cu ft. Response: 25-1500 Hz. Net weight: 9 lbs. Pioneer #A30GU40-51D 	PIONEER HORN TWEETER Mylar dome. 2.93 oz. barium ferrite magnet. 8 ohm. Response: 1800-20000 Hz. 35W RMS, 50W max. fs = 2000 Hz, SPL = 106 dB. Pioneer #AHE60-51F 	15" THRUSTER WOOFER Thruster by Eminence. Made in USA. Poly foam surround, 56 oz. magnet. 2-1/2", 2 layer voice coil. 150 watts RMS, 210 watts max. 4 ohm. fs = 23.5 Hz. QTS = .33, VAS = 17.9 cu ft. SPL = 94.8 dB 1W/1M. Net weight: 15 lbs. 	TITANIUM COMPOSITE TWEETER Titanium is deposited on a polymer dome to combine the advantages of both hard and soft dome technologies. 8 ohm. Ferro fluid cooled voice coil. fs = 1200 Hz. SPL = 90 dB 1W/1M. 50 watts RMS, 70 watts max. 4" round. Polydax part #DTW100T125. 			
GRILL FRAME KIT With this kit you can make speaker grill frames up to 30" x 40". Kit includes 4 corner pieces, 2 "T" brackets, and 7 frame bars. Grill mounting kit included. 	1989 CATALOG 		FREE CATALOG				
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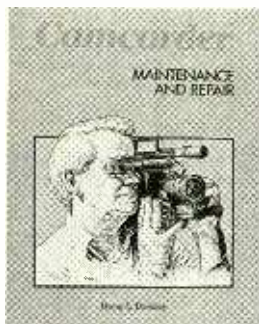
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CAMCORDER MAINTENANCE AND REPAIR

by Homer L. Davidson

Written for everyone who owns a camcorder, this book explains how camcorders work, how to keep them in good working order, and how to make simple repairs. Only a few tools are needed, and no electronics expertise is required. By following the easy-to-read text and clear block diagrams, even a novice can confidently maintain and repair his camcorder, from simple head cleaning to motor replacement. The author points out those problems that are too complex to be attempted at home, and recommends professional repairs in those cases.

The book first explores the basics: Different formats—VHS, Beta, and 8mm—and their offshoots—Super-VHS, VHS-C, Super 8, etc.—are explained. Camera specifications, simple operating procedures, safety and service precautions, pointers on reading the owner's manual, and battery-saving tips are also presented up front.



For basic troubleshooting, an explanation of how to use a digital multimeter to check the diode, transistor, and IC components is presented.

Building upon those basics, the author goes on to explain clean-up, lubrication, videocassette selection, and battery care. The camera system and VCR system are

discussed in detail, as are the various parts that make up each system, including the capstan, loading, iris, focus, control, and zoom motors. The book also explains how to remove panels and components, and how to solve power, battery, recording, playback, viewfinder, video, sound, and AC-adaptor problems.

Camcorder Maintenance and Repair is available for \$16.95 from TAB Books Inc., Blue Ridge Summit, PA 17294-0850; Tel. 1-800-233-1128.

CIRCLE 98 ON FREE INFORMATION CARD

COMPONENTS CATALOG

from Arrow Electronics, Inc.

This comprehensive sourcebook provides one-stop shopping with more than 450 pages of electronics parts and accessories. The catalog is divided into the following categories: Cabinets & Enclosures; Capacitors & Filters, Connectors, Sockets, Terminal Blocks & Accessories; Fans & Motors; Fuses & Circuit Breakers; Hardware, Batteries & Tools; Indicator Lights, Lamps & Optoelectronics; Meters, Test Equipment & Instruments; Power Supplies; Relays; Resistors, Potentiometers & Dials; Semiconductors, Microprocessor & Microprocessor Crystals; Solder & Solder Equipment; Switches & Knobs; Transformers & Chokes; and Wire & Cable. Over 100,000 different part numbers from more than 90 leading manufacturers are listed. Detailed photographs and illustrations accompany the product descriptions, and four different cross-reference indexes provide quick access to the needed components.

Catalog Division: Volume 2 is available for \$25.00 from Arrow Electronics Inc., 25 Hub Drive, Melville, NY 11747; Tel. 1-800-93-ARROW.

CIRCLE 101 ON FREE INFORMATION CARD

THE AERONAUTICAL COMMUNICATIONS HANDBOOK: HF Edition

by Robert E. Evans

The exciting hobby of monitoring aeronautical radio communications includes tuning into conversations between commercial airliners and ground facilities on all five continents, following the Concorde's flights to and from Europe, monitoring the progress of Russian Aeroflot flights working Cuba in Morse code, and deciphering the RTTY messages of the Aeronautical Fixed Telecommunication Network. Veteran DX'er Robert Evans covers all that and more in this guide to aeronautical communications.

The book is organized by topic with individual frequency lists. It includes a comprehensive introduction to shortwave,

propagation, and aeronautical utility monitoring; and an explanation of key terms and concepts to help the reader understand commercial aircraft-to-ground communications and messages. It offers detailed explanations and frequencies for major world air route areas; shortwave fax stations; civil aviation and Civil Air Patrol; the U.S. Drug Enforcement Agency; NASA; Coast Guard Search and Rescue; U.S., Canadian, and other world air forces.

THE AERONAUTICAL COMMUNICATIONS HANDBOOK H.F. EDITION



Directions are given on how to submit reception reports and QSL aircraft and ground stations. The book includes master frequency lists (including confirmed services and stations) of over 500 active monitored frequencies.

The Aeronautical Communications Handbook: HF Edition is available for \$19.95 plus \$1.00 shipping from Universal Radio, 1280 Aida Drive, Reynoldsburg, OH 43068; Tel. 800-431-3939. (In Canada, the book costs \$25.00 plus postage, and can be ordered from Ontario DX Association, P.O. Box 161, Station A, Willowdale, Ontario, M2N 5S8.)

CIRCLE 102 ON FREE INFORMATION CARD

EASY DOS IT! and HARD DOS IT!

by Ron Bauer

These two books comprise the "Learn In A Day Way" series of DOS instructional material for new computer owners—almost all of whom need some help getting started with MS-DOS. They are easy—and even fun—to read, and include examples, shortcuts, and tips designed to take the mystery and frustration out of learning to use DOS.

Easy DOS It! teaches the "Essential Eleven" DOS commands in a step-by-step format that readers can follow at their own pace. It shows three different ways to boot up, easy ways to format and copy disks, and other basic information. *Hard DOS It!* is the follow-up book, written for those who have hard-disk drives. It teaches beginners to use hard-disk directories in an easy-to-understand way, using only eight commands in addition to the eleven pre-

Electronics Library

ment, collect data from it, analyze the data, and present the data in a useful fashion. The book includes examples to guide the reader, and comes with "The Scientific Routines Disk," which contains all of the programs listed in the text and allows the reader to try out and modify the software immediately.

After an introductory overview of laboratory automation and IBM PC's, the book covers both the theory and application of digital-to-analog converters, which are often used to synthesize analog signals that con-

STEPHEN C. GATES WITH JORDAN BECKER

LABORATORY AUTOMATION USING THE IBM PC



rol devices such as recorders and oscilloscopes. Analog-to-digital converters are also covered, followed by discussions of noise-detection and -reduction techniques, digital input and output, IEEE-488 GPIB interfaces, serial communications, timers and counters, and coordinated data collection and control. A full section on data analysis includes software, and covers peak detection and digital image processing. Advanced techniques such as local-area networks are also explored in detail.

Laboratory Automation using the IBM PC is available for \$36.00 (hardcover) and \$18.00 (paperback) from Prentice Hall, Englewood Cliffs, NJ 07632.

CIRCLE 99 ON FREE INFORMATION CARD

SCANNER CATALOG

from Universal Shortwave Radio

Covering a broad range of items for the VHF-UHF monitoring enthusiast, catalog No. 89-06 features a full line of both portable and base scanners. Antennas, headphones, books, and accessories are also included in its 24 pages. Some items of particular interest are the Icom R-9000 "DC to daylight" communications receiver, a new line of Regency hand-held scanners, and the Kenwood RZ-1 wideband 12-VDC receiver that covers the range of 0.5 - 905 MHz.

The Scanner Catalog No. 89-06 is available for \$1.00 (or 3 IRC's) or is free with

any purchase from Universal Shortwave Radio, 1280 Aida Drive, Reynoldsburg, OH 43068.

CIRCLE 105 ON FREE INFORMATION CARD

LIGHTING EFFICIENCY APPLICATIONS

edited by Albert Thurman, P.E., C.E.M.

Including contributions from experts in the field, this book guides the reader through the design, specification, and application of state-of-the-art lighting systems, which can reduce building operating costs by as much as 50% when compared to traditional or outdated systems. It offers many examples and case studies that illustrate efficient lighting designs for new facilities and for retrofit applications.

The opening chapter provides an overview of lighting design. The book provides an assessment of reflectors and other new devices on the market, with guidelines to



help the reader evaluate manufacturers' claims and achieve the best results. It presents methods for achieving the highest efficiency lighting through the proper matching of fluorescent lamps with solid-state ballasts. The book also examines the effective use of lighting controls, and using microcomputer software for lighting design.

Lighting Efficiency Applications is available in hardcover for \$58.00 from Prentice-Hall, Inc., Englewood Cliffs, NJ 07632.

CIRCLE 99 ON FREE INFORMATION CARD

IMPEDANCE MATCHING

by Wilfred N. Caron

The American Radio Relay League (ARRL)'s new publication addresses the question of how to select the right antenna. A properly matched antenna as the termination for a line minimizes feed-line losses and eliminates the need for a matching net-

work at the line input. This 200-page book covers the basics of transmission lines and how they function as circuit elements. It shows readers how to use the Smith Chart to develop even the most complex matching network. Impedance-matching techniques are explored, and the book discusses how to match over a band of frequencies and other matching solutions. It also describes the construction of an overlay tracing box.

Antenna Impedance Matching is available in hardcover for \$15.00 (plus \$2.00 shipping and handling; \$3.50 U.P.S.) from ARRL, 225 Main Street, Newington, CT 06111.

CIRCLE 106 ON FREE INFORMATION CARD

ELECTRONIC PROJECTS FOR YOUR COMMODORE 64 AND 128

by John Iovine

Eleven projects that will enhance the performance and value of Commodore PC's are presented in this book. The projects, each costing under \$65, cover all levels of complexity, ranging from a simple LED interface for the user port to a full-featured digital camera. By teaching skills and concepts as well as providing building instructions, the book gives readers a firm foundation in designing as well as in building techniques. No prior electronics experience is assumed or necessary.

The book covers such subjects as analog-to-digital conversion, subliminal communications, appliance control, monitoring, and fractals. The projects include a speech synthesizer and a speech-recognition program; a digital oscilloscope; an automatic ventilation control; heat, light, and toxic-gas sensors; and a digital audio record/playback unit.

Electronic Projects for Your Commodore 64 and 128 is available for \$15.95 from Tab Books Inc., Blue Ridge Summit, PA 17294-0850; Tel. 1-800-233-1128.

CIRCLE 98 ON FREE INFORMATION CARD

THE SCANNER LISTENER'S HANDBOOK: How to Hear More on Your Scanner Radio

by Edward Soomre, N1BFF

The 25- to 2,000-MHz frequency range is so broad, and today's state-of-the-art scanners and receivers can cover such large portions of it, that it's difficult for scanning enthusiasts to learn where to tune for specific types of transmissions. This handbook is written to help listeners find their way around those bands. It lists and defines the various services that use those frequen-

(Continued on page 12)

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Some of today's hottest jobs in electronics are in telecommunications, where the explosion of new technologies is transforming the worldwide computer and telephone network into a multibillion dollar high-tech hotline for new communications services.

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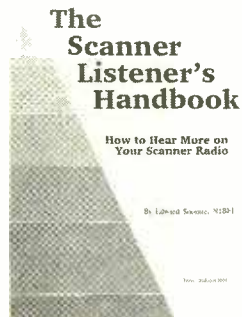
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(Continued from page 8)

cies, and matches each one with its assigned bands. Listings are provided both alphabetically and in sequential order from 25 to 2100 MHz.

The book provides more than just listings, however. Also covered are scanner basics—with an overall introduction to the hobby, explanations of the various types of equipment available, and detailed descrip-



tions or more than 55 models. Discussions on antenna, coaxial cable, accessories, computer-controlled monitoring, two-way radio systems, and monitoring laws are included. Listeners will also find valuable information in the appendixes, which list equipment manufacturers, sources of frequency directories, periodicals, CTCSS tones, scanner clubs, and coaxial-cable charts.

The Scanner Listener's Handbook: How to Hear More on Your Scanner Radio is available for \$14.95 (plus \$2.00 shipping and handling) from Tiare Publications, P.O. Box 493, Lake Geneva, WI 53147.

CIRCLE 107 ON FREE INFORMATION CARD

1990 COMPUTER-RELATED CATALOGS

from Radio Shack

The pages of Radio Shack's three computer-related catalogs for 1990 are filled with descriptions of personal computers, printers, peripherals, software, and accessories for the home, home-office, education, and business environments.

The 1990 Tandy Computer Catalog features a wide selection of desktop and portable computers, printers, and peripherals. Four PC's based on the Intel 386 microprocessor are offered, and new products include the 25-MHz Tandy 4025 LX and 20-MHz Tandy 4020 LX computers, which provide high-speed performance, "SmartDrive" hard drives utilizing integrated controllers, and industry-standard compatibility.

The 1990 Radio Shack Educational Prod-

ucts Guide contains 31 pages of products specifically designed to enhance classroom curricula and aid administrative functions.

More than 900 software titles from leading software publishers are featured in the 1990 Express Order Software Buyer's Guide. The 87-page catalog contains programs for MS-DOS, XENIX, TRSDOS, Microsoft Windows, and MS-OS/2 operating systems, as well as titles for Tandy's popular Color Computer family and portables.

All three 1990 computer-related catalogs are available at no charge at more than 7,000 Radio Shack Computer Centers nationwide.

CIRCLE 108 ON FREE INFORMATION CARD

ANALOGUE AND DIGITAL SIGNAL PROCESSING AND CODING

by P.M. Grant, C.F.N. Cowan, B. Mulgrew, and J.H. Dripps

Based on an industrial course given by the Electrical Engineering Department at Edinburgh University in the U.K., this book covers signal processing and coding from a practical point of view. It explains basic techniques such as Laplace and z-transforms, Fourier transforms, sampling theory, and time-domain analysis. The design of both finite and infinite impulse-response frequency filters is discussed, along with such subjects as spectral estimation and coding techniques. The practical aspects of signal processing—including analog and digital implementations and the use of matched filters in radar and communications—are also included. The book is fully illustrated and contains tutorial sections and chapter summaries to aid the learning process. A glossary of technical terms is also included.

Analogue and Digital Signal Processing and Coding is available for \$21.75 (MasterCard and Visa only) from Chartwell-Bratt Publishing and Training Ltd., Old Orchard, Bickley Road, Bromley, Kent, BR1 2NE, United Kingdom.

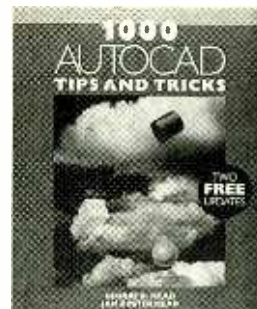
CIRCLE 109 ON FREE INFORMATION CARD

1000 AUTOCAD TIPS AND TRICKS

by George O. Head and Jan Doster Head

Organized by level of complexity, this book will help professionals to improve their productivity with techniques and shortcuts for almost every AutoCAD command and feature. The information-packed reference provides hundreds of drawing and editing tips, 3D shortcuts and enhancements, and more than 300 working AutoLISP programs. Many of the pointers do not appear in the AutoCAD manual, and some 200-odd tips have never been published before.

For easy access to the information it contains, the book is divided into eight chapters, each addressing a major subject area such as drawing, editing, viewing, utilities, and 3D. Those chapters are each divided into three sections—a how-to part, tips and



shortcuts, and AutoLISP programs. The book is extensively indexed, both alphabetically and numerically, to further help readers find the information they need.

While it was written for users of IBM-PC-compatible computers and AutoCAD release 10, more than 90% of the routines included can be used on a Macintosh, and many of the tips work with releases as early as Version 2.6. The book includes two free updates that will contain additional, previously unpublished, up-to-the-minute tips.

1000 AutoCAD Tips & Tricks is available for \$24.95 from Ventana Press, P.O. Box 2468, Chapel Hill, NC 27515.

CIRCLE 110 ON FREE INFORMATION CARD

PARTS CATALOG

from DC Electronics

Containing a full line of parts and accessories, this 50-page brochure includes listings of batteries and holders, kits and projects, sockets, switches, cabinets and enclosures, capacitors, diodes, rectifiers, resistors, LED's, transistors, computer accessories, hardware, and IC's. Several new products are featured as well, including a fiber-optics projects kit, instrument



"Every time I turn my back it welds my lunchbox to the bench."

cases, image film for making PC boards in copiers, and plastic enclosures.

The 1989 Parts Catalog is available free upon request from DC Electronics, P.O. Box 3203, Scottsdale, AZ 85271-3203; Tel 1-800-423-0070.

CIRCLE 112 ON FREE INFORMATION CARD

IT'S FUN!

from Heath Company

This 20-page catalog, offered as a promotional aid for Heath's line of hobby-kit products, features electronic projects and educational courses for hobbyists of all ages and skill levels. It contains everything from basic beginner kits like a soil-moisture probe or home intercom to more challenging construction projects like a portable 9-inch television and a digital weather computer. Heathkit/Zenith home-study educational courses, including a Novice amateur-radio-license course and a basic electricity course, are also fully described in the booklet.

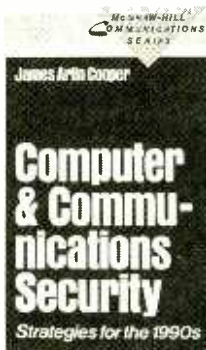
It's Fun! is available at full-line hobby shops and science stores nationwide. (Dealers and store owners can obtain further information by contacting Heath Dealer Sales, Benton Harbor, MI 49022.)

CIRCLE 113 ON FREE INFORMATION CARD

COMPUTER & COMMUNICATIONS SECURITY: Strategies for the 1990s

by James Arlin Cooper

A major challenge facing businesses, government agencies, and educational institutions is how to protect their computer and communications systems from potential threats from such sources as hackers, crim-



inals, disgruntled employees, and espionage agents. Problems ranging from software viruses and malfunctions to natural disasters are discussed, along with the tech-

nological advances that can be used to exploit security weaknesses.

The book's three major objectives are to explore the security techniques that will be available in the 1990's, to explain how to analyze existing systems in terms of their security, and to survey the safeguards that can be implemented to secure computer and communications systems. It focuses on establishing a comprehensive and effective security program, based on a systematic selection of cost-effective security measures. The many available options are described in detail, including hardware de-

vices, software strategies, mathematical approaches, and protective techniques. Six key problem areas are discussed—physical, personnel, regulatory, hardware, software, and network security. The book includes several case studies that illustrate the issues involved.

Computer and Communications Security: Strategies for the 1990s is available in hardcover for \$44.95 from McGraw-Hill Book Company, 11 West 19th Street, New York, NY 10011; Tel. 1-800-2-MCGRAW.

CIRCLE 96 ON FREE INFORMATION CARD

***QUALITY PARTS *DISCOUNT PRICES *FAST SHIPPING**

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<p>3 to 6 Vdc MOTOR with GEARBOX Probably designed for chld toys. Lever selects 2 forward and one reverse speed. 1st gear approx. 120 rpm/6vdc, 2nd gear approx. 300 rpm/6vdc, Reverse approx. 120 rpm/6vdc. 3.35" X 1.75" X 3.25" CAT# DCM-10 \$6.00</p>	<p>4 AA BATTERY PACK (USED) Four AA nickel cadmium batteries connected in series to make 4.8 volt pack. Batteries are in a 2 X 2 configuration with a 2 pin connector attached. The four batteries can be separated into single AA size solder tab nickel cadmium batteries or recased into other configurations. SPECIAL SALE PRICE - WGR#- \$4.00-per-pack NOW \$3.00 per pack CAT# NCB-41AAU</p>	<p>6 VOLT D.C. 9.5 AMP/HOUR GEL-CELL Epowers 695 6 volt, 9.5 amp/hour rechargeable gel-cell battery. 4.25" X 2.75" X 5.5". Quick connect terminals. CAT# GC-695 \$15.00 each</p>	<p>12 VOLT DC MINI FAN Housed in stainless steel. 12 Vdc, 0.10 amp, 1.0 watt. Compact plastic housing, 0.36" square X 1.275" thick. 3 blade fan. Two 97 degree leads. CAT# CF-121 \$9.00 each</p> <p>115 VAC COOLING FAN STANDARD SIZE COOLING FAN Features die cast metal housing for strength and durability. IMPEDANCE PROTECTED 4 1/16" square X 1/2" deep. Factory new 120 Vac fans. CF-1N \$9.50 each</p>
<p>WALL TRANSFORMERS ALL PLUG DIRECTLY INTO 120 VAC OUTLET 3 Vdc @ 300 ma. CAT# DCTX-499 \$2.25 3 Vdc @ 200 ma. CAT# DCTX-498 \$2.50 15 Vdc @ 1 amp. CAT# DCTX-168 \$3.50</p>	<p>LED'S STANDARD JUMBO DIFFUSED 71-24 series RED CAT# LED-1 10 for \$1.80 - 100 for \$13.00 GREEN CAT# LED-2 10 for \$2.00 - 100 for \$17.00 YELLOW CAT# LED-3 10 for \$2.00 - 100 for \$17.00 FLASHING LED with built in flashing about operates on 6 volts. RED \$1.00 each CAT# LED-4 10 for \$9.00 GREEN \$1.00 each CAT# LED-5 10 for \$9.00 BI-POLAR LED Light Red one direction, GREEN the other. Two leads CAT# LED-6 5 for \$1.00 LED HOLDER Two piece holder. CAT# HLED-10 10 for \$1.00</p>	<p>PHOTO FLASH CAPACITOR Rubycon FKK 200 mfd, 350 volts. 0.70" diameter X 1.11" high Solder loop terminals. CAT# PPC-200 \$3.25 each 10 for \$30.00 - 100 for \$275.00</p>	<p>PIEZO WARNING DEVICE Musical Era PWB-440 High pitched audible alarm. Operates on 3-20 Vdc @ 20 ma. 1" high x 7/8" dia. P.C. board mount. CAT# PWB-440 \$1.75 each</p>
<p>SWITCHES ITT PUSH BUTTON 1/2" MDP, series, 3/4" X 1/2" grey rectangular. Key ops. S.P.S.T., N.O. Push to close. RATED, 0.1 amp switching, 0.25 amp carry current. P.C. mount. CAT# PWB 100 each - 10 for \$9.00 - 100 for \$90.00</p> <p>10 POSITION MINI-ROTARY Omron SP20-011-1104-C Mini rotary switch. Non-shorting. 1 deck, 10 positions. 120° dia. shaft X .275" long. .377" behind the panel depth. P.C. pins. Switch body: .86" X .44" X .28". CAT# PB-10 \$1.88 each - 10 for \$1.80 each</p> <p>SPDT PUSHBUTTON Manurville 1343 Rated 5 amps @ 120/250 Vdc. Blank plastic pushbutton. Switch body: .86" X .44" X .28". CAT# PB-10 \$1.88 each - 10 for \$1.80 each</p>	<p>RELAYS 12 VOLT D.C. COIL S.P.D.T. Omron G5LE-10MP 4 amp contact 336 ohm coil. Sugar cube size. 41" X .47" X .44" high. P.C. mount with pins on DIP spacing. CAT# REL-797 \$1.90 each 1.5 X 2.0 X 2.5" 5-4 VDC SP REED RELAY Circuit "See Boy's BBS1104M10 5-4 Vdc, 800 ohm coil. S.P.S.T., normally open reed relay. 0.5 amp contacts. DIP configuration. 1.5 X 2.0 X 2.5" CAT# RRLY-4P5 \$1.10 each - 10 for \$10.00</p>	<p>22/44 PIN CONNECTOR .156" pin spacing, 0.200" between double rows, gold contacts, P.C. mounting. SPECIAL Same as AMP# 2-35355-5 CAT# EBC-12 \$1.00 each - 10 for \$8.00</p> <p>SOUND AND VIDEO MODULATOR T91111-1111 Designed for use with T.I. computers. Can be used with video cameras, games or other audio/visual sources. Built in A/B switch enables user to switch from T.V. antenna without disconnecting. Operates on channel 2 or 4. Requires 12 Vdc. Hook up diagram included. CAT# AMOD \$8.00 each 1 1/2" X 1 1/2" X 1 1/2"</p>	<p>NICKEL-CAD BATTERIES (RECHARGEABLE) SPECIAL! AA SIZE Ransomer P18AA 1.2 vdc @ 180 MAH CAT# NCB-AAAX \$1.80 each 10 for \$13.00 - 100 for \$126.00</p> <p>AA SIZE \$2.00 each 1.25 vdc 800 mA CAT# NCB-AA AA SIZE \$2.50 each WITH HOLDER TABS CAT# NCB-AA-A C SIZE \$4.25 EACH 1.2 vdc 1300 mA CAT# NCB-C D SIZE \$4.50 each 1.2 vdc 1300 mA CAT# NCB-D</p>
<p>LOOK WHAT \$1.00 WILL BUY 1/4 WATT RESISTORS Bare leads, carbon comp. and carbon film. CAT# GR# \$1.00 per assortment</p> <p>200 ASSORTED 1/2 WATT RESISTORS Bare leads, carbon comp. and carbon film. CAT# GR# \$1.00 per assortment</p> <p>50 ASSORTED DISC CAPACITORS Most are out (p.c. leads). Some to 500 volts CAT# GR# \$1.00 per assortment</p> <p>15 VALUES OF ELECTROLYTICS Contains both axial and radial styles from 1 mfd. CAT# GR# \$1.00 per assortment</p>	<p>10 AMP SOLID STATE RELAY ELECTRONIC P1818 CONTROL: Rated 5.5 to 10 Vdc (will operate on 3-32 Vdc) LOAD: 10 amp @ 240 Vdc 2 1/4" X 1 3/4" X 1 7/8" CAT# REL110108 \$9.95 each QUANTITY DISCOUNT 10 for \$81.00 or \$175.00 50 for \$300.00 - 100 for \$600.00</p> <p>XENON TUBE 1" long Resubstrate prepared with 3 1/2" red and black leads. Ideal for electronic flash or drive projects. CAT# PRT-1 2 for \$1.00</p>	<p>1/4 WATT RESISTOR KIT Ideal for the workshop, this 144 resistor kit contains 10 plastic each of 42 of the most popular values (420 values to include a divided band and a parity resistor). VALUES in this kit are: 1 ohm, 10 ohm, 39 ohm, 47 ohm, 51 ohm, 68 ohm, 100 ohm, 150 ohm, 180 ohm, 220 ohm, 330 ohm, 470 ohm, 560 ohm, 820 ohm, 1K, 1.2K, 1.5K, 2K, 3.2K, 3.7K, 3K, 4.7K, 5.1K, 5.6K, 10K, 15K, 22K, 30K, 33K, 39K, 47K, 56K, 68K, 100K, 120K, 150K, 200K, 470K, 1 MEG, 5.1 MEG, 10 MEG The resistors above would sell for \$21.00 Complete kit - CAT# REKIT-14 \$17.00</p>	<p>TIL-99 PHOTO TRANSISTOR 10-18 case with window. For wide-angle viewing applications. Spectrally and mechanically compatible with TL-318. CAT# TL-99 \$1.00 each - 10 for \$9.00</p> <p>TIL-318 PHOTO DIODE 10-18 case with window. Infrared emitting photo diode. CAT# TL-318 \$1.00 each - 10 for \$9.00</p> <p>N-CHANNEL MOSFET PFS-111 200 series CAT# MP \$11 \$1.00 each - 10 for \$9.00 LARGE QUANTITY AVAILABLE</p> <p>L.E.D. FLASHER KIT Two L.E.D.'s flash in unison when a 9 volt battery is attached. This kit includes a 9 volt battery and instructions to make a simple flasher circuit. A quick and easy project for anyone with basic soldering skills. CAT# LEDKIT \$1.75 per kit</p> <p>TELEPHONE COUPLING TRANSFORMER Multi Production International P18H40-1D1 Primary 800 ohm Secondary: 800/200 ohm 77 X .81 X .85 High 6 p.c. pins on .187 contacts. Primary Inductance: 300 mH min. @ 180 Hz, 1 volt. CAT# TCT-1 \$1.25 each - 10 for \$11.00</p> <p>OPTO SENSOR U shaped package with mounting wires. 1/8" spacing. 3/4" mounting holes. CAT# OSU-4 \$9.00 each NEW \$4.95</p> <p>OPTO ISOLATOR Signal 2011-1281. Signal applied to the input is coupled by means of light to isolated photo-conductive cell. High reliability switching. 12 volt input. CAT# OP-381 \$1.50 each</p> <p>A.C. LINE CORDS Black str., 18x2, set-2 Spartan Industries CAT# LCAC 2 for \$1.00 - 100 for \$68.00 POLARIZED PLUG CAT# LCPA 2 for \$1.00 - 100 for \$60.00</p> <p>14.7 VOLT TRANSFORMER Spartan Industries CS-10A 14.7 volt. 60 Hz, 8.82 Va. 1.81" high X 1.96" X 1.47" mounting holes on 2.32" centers. CAT# TX-147 \$3.00 each 10 for \$27.00 - 100 for \$250.00</p>

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CIRCLE 11 ON FREE INFORMATION CARD



New Products

To obtain additional information on new products covered in this section from the manufacturer, please circle the item's code number on the Free Information Card

FAX/ANSWERING MACHINE

Combining a facsimile machine, a telephone, a desktop copier, and a telephone-answering machine in one compact, lightweight unit, *Toshiba's 3600* offers users a wide selection of phone and fax features. The G2- and G3-compatible model 3600 has a built-in handset for voice conversations and can store up to 30 facsimile and 30 telephone numbers for automatic speed dial. Ten of those numbers can be accessed with single-touch memory buttons. The machine also features a two-line LCD, pause, on-hook dialing capability, simple and delay polling, and delay send. Up to ten pages can be fed automatically while the machine is unattended, and a 16-level gray scale is



provided for sending clear half-tones or photos. A "voice-confirmation-request" function lets both sender and receiver talk after a fax message is sent.

A full-featured voice-activated telephone-answering device is built into the 3600. The answering machine has a digital outgoing announcement and a 30-minute incoming-message microcassette. Calls can be retrieved from any touchtone telephone, and other remote features include announcement change, on and off, fast forward and rewind, and toll saver.

The 3600 facsimile with answering machine has a suggested retail price of

\$1695.00. For additional information, contact Toshiba America, Inc., Telecommunication Systems Division, 9740 Irvine Blvd., Irvine, CA 92718.

CIRCLE 75 ON FREE INFORMATION CARD

STEREO-TV ACCESSORY

If you've experienced problems getting the optimal audio from your stereo television, *PowerPak* from *NHT*, which lets you connect full-range hi-fi speakers to a TV, might be the solution. The *PowerPak* overcomes the limitations of built-in amps and speakers, giving video sound the depth of high-quality audio. It can accept signals directly from speaker terminals, the headphone jack, or audio-line outputs, while allowing all the TV's controls—including the remote—to function normally.

The universal input interface does not degrade the signal. Total power output ex-



ceeds 40 watts, and response and distortion specifications are better than for most conventional audio gear. The *PowerPak* can also serve as a surround-sound amp, or can be combined with a portable CD player and a pair of speakers to create a high-performance, low-cost audio system.

The *PowerPak* universal input interface has a suggested retail price of \$129.00. For further information, contact Now Hear This, Inc., 537 Stone Road, Building E, Benicia, CA 94510.

CIRCLE 76 ON FREE INFORMATION CARD

RADAR DETECTOR

Billed as the "industry's smallest three-band radar detector," the *Ultima 3* from *Fox Marketing* detects X, K, and KA bands. It weighs in at just 4 ounces and measures 3⁵/₈ inches deep by 2⁹/₁₆ inches wide by 1¹/₁₆ inch high.

The superheterodyne radar detector features a 5-LED signal-strength meter, a 3-position city/highway/extended-range sensitivity switch, and separate dark and mute modes. Reception frequencies are 10.525, 24.150, and 34.360 GHz; bandwidth is 200 MHz. The *Ultima 3* comes with a carrying case, coiled and straight power cords, and a suction-cup windshield-visor mounting bracket.

The *Ultima 3* three-band radar detector



has a suggested retail price of \$279.95. For more information, contact Fox Marketing, 1747 Cattlemen Road, Sarasota, FL, 34232.

CIRCLE 77 ON FREE INFORMATION CARD

ANALOG MULTIMETERS

Goldstar Precision recently introduced its line of analog multimeters to the American market. The *AM-201* (pictured) and the *AM-1001* each execute five functions and have pivot- and jewel-screw-mechanism meter movements. The *AM-201* has diode protection, and the *AM-1001* has both fuse and diode protection.

The model *AM-2001* performs six functions and features continuity checking with audible alarm, fuse and diode protection, and a battery checker. It offers jewel-screw-mechanism meter movement and a mir-



rored scale. Specifications for the *AM-2001* are 20K-ohms/VDC and 8K-ohms/VAC sensitivity and current up to 10A DC.

Suggested retail prices for the *AM-201*, *AM-1001*, and *AM-2001* are \$14.95, \$19.95, and \$24.95, respectively. For more information, contact, *Goldstar Precision*, 13013 East 166th Street, Cerritos, CA 90701.

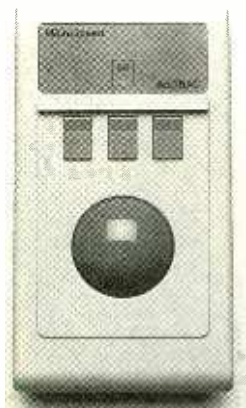
CIRCLE 78 ON FREE INFORMATION CARD

AMIGA TRACKBALL

The first precision trackball for the Commodore Amiga, the *AmTRAC* from *Micro-Speed*, is a cost-effective alternative to the standard mouse for graphic applica-

tions. With finger-tip control and a large tracking surface, it offers high pointing resolution and precise control. Because it doesn't come in direct contact with the work surface, the device requires virtually no cleaning.

AmTRAC is a direct plug-in replacement — no software installation is required — for the mouse on Commodore Amiga 500,



2000, 2000H, and 2500 computers. The 4 1/2-inch AmTRAC is controlled with three buttons located directly above the trackball. The left and right buttons perform the normal pointing operations of a standard Amiga mouse. The center cursor drag-lock button toggles the cursor drag lock on and off, eliminating the need to hold down a button to drag the graphics cursor. An illuminated drag-lock indicator shows when that function is activated.

The AmTRAC trackball has a suggested retail price of \$99.00. For more information, contact MicroSpeed, Inc., 55 South Market Street, Suite 1660, San Jose, CA 95113-2327.

CIRCLE 79 ON FREE INFORMATION CARD

HAM LICENSE COMPUTER COURSE

The *MFJ Theory Tutor* is a different type of study aid for those who plan to take any level of the FCC licensing exams for ham-radio operators. Rather than the usual handbook or training class, *Theory Tutor* is an IBM-compatible software package that is tailor-made for studying ham radio.

It contains the FCC question pool, which can be pulled up for review in whatever



order best fits the students needs. Every question can be reviewed, or specific areas of study can be reviewed individually. Users can try taking sample tests on screen, or can print out the tests. Each study session is automatically saved and can be retrieved at any time. Theory Tutor offers excellent graphics with appropriate questions, complete scoring analysis, color-change options, and an on-line calculator. Explanations are provided for difficult questions.

The MFJ Theory Tutor is available for each license class: Novice (*MFJ-1610*), Technician (*MFJ-1611*), General Class (*MFJ-1612*), Advanced (*MFJ-1613*), and Extra (*MFJ-1614*) for \$29.95 each. For additional information, contact MFJ Enterprises, Inc., P.O. Box 494, Mississippi State, MS 39762; 800-647-1800.

CIRCLE 80 ON FREE INFORMATION CARD

HIGH-END CD PLAYER

Incorporating *Kenwood's* exclusive Digital Pulse Axis Control (DPAC), the DP-8010 compact-disc player provides an "almost three-dimensional" delivery to the digital format. DPAC, a process in which the digital bitstream is realigned prior to analog con-

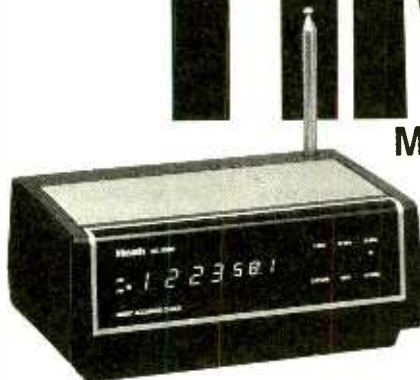
version, increasing the fidelity and virtually eliminates "jitter."

The player's digital delivery is further enhanced by twin-quartz PLL circuitry with 8-times oversampling—which improves stereo imaging and high-frequency response, and minimizes the need for analog filters—and 18-bit linear dual digital-to-analog converters that assure the necessary linearity. A linear motor mechanism with a low center of gravity is used to move the laser pick-up across the disk, allowing rapid track access and greater tracking stability.

The DP-8010 offers optical and coaxial direct digital output, and a vibration-insulation system. A full range of convenience features include a remote control, an easy-to-read display on the face of the player, random program memory, and 20-track direct access.

The DP-8010 compact-disc player has a suggested retail price of \$650.00. For fur-

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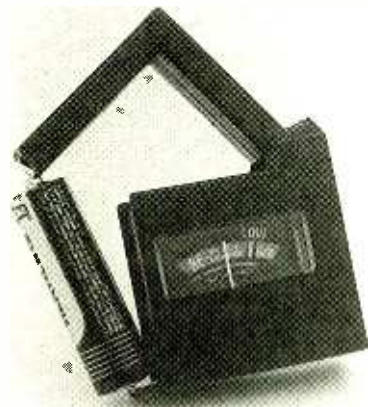
New Products

For more information, contact Kenwood USA Corp., 1315 East Watson Center Rd., Carson, CA 90745.

CIRCLE 81 ON FREE INFORMATION CARD

MINI BATTERY TESTER

If you always have lots of batteries around, but are never sure how much life they've got in them, *Carter Craft's* model 34-148 mini universal battery tester could help solve the problem. Designed to help you save money by not discarding live batteries, the



tester checks the available power in all types of batteries—"D," "C," "AA," "AAA," "N," 9-volt, and button cells. Measuring just $2 \times 2 \times 7/8$ inches, it fits easily into a shirt pocket, briefcase, or tool kit.

The 34-148 mini universal battery tester has a suggested retail price of \$9.95. For more information, contact Carter Craft, Inc., 1926 7th Street, Box 5185, Rockford, IL 61125.

CIRCLE 82 ON FREE INFORMATION CARD

60-MHZ OSCILLOSCOPE

Beckman's model 9106 oscilloscope provides the user with three input channels with a frequency bandwidth of 60 MHz. In the vertical display modes, the unit can display up to eight traces on the CRT screen. The third channel is for waveform monitoring or observing an external sync signal.

The scope also features a multi-turn delay-time control for simple waveform expansion that combines dual adjustments for both coarse and fine controls in one knob. The 9106 is equipped with trigger circuitry for display stability, and a variable hold-off control to ensure proper triggering on complex signals. Other features include "A" and "B" sweeps with delayed sweep and segment magnification, camera-mount CRT bezel, variable scale illumination and single-



sweep operation for waveform photography, and z-axis input for blanking or intensified markers.

The model 9106 oscilloscope—complete with operator's manual, tilt stand, two switchable $\times 1/\text{REF}/\times 10$ probes, and a three-year warranty—is priced at \$1290.00. For more information, contact Beckman Industrial Corporation, Instrumentation Products Division, 3883 Ruffin Road, San Diego, CA 92123-1898.

CIRCLE 83 ON FREE INFORMATION CARD

MICROWAVE LEAKAGE TESTER

A.W. Sperry's SMW-1 Microcheck is a non-contact microwave-leakage detector designed for checking microwave ovens for possible harmful radiation leakage. The detector reads microwave radiation as low as 0.1-milliwatt per square centimeter. The meter's midscale is calibrated to 1 milliwatt



per square centimeter. The lightweight Microcheck is rugged and easy to use, with no switches to set or leads to hook up.

The SMW-1 Microcheck has a suggested retail price of \$17.95. For further information, contact A.W. Sperry Instruments Inc., 245 Marcus Blvd., Hauppauge, NY 11788.

CIRCLE 84 ON FREE INFORMATION CARD

SOLDERING-IRON POWER SUPPLY

Designed for production and laboratory use,

M.M. Newman's Antex 24-volt power-supply station handles all 24-volt soldering irons rated at 50 watts or less. The Antex has a built-in spring holder, a removable sponge tray, and a selection of three bezels to accommodate most irons. The rugged bench-top power-supply unit measures 3-inches high by $4\frac{1}{4}$ -inches wide by $7\frac{3}{4}$ -inches deep, has four rubber feet for stabil-



ity and a grounded power cord, and operates on 115 VAC. A compatible 24-volt, temperature-controlled soldering iron that uses slide-on tips is available optionally.

The Antex 24-volt power supply has a suggested list price of \$69.95; with the optional soldering iron included, the suggested list is \$129.95. For more information, contact M.M. Newman Corporation, 24 Tioga Way, P.O. Box 615, Marblehead, MA 01945.

CIRCLE 85 ON FREE INFORMATION CARD

MICROPHONE SYSTEMS

Providing professional features and reliability at a moderate price, *Shure's* L Series wireless-microphone products are offered as individual components and in four complete systems developed to suit various users needs. They are available in six stock frequencies and can be special-ordered in others.

For guitars and other instruments, system LS13 with an L3 non-diversity receiver and system LS14 with an L4 MARCAD diversity receiver both include the L1 body-pack transmitter and the WA300 instrument-adaptor cable (not pictured). The LS13/389 and LS14/389 wireless lavalier systems include the 839W omnidirectional lavalier microphone instead of the instrument-adaptor cable.

The body-pack transmitter offers such features as wide-range audio-gain control, mirror-image companding, and a full 50-mV output level. It has a noiseless audio-mute switch that cuts off the sound from the in-

strument or microphone without shutting off the transmitter, and a "universal" input connector that allows use of the transmitter with other compatible microphones and electronic musical instruments.

The L3 non-diversity receiver comes in a rack-mountable metal case. Its detachable, quarter-wave whip antenna with a UHF-type connector can be located remotely. A red audio-peak warning light indicates audio



overload. Other features include double-tuned RF stages, dual ceramic IC filters, and a three-pole Chebyshev audio low-pass filter.

The L4 MARCAD diversity receiver employs the signals received by two antennas and, similar to a switching system, those antennas operate two separate radios. The signals from both radios are constantly monitored to determine when each is providing

a usable signal, and then added accordingly. Either signal can be selected, or they can be combined when both are acceptable. The L4 has all the features of the L3, plus a second antenna and a balanced microphone-level output.

The 839W wireless lavalier condenser microphone has a wide-range frequency response with a controlled low-frequency rolloff to reduce pickup of unwanted noises. The side-exit cable and special tie-bar mounting accessory make it unobtrusive. The 839W connects easily and directly to the L1 transmitter.

The LS13, LS14, LS13/839 and LS14/839 systems have suggested user net prices of \$360.00, \$495.00, \$445.00, and \$580.00, respectively. Components and optional accessories are also available separately. For further information, contact Shure Brothers Inc., Customer Services Department, 222 Hartrey Avenue, Evanston, IL 60202-3696; 1-800-257-4873 (in IL, 1-800-624-8522).

CIRCLE 86 ON FREE INFORMATION CARD

REMOVABLE CAR STEREO

Offering high power, improved reception, and Dolby-B noise reduction, Sharp's RG-

F840 in-dash car stereo provides the convenience of easy installation and removal for theft prevention. A CD input on the RG-F840's front panel makes it easy to hook up a portable CD player. The 100-watt unit includes an auto-reverse cassette deck, 18 station presets (12 FM/6 AM), preset mem-



ory scan, and auto-program-search for easy tuning. When traveling outside of the usual reception area, a seek/scan feature searches and tunes in local stations at the touch of a button. A DX/LOCAL switch improves reception when driving at the fringes of a broadcast area.

The RG-F840 removable car stereo has a suggested retail price of \$429.95. For more information, contact Sharp Electronics Corporation, Sharp Plaza, Mahwah, NJ 07430-2135.

CIRCLE 87 ON FREE INFORMATION CARD

(Continued on page 18)

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Compared to Nitinol, a popular SMA developed in the 1960's, BioMetal has a much longer lifetime and greater repeatability. BioMetal samples have been operated over 20 million cycles with virtually no change in performance. With BioMetal, SMAs can compete with the lifetimes demanded of motors and solenoids.

In many instances BioMetal outperforms motors and solenoids thanks to its longer lifetime, smaller size and very low mass. BioMetal's direct linear action can simplify design, reduce costs, and increase overall performance. BioMetal has vast potential for use in everything from toys to robotics, almost any place requiring electrically driven motion.

Shape Memory Alloys have crystal structures that can assume radically different forms at distinct temperatures. When passing an electric current, BioMetal's internal resistance causes it to heat, and activate this "shape change". The wire shortens in length, and pulls with a usable amount of force. When cooled, BioMetal returns to its original shape. If not overheated or overextended, BioMetal will perform for millions of repeated cycles.

As performance depends on the heating and cooling rate, BioMetal's small diameter provides optimum results. BioMetal can be heated by electric current, with higher currents providing faster activation. Caution must be used to prevent overheating the wire. Cooling speed can be increased by coating the BioMetal wire with silicone rubber (which acts as a heat sink to draw the heat away), or even by immersing the wire in a fluid such as water with a small amount of glycerine.

In applications requiring greater strength, several BioMetal wires can be used in parallel. This gives much faster response than would a single larger wire having an equal cross-sectional area. Many unique and clever devices are possible using groups of wires - one only needs look at nature for examples of linear muscle contractions and their applications.

3 CONVENIENT LOCATIONS

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New Products

(Continued from page 17)

GRAPHIC EQUALIZER

For customizing the sound from car-audio systems, and to allow for low-pass subwoofer systems, Pioneer's EQ-6000 graphic equalizer lets the listener "direct" sound levels to both full-range speakers and subwoofers. The unit's post-equalizer crossover network allows the user to select a crossover frequency point that will activate the high- and low-pass filters and set their crossover point. Frequencies above that point will reach the front and rear speakers; fre-



quencies below that point will be directed to the subwoofer system. The equalizer has a dual-amp balancer and gold-plated RCA preamplifier outputs. The frequency response is 20–30,000 Hz (± 3 dB); signal-to-noise ratio is 101 dB. It has nine frequency-band controls, each with an equalization range of ± 12 dB.

The EQ-6000 graphic equalizer has a suggested retail price of \$240.00. For more information, contact Pioneer Electronics (USA) Inc., 2265 East 220th Street, P.O. Box 1720, Long Beach, CA 90801-1720.

CIRCLE 88 ON FREE INFORMATION CARD

SUPER WALKMAN

Commemorating the tenth anniversary of the Walkman, Sony has introduced the WM-F701C Super Walkman, an AM/FM stereo cassette player in an ultra-slim case with rounded corners. It offers digital synthesized tuning for accurate reception and 14 station presets for convenience. Other features offered by the WM-F701C include a full-logic wired remote control, ultra-light



headphones, a rechargeable battery and charger, and auto reverse with mode and direction selectors. "Mega Bass" circuitry enhances bass tones for a richer sound, and Dolby-B/C noise reduction provides a cleaner sound.

The WM-F701C Super Walkman has a suggested retail price of \$379.95. For additional information, contact Sony Corporation of America, Corporate Communications Dept., 9 West 57th Street, New York, NY 10019.

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AC CURRENT METER

Designed for use by electricians, technicians, servicemen, and hobbyists who need an accurate instrument that is always ready to use, Elenco's ST-1010 AC current meter is completely portable. It provides AC-current measurement up to 1000 amperes. Its other functions include AC and DC volts, resistance, diode test, data hold, peak hold, audible continuity. Insulation testing can also be done, with the addition of an optional 500-volt insulation-tester unit. The ST-



1010 has a 3 $\frac{1}{2}$ -digit LCD display, and is designed for convenient hand-held use. It is powered by a standard 9-volt battery, providing 150–200 operating hours. The instrument comes with a carrying case, test leads, operator's manual, and a wrist strap.

The ST-1010 AC-current meter costs \$99.95. For additional information, contact Elenco Electronics, Inc., 150 West Carpenter Avenue, Wheeling, IL 60090.

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COMPACT AUDIO EQUIPMENT

Bondwell's MC-100 Series portable sound system with speakers is designed to provide optimum performance quality from portable CD players, personal stereos, or portable radio/cassette units—which fit into a special compartment on the MC-100, and can be plugged directly into the system. The MC-100's speakers provide studio-quality sound—featuring timbre that is usually associated only with the best quality wood enclosures—due to special proprie-



tary materials used in the structural foam enclosures of the MC-100 Series speakers.

The MC-100 contains a 50-watt-per-channel power amplifier with 0.2% THD and two-way bass-reflex speakers with 4.5-inch woofer and $\frac{1}{5}$ -inch tweeter. It has separate controls for bass, treble, speaker volume, and balance; connections for a microphone, an AC/DC adapter, and auxiliary sound source; and dust-proof CD and cassette racks.

The MC-100 portable sound system has a suggested retail price of \$129.00. For further information, contact Bondwell Industrial Co., Inc., 47485 Seabridge Drive, Fremont, CA 94538.

CIRCLE 91 ON FREE INFORMATION CARD

MONITOR/VCR COMBINATION

Combining a 19-inch color monitor with a built-in VCR, Samsung's VM6003 features a quick-start picture tube for improved color contrast. The VCR section has 110-channel capability and HQ circuitry. It offers on-screen display for easy programming, and a four-event/14-day timer. The VCR also



has automatic power-on, rewind, and play. Both the monitor and the VCR can be operated by a 22-key wireless remote control. The combination unit provides audio/video input and output jacks.

The VM6003 monitor/VCR has a suggested retail price of \$899.95. For more information, contact Samsung Electronics America, 301 Mayhill Street, Saddle Brook, NJ 07662. ■

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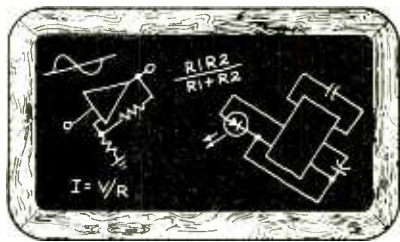
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Think Tank

By Byron G. Wels

THE GOOD OLD DAYS?

The good old days were bad old days. Oh, it may be fun to reminisce, but when you take the time to think about it, things were not all that easy. Today we enjoy the pleasures of teensy-weensy resistors, nicely encapsulated in plastics with color-coded bands. Back in the days of yore, you had to make your own with a carbon pencil and a piece of wrapping paper. And who had IC's? You needed vacuum tubes, big, bulky devices that ate up batteries like they were going out of style!

Convenience? Soldering irons had to be heated in a gas flame, and tinned by rubbing on a block of sal amoniac. You had to remove the oxidation with a file. I'm not making all this up, it was true.

Last week I bought a new tip for my soldering iron. I wanted a chisel tip, and all they had were pretinned pyramid tips. I bought one, and explained that the first time I tinned it, I'd file it to the shape I wanted. My boss, who was with me, looked at me as if I was crazy. "Tin?" he asked, "Nobody tins soldering iron tips any more—they're *permanently* tinned."

Yes, times are a-changin' and you've just got to keep up. Sometimes I feel like some old fogey that's been passed on the wayside.

I wonder too, if electronics is still as much fun as it used to be. I remember (for example) when I worked as an electronics technician, an engineer had us build this huge high-voltage power supply. It got finished just before lunch, and he was going to test it right after he got back from lunch. During lunch we rigged a twenty-foot length of plastic tubing from one end of the lab to under the chassis.

Charley waited at the far end of the tube with his cigar. Our engineer, a bright young fellow, came back from lunch and flipped the filament switch on. Everything seemed okay, so after a three-minute warmup, he went for the plate switch. "Click!" said the switch. A

huge cloud of white smoke appeared under the chassis. He quickly turned the switch off and started scratching his head. Everything *still* looked okay, so he tried the switch again, and got another big cloud of smoke. Then he got a whiff of the smoke and, of course, Charley got fired.

One time, we had to field test a new magnetic anomaly detector, and had rigged a small trailer out in a barren field. All the equipment except for the detector itself, was in the van. The two engineers were cozy and warm inside, I was out about 200 yards away in the field, resetting the detector on its tripod, when an amplified voice came out of the bull horn. "Byron, you've got metal in your pockets. Can you take your pants off?"

I looked around, the field was empty. Off came the pants. Next, it was the metal snaps in my shorts. The next thing you know, the only thing I had on were the goose pimples on my skin. Man, it was cold! And that's when those dirty rats called the lab secretary and asked her to bring out a few containers of hot coffee.

Yup. Electronics used to be fun, and I wonder if it still is!

Now that we've got that all straightened out, let's see what's in the mail bag this month.

Electrometer. Since I work with a lot of CMOS devices, I am always concerned about static electricity around my workbench. Because of that, I built the metal-leaf electroscope from an article in **Popular Electronics** (June, 1989). While the device isn't especially sensitive, if I didn't have such an instrument, countless CMOS chips that I bought would be wasted, for static electricity can destroy such devices, as well as other semiconductor components.

Since then, however, I've come up with a circuit (see Fig. 1) for an electrometer that has no moving leaves as indicators, and doesn't require shelter-

ing in a glass flask. The amount of static charge is shown on an ammeter and the JFET can be a 2N3814 or equivalent. The meter is a 0–1-mA unit; if such a meter is not sensitive enough for your needs, you can substitute a more sensitive unit. The potentiometer is adjusted so that the needle points to 1 mA when no charges are around. When the probe is brought close enough to a charge, the meter reading decreases to 0 mA.

To check if your CMOS storage space is free from static, press the probe into

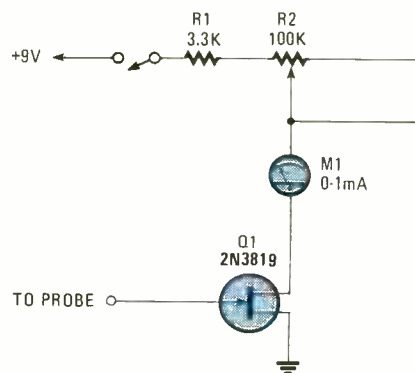


Fig. 1. The Electrometer has no moving leaves as indicators, and doesn't require sheltering in a glass flask.

the area, and if the reading remains at 1 mA, there is no static charge around. And if you're soldering a CMOS device to a circuit board, be sure to ground the iron tip.

I hope this earns me a copy of the Fips book.

—Edwin Chang, Hong Kong, China
It sure does, Ed; the book is on the way. And thanks a lot for your contribution to this column.

RAM-Killer Detector. I called this circuit (see Fig. 2) the *Ram Killer Detector* because it is capable of detecting high-voltage sources like static electricity that may have built up on your body. That static electricity can kill your RAM or other static-sensitive device. The circuit is so simple, I feel like the inventor of the paper clip! I was surprised that I didn't think of it sooner. It uses only seven components, including a 555 oscillator/timer. It also uses a FET as the "eye" to detect static-charge build-up.

When the antenna gets close to a high-voltage source, it lowers the 555's switching rate and you can actually see that by the change in the flash rate of the two LED's. I do not recommend that a CMOS 555 be used, because the

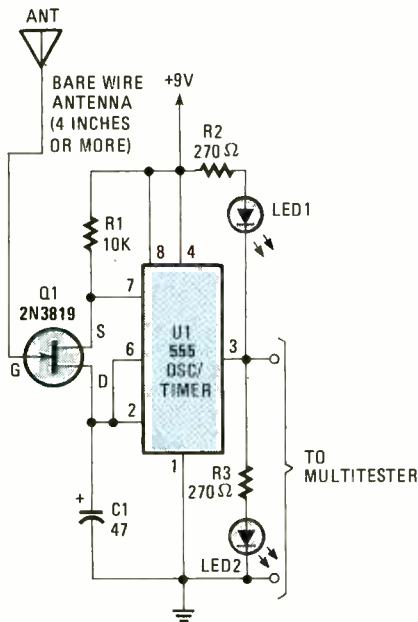


Fig. 2. This circuit is capable of detecting potentially destructive static charges, that can kill RAM or other static-sensitive devices.

high voltages might damage it. To see if your unit works, bring the antenna very close to a television screen and the flash rate should slow down. To reset the circuit, simply touch the antenna to a grounded object a couple of times. That should bring the flash rate of the LED's back to normal.

The circuit could be used with a multimeter for greater accuracy. The circuit is very simple, it's very sensitive to high voltages, it can save you a lot of money, and all the components are available at your local Radio Shack store. The current drain is so slight that the circuit can run for a couple of hours without slowing down.

Okay Byron, there it is. Is it worth a Fips Book?

—Wallace Ly, San Francisco, CA

Good circuit, Wally. We've been getting lots of requests for unusual and helpful test equipment, and yours certainly fills the bill. Your book was sent out today. Hope you enjoy it!

Water-Level Measurements. It's often necessary to measure the level of water in a sealed container, using a non-movable sensor. My solution to the problem is to use a cylindrical capacitor. One of the plates is formed by the liquid that surrounds an insulated wire. The dielectric is the wire insulation and the other plate of the capacitor is the wire itself. The level of the liquid in the container is proportional to the capac-

itance, which can be measured by a simple circuit that converts the linear variation of a capacitor to a linear voltage that is proportional to the capacitance.

The heart of the circuit (see Fig. 3) is a monostable circuit formed by the capacitive transducer and half of a 555 dual oscillator/timer. The pulsewidth of the monostable is proportional to the capacitance of the RC resonant circuit made up of R4 and the variable capacitance of transducer C5, the capacitance of which depends on the

part immersed in liquid. The other half of the timer is a clock running at 22 kHz that provides the trigger pulse for the monostable. The connection of the capacitor to ground is made by an electrode that is immersed in the fluid to be sensed, or it can be connected to the container, if a metallic container is used. You can also use a graphite rod salvaged from an old lantern battery in the event that the container is non-conductive.

Potentiometer R6, a 5K unit, is used for calibration of the meter's range; R8, a 1k

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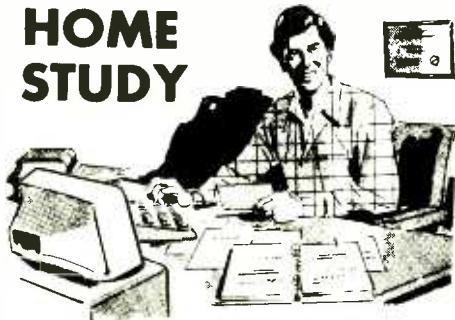
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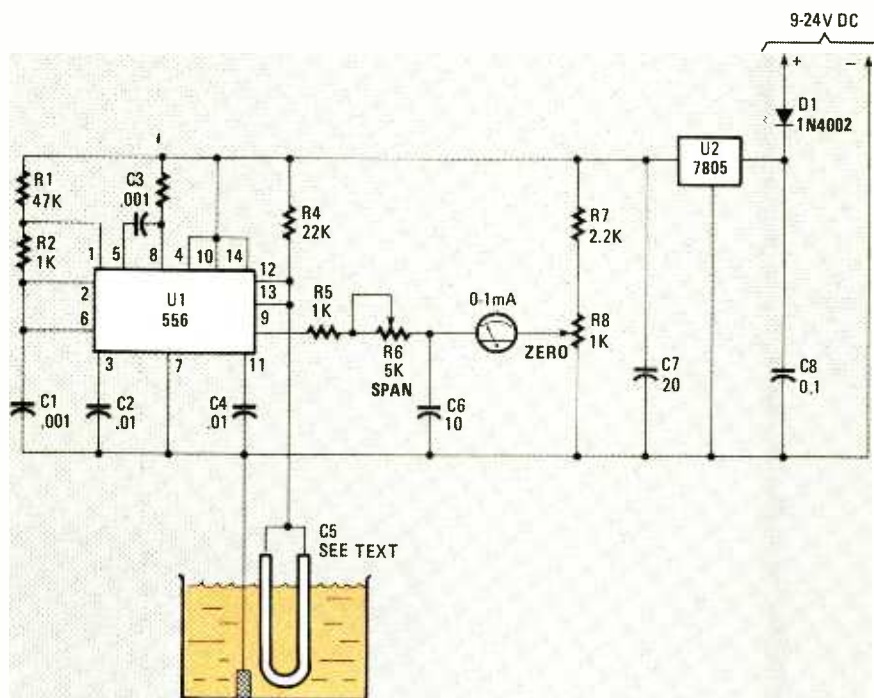


Fig. 3. The heart of the water-level measurement scheme is a monostable circuit formed by the capacitive transducer and half of a 556 dual oscillator/timer. A more complicated version of this circuit was used to measure wave heights in the Gulf of Mexico.

potentiometer, is used for nulling out any parasitic capacitance in the circuit.

You can make the sensor out of 20 inches of No. 22 enamelled wire and can sense levels of ten inches. If you shape the sensor into a "U," you can measure up to 20 inches. If you're concerned with even higher levels, 100 inches of No. 22 plastic-covered wire can be used.

The 7805 regulates the 9- to 24-volt input.

I have used a slightly more complicated circuit based on the same principles to record 30-foot wave levels on a platform in the Gulf of Mexico.

—Juan J. Martinez, Mexico.

Thanks Juan. I'm sure this circuit could function in the lab as well. Please look for your Fips Book in the mail, and I'm certain we'll be getting some reader mail on this unusual circuit to pass along as well.

Stalled-Output Detector. This circuit can be used as a building block to detect a stuck output or node in a circuit. (See Fig. 4.) The input charges capacitor C1, which then biases Q1 (a 2N3904 transistor) on, causing the LED to light. If input is lost, Q1 turns off and the LED goes out. Should the input get stuck in the high state, Q2 blanks the LED.

The circuit detects the loss of the

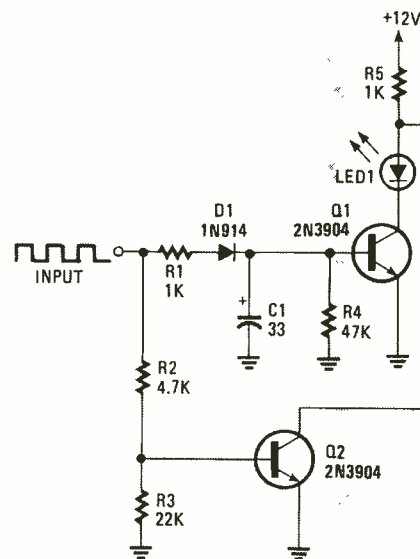


Fig. 4. The Stalled-Output Detector can be used as a building block to detect a stuck output or node in a circuit.

pulse train, and can be used as a building block or module for a transistor or IC tester, a security system, an AC power-fail detector, or a host of other applications.

I should tell you, however, that if you use this, I already have the "Fips" book and the "Think Tank" book. Have you anything else?

—Craig Sharp, Pardeeville, WI

Are you kidding Craig? We've got lots

of books. I'll pick a good one for you, and keep those ideas coming! And Craig didn't stop with one...He sent in two ideas, and here's the next one!

Car Alarm. This turn and back-up alarm uses the car's horn as a loud-speaker. And did you know that you can play music (low-fi) through your car horn? With this circuit (see Fig. 5), the car horn does not function in the usual fashion. The low duty-cycle 12-volt pulses drive the horn as a sound mcker.

After you've wired the circuit, you've got to make a few external connections to the car. One wire goes to the turn-signal flasher, another to the back-up light switch, and a third one to the horn relay or switch. You'll need to connect two additional leads from the circuit to the auto's power supply system: one to ground and the other to +12 volts from the ignition or accessory terminal. Make sure that you use good automotive electrical wire for that job.

Okay Byron, that should help for this month. I hope that this is the sort of thing that you're looking for!

—Craig Sharp, Pardeeville, WI

Yup! You did it again, Craig. And to

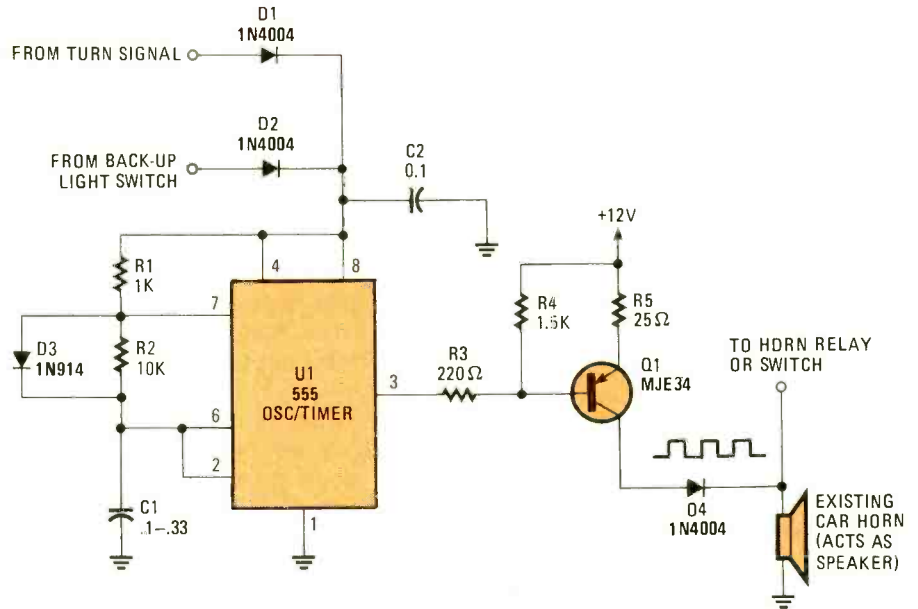


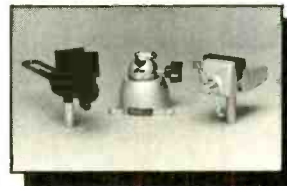
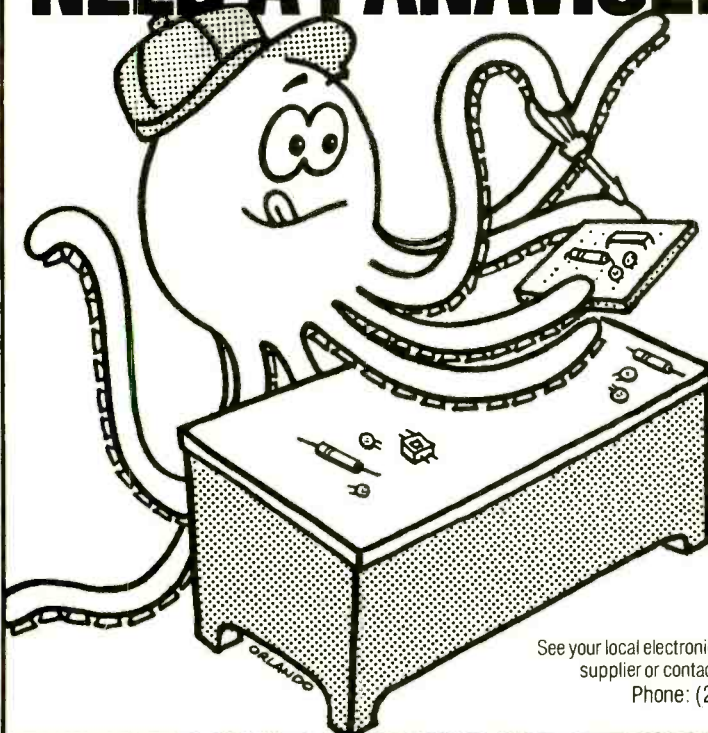
Fig. 5. The Car Alarm uses the car's horn as a loudspeaker.

thank you, the books are on the way. Hope you enjoy them as much as we've enjoyed your innovative circuits.

Window Generator. My partner and I have found this simple window gener-

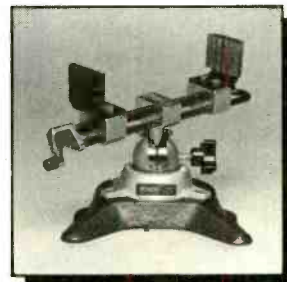
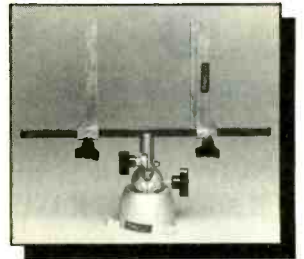
ator to be useful in numerous test situations as well as a few oddball experimental applications. Only three of the four op-amps available in the LM324 are used, leaving one open for use as a preamp, voltage-follower,

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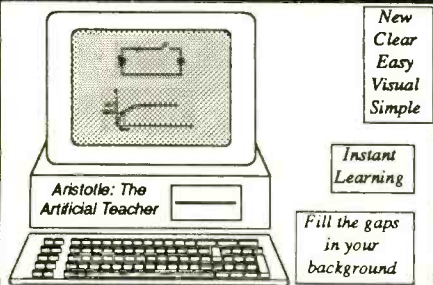
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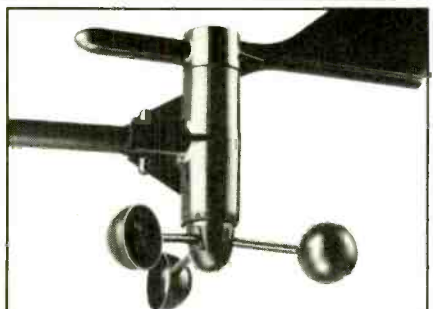
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comparator, or whatever suits your application.

In Fig. 6A, U1-a is wired either as a high-impedance voltage follower, or as an amplifier for low signal levels. Two other op-amps within the LM324 package (U1-b and U1-c) are wired as a pair of comparators with hysteresis. When U1-b goes high, current flows through LED1, turning it on. When U1-c goes high, the current stops flowing, making LED1 dark. Numerous output configurations are possible. A few examples of what can be done are provided; component values are not shown as they will vary depending on the application.

The output can be used to drive an LED (LED1 in Fig. 6A) or optoisolator by connecting it in place of the LED. We have successfully used the circuit (coupled with the sub-circuit shown in Fig. 6B) to test the slew rate of a chart recorder between its 10% and 90% points. The setpoint potentiometers are adjusted with the recorder's pen at the

10% and 90% setpoints, respectively, then the input voltage to the chart recorder is flipped from ground to the recorder's full-scale input voltage.

The window generator activates the optoisolator while the pen is between the 10% and 90% setpoints, enabling the AND gate, which then passes the 10-kHz signal to the counter for a time readout. Of course, the output of the optoisolator may be tied into CMOS or TTL circuits with a minimum of components, or can be used to drive transistors to operate relays or whatever. Note that the circuit is suited to battery operation.

The window generator can also be used as a light or dark detection circuit to set minimum and maximum light levels. That can be done by connecting one of the circuits in Fig. 6C to the input of the window generator, which would cause the circuit to trip only when the light striking the sensing element—be it a phototransistor, photodiode, or a light-dependent resistor (LDR)—falls between those levels. It's a good idea to put a resistor in series with the potentiometer to prevent accidentally shorting V_{CC} to ground.

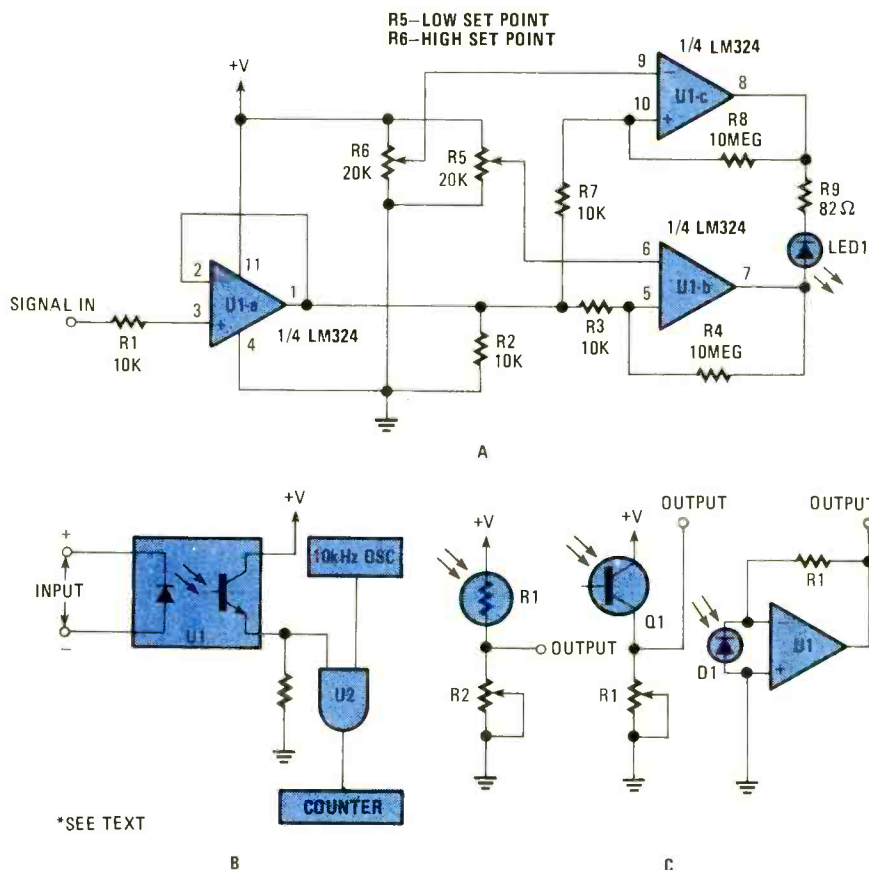


Fig. 6. This Window Generator has many useful applications; for instance, by connecting the circuit shown in B in place of LED1, the circuit was used to test the slew rate of a chart recorder between its 10% and 90% points.

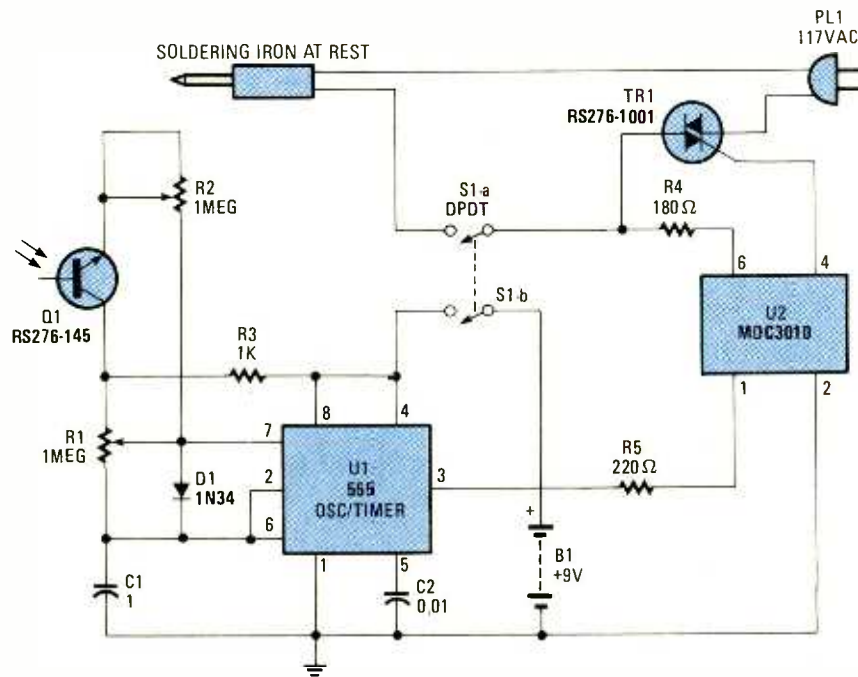


Fig. 7. The IR-Controlled Soldering Station is a circuit that's designed to sense temperature and adjust power to the heating element accordingly.

A possible application might be turning a light on at dusk and off at dawn. The sensor would have to be positioned where stray light would not fall on it. A rain detector would be another application. And a thermistor makes it an excellent temperature monitor. The window generator is really a solution looking for problems! So what ya' say, Byron? Do we rate a book?

—Jim Barzydlo and Darwin Johnson, Lincoln, NE

Jim, you rate two books, but I'm only sending you one. When you get through with it, let Darwin see it too.

IR-Controlled Soldering Station.

I've always admired those automatically controlled soldering stations, but the prices threw me. I've used my soldering iron to build all sorts of complicated devices, why couldn't I use it to build my own soldering station—sort of let the soldering iron make its own comfort! (See Fig. 7.)

The soldering station's phototransistor has to be level with and a few inches from the soldering iron's tip. When the iron is in its holder, the detector sees the tip through an opaque tube about 3/4 inch I.D. (inside diameter) and one-inch long. I used an old Kodachrome color-film negative as an IR filter. The potentiometer, R2, can be a little cheapie to set sensitivity. The heat level is adjusted via potentiometer R1.

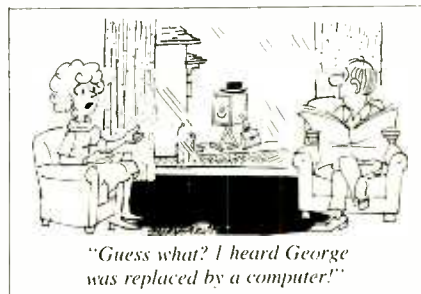
You must understand that when you remove the soldering iron from its hold-

er, it is not being viewed by the IR detector, and the heat will increase somewhat until the pencil is returned to the holder. The circuit has a built-in lag time and if you return the pencil to the holder after each use, it should not be a major sort of problem.

In actuality, what we have here is an infrared detector that can serve in many assorted applications. I hope that this will get me a Fips Book.

—Don M. Beaver, Santoquin, UT
Great idea, Don. Of course, you're going to need a stand for the iron, and I've checked 'em out. The plain spiral-wire holders are a heck of a lot cheaper than the electronically controlled devices. But your circuit is an electronic control for the ordinary type. Your book is on the way!

Well that's a wrap for this month, but be sure to join us next month when we will again present a collection of circuits submitted by your fellow readers. Until then, I'll be waiting to hear from you. Good luck and may the flux be with you. ■



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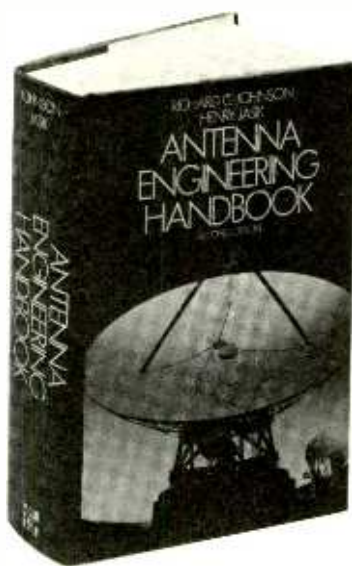
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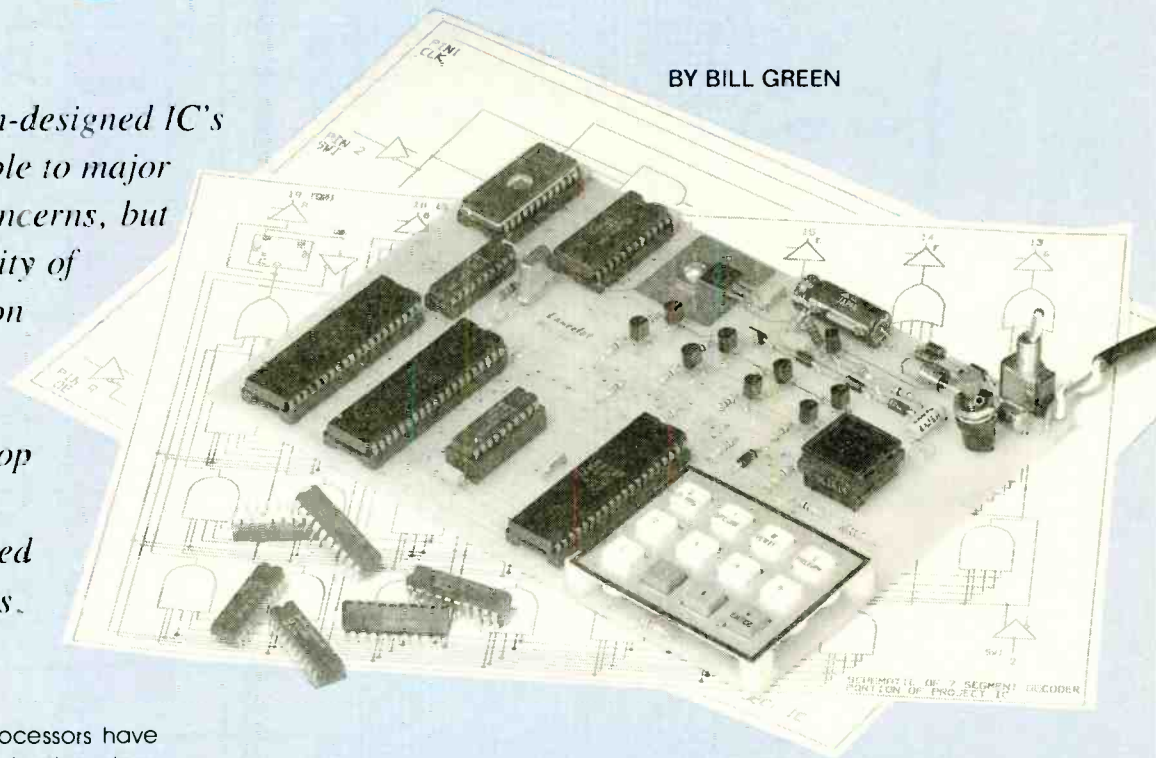
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CREATE YOUR OWN IC'S

For years, custom-designed IC's have been available to major manufacturing concerns, but with the availability of the next generation of user-configurable devices, anyone can develop circuits designed around customized integrated circuits.

BY BILL GREEN



For years microprocessors have been available to the electronics hobbyist for use in experimental projects. Although microprocessors do the job, not every project needs the versatility and programmability they offer, and not everyone has a computer and the software to write the programs they require.

Although designing the hardware to implement them is easy enough, wiring or building the hardware requires a lot of time and effort. Even if you possess the ability to prepare a printed-circuit board, designing the board, taping the artwork, exposing, etching, and drilling

the board can be a tedious and time-consuming task.

Because all printed-circuit designs that contain microprocessors have many traces, a double-sided board is usually required. Few if any experimenters have the equipment to plate holes. So, the average experimenter would have to solder through-the-board jumpers, solder socket pins on both side of the board, etc. The plain truth is that for most home projects, microprocessors are overkill.

Fortunately, there is a viable alter-

native; something called a bipolar fuse-link Programmable Logic Array (PLA). Such devices have true and inverted inputs that can be programmed into massive AND-logic arrays, and fixed or logic arrays feeding output buffers directly or through flip-flops. But they have some drawbacks. The equipment required to program PLA's is complex and expensive, and PLA's take a lot of time to program, require a lot of power, and can only be programmed once.

Input Lines (0-35)

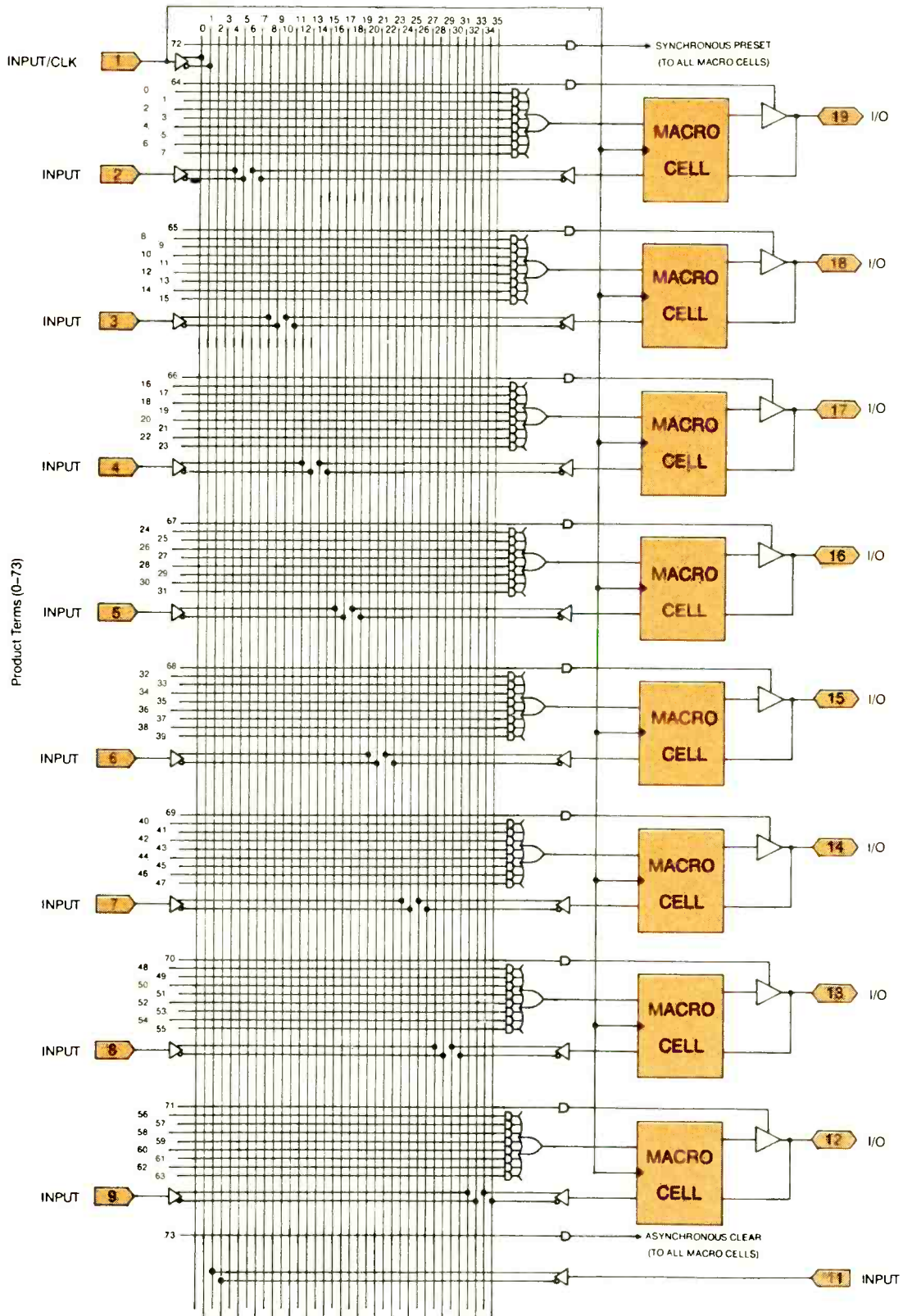


Fig. 1. PEEL devices can be thought of as huge integrated micro-breadboards that can be programmed and reprogrammed. These 74 AND logic gates are shown as having only one input, but they actually have 36. Each junction on the 36 input lines is a programmable connection. Programming those connections is the electronic equivalent of wiring a jumper on a breadboard (having 2664 possible connections).

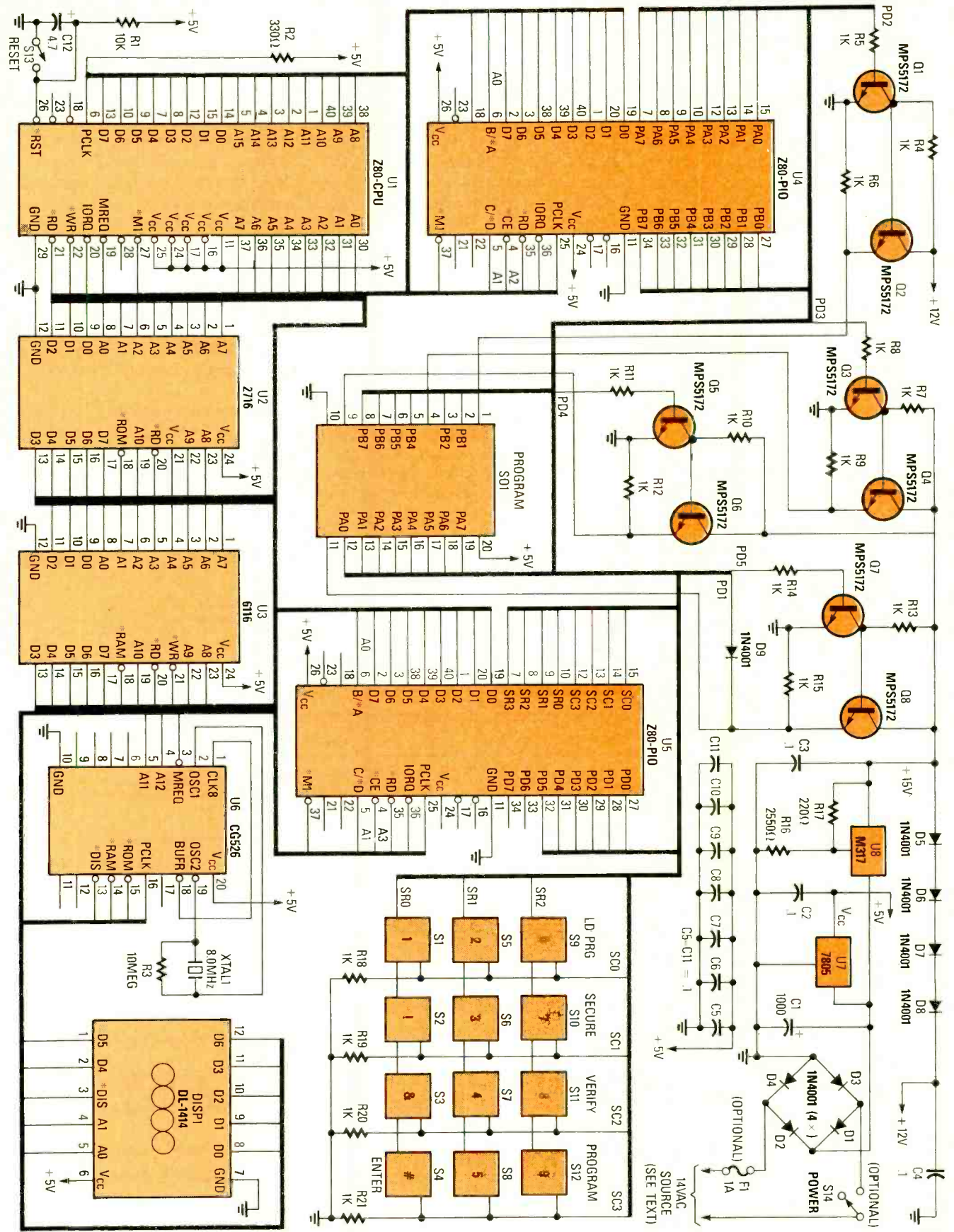


Fig. 2. The IC Designer, which is built around several integrated circuits—including a Z80-CPU—and a handful of support components, has a 12-key keyboard and a 4-digit alphanumeric display to allow entry and editing of program data and commands.

The Next Generation. A few years ago, International CMOS Technology (as well as other semiconductor manufacturers) came up with something even better—Programmable Electrically Erasable Logic, or PEEL.

The PEEL contains an EEPROM (Electrically Erasable Programmable Read Only Memory) array, which programs the true and inverted input pins into the AND logic array, and configures the output cells to be either true or inverted, registered (using D-type flip-flops) or not, and determines whether the pins connected to those cells are to be output, input, or both (I/O).

Being erasable means, of course, that they can be reprogrammed (at least a thousand times) and they remain as programmed for at least 10 years. And on top of that, they're fun to design with, too.

The 18CV8 PEEL has other advantages over the standard 16L8, 16R4, 16R6, and 16R8 PLA IC's, in addition to

being able to replace those and many other 20-pin PLA devices. The 18CV8 has 10 input pins, plus eight output pins. All of the output pins may be used as inputs, giving a total of 18 inputs, whereas the PLA's have only 16 inputs. As mentioned above, each 18CV8 output-cell may be programmed to be combinatorial or registered, true or inverted; feedback to the array may be registered, combinatorial, or from the OR gate.

The above mentioned PLA's have fixed, inverted outputs and the feedback source cannot be altered. The registered outputs of the 18CV8 can be preset and cleared by directly programming their respective terms. The PLA's do not have direct preset or clear capabilities. The usefulness of those features will be demonstrated in the project IC that we'll design later in this article.

Think of the PEEL devices as huge, integrated, micro-breadboards that

you can program and reprogram yourself again and again. To get a better idea of what the PEEL is, take a look at Fig. 1. Note: Due to space limitations, each of the 74 AND logic gates are shown as having only one input, whereas they actually have 36.

Each junction on the input lines of the 36-input AND gates (called a product term) is a programmable connection. Programming those connections is the electronic equivalent of wiring a jumper on a breadboard. A breadboard with 2664 possible connections, and with 74, 36-input AND gates, eight 8-input OR gates, eight D-type flip-flops, and eight 3-state output buffers. A security bit in the IC can be set after programming to prevent copying of the design.

Programming the PEEL has been a drawback until now. All programmers available to date require computer support and are very expensive. The *IC Designer* described in this article has no

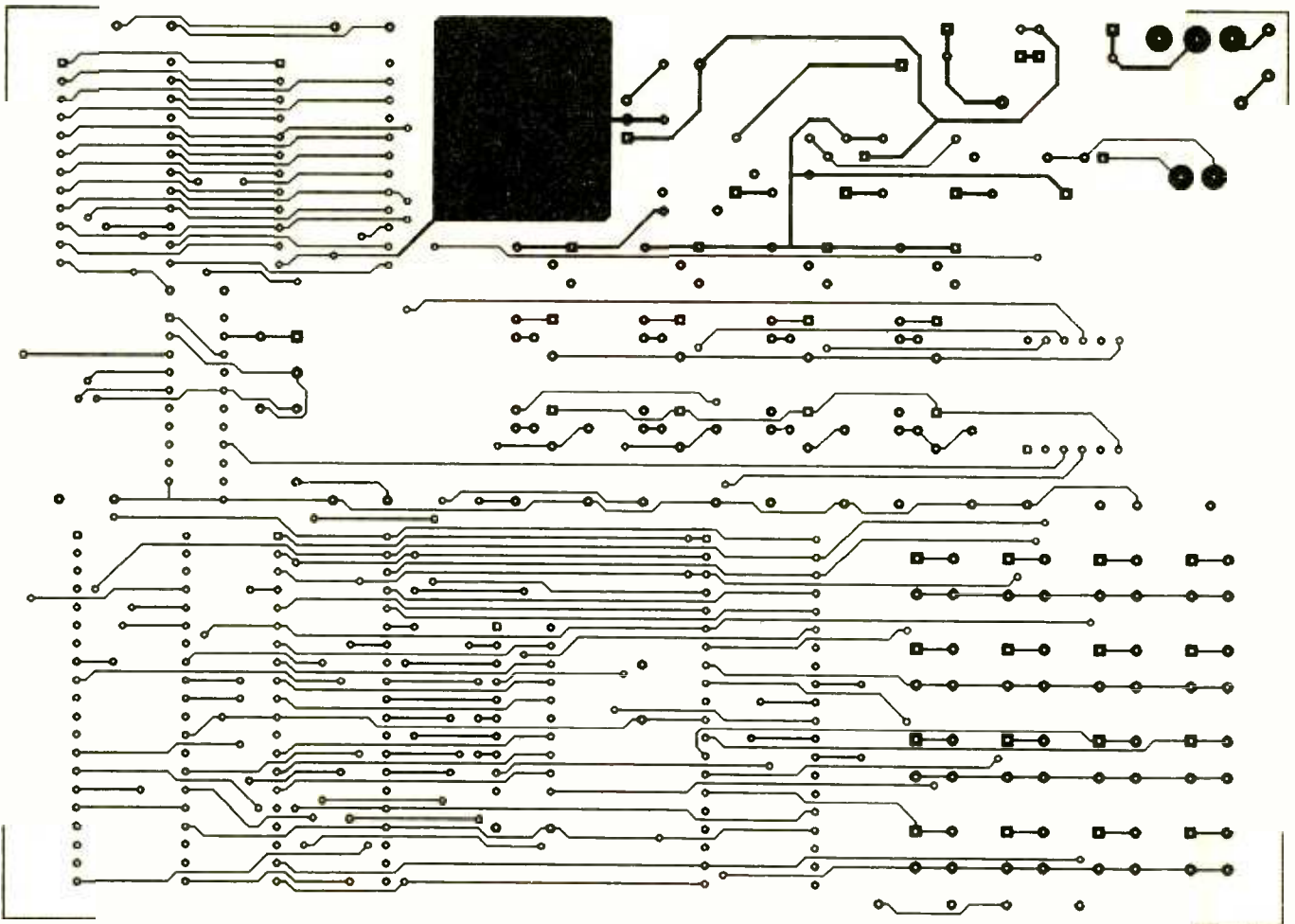


Fig. 3. The *IC Designer* was built on a double-sided printed-circuit board; the template for the component side of the board is shown here for those who wish to etch their own. But remember making a double-sided, printed-circuit board is lot more difficult and time-consuming than producing single-sided boards.

computer requirement, and best of all, it's affordable. A design and construction project—a *Lottery Number Selector*—is presented later in this article to show just how easy a complex circuit can be built with a PEEL.

To summarize, PEELs can make your life a lot simpler. By reducing circuit board size and complexity, you can increase productivity, thereby helping you to make more-complex projects with less effort. You can also protect your design from copying and increase the odds in favor of your projects working better the first time.

On a personal note, designing with the PEEL, beside being challenging and educational, is a lot of fun. We have been designing with micro-processors for years, but it's been a long time since we have enjoyed a project as much as the IC used in design and construction project mentioned above.

About the IC Designer.

The IC De-

signer has a 12-key keyboard and a 4-digit alphanumeric display to allow entry and editing of program data and commands. The display prompts the user to enter data as necessary and displays entry results, entry errors, and the results of the entered commands.

Programming the PEEL is a straightforward operation. Using logic equations generated from your design, you simply enter the data on the IC Designer's keyboard and it programs the data into the PEEL.

Figure 2 shows the schematic diagram of the IC Designer, which is built around several integrated circuits—including a Z80-CPU—and a handful of support components. The Z80, with its 8-bit data bus, requires little external support: only memory, a 5-volt regulated power supply, a reset capacitor and resistor, and a clock.

The processor's clock is generated by an 8-MHz crystal connected to two inverters within U6, and divided down to 2

MHz by a divide-by-four counter (also internal to U6). A crystal clock is required for precise timing of the programming pulses. Note: U6 is a custom IC, which was designed and produced by the author and placed within a PEEL device. (See Parts List for ordering information.)

The 2716 EPROM, U2, contains the IC Designer's program memory; e.g., the instructions that control the Z-80. A 6116 2048-byte static RAM, U3, is used to store program data entered by the operator by way of the keyboard, as well as various temporary data needed by the CPU.

The first Z80-PIO (*Parallel Input/Output*), U4, is connected to the PROGRAM socket, SO1. The signals from its two ports supply address and data to the PEEL for programming. The port "B" terminals of U5 (PD1 thru PD5) switch the four transistor pairs on and off applying +12 or +15 volts as appropriate to control the mode of the PEEL. That al-

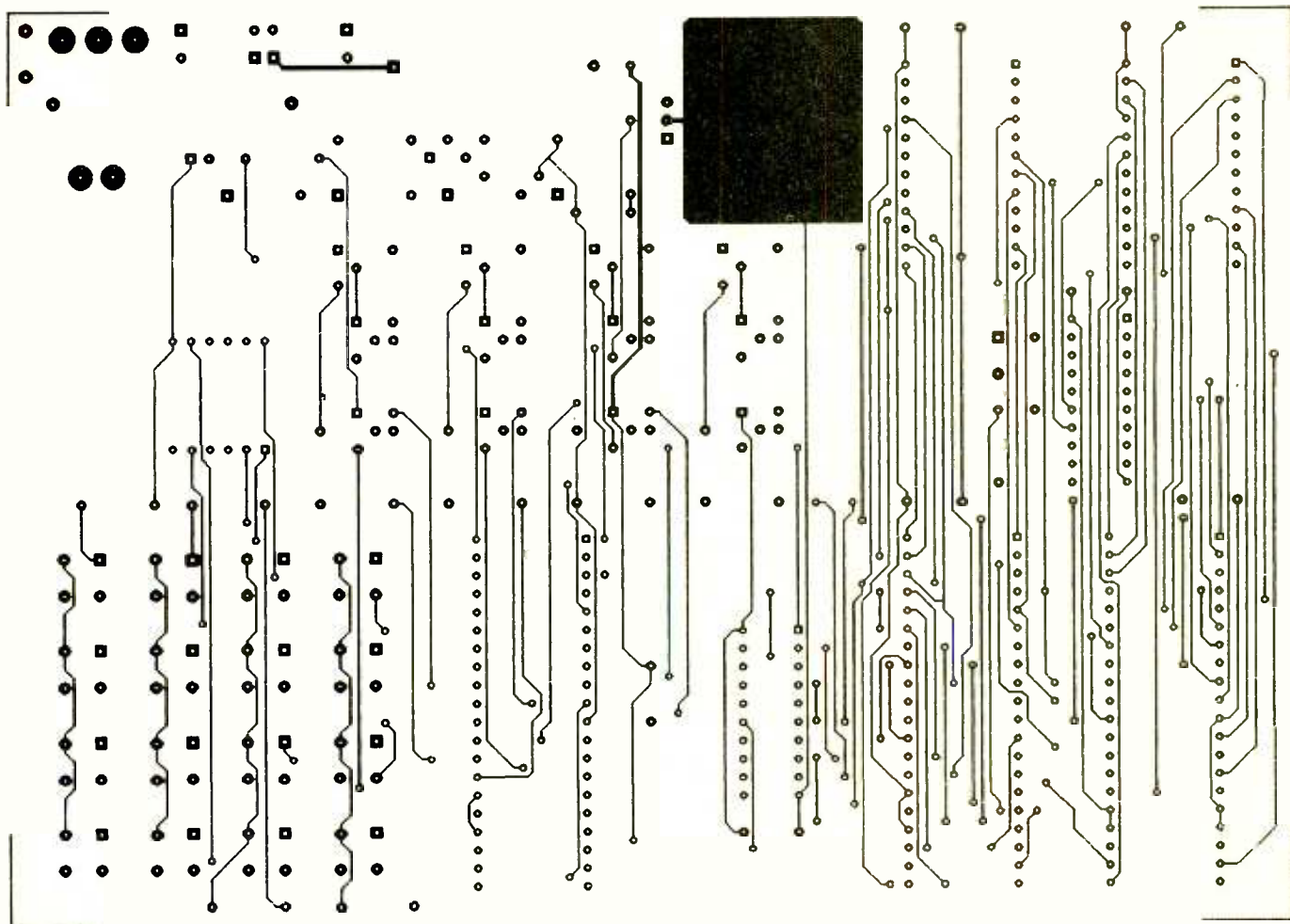


Fig. 4. Shown here is the foil side of the IC Designer's double-sided, printed-circuit board. However, if you prefer not to go through the hassle of etching, drilling holes (530 of them), and soldering through-the-board jumper connections, one can be purchased from the supplier listed in the Parts List.

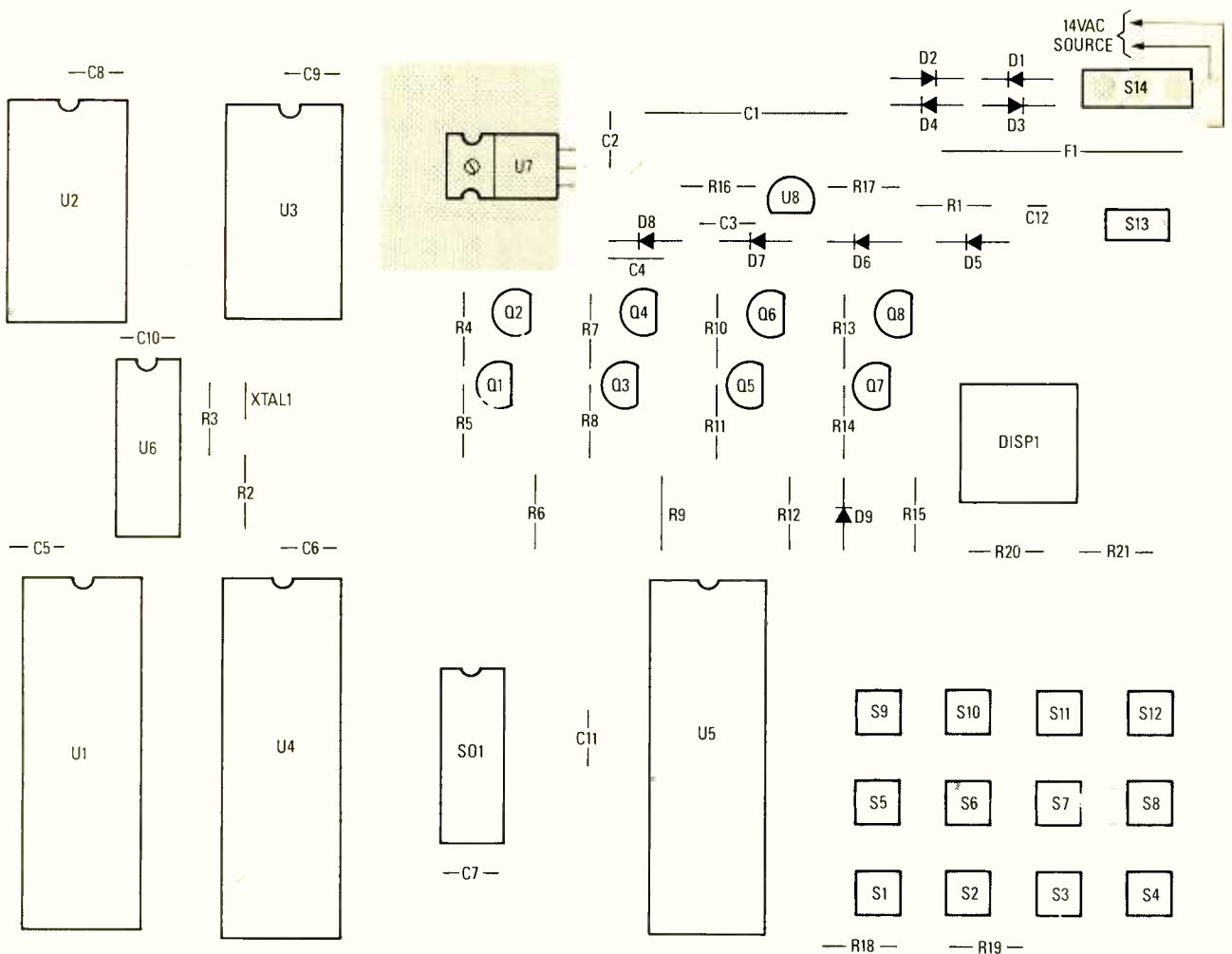


Fig. 5. Once you've obtained the board and all the components, begin assembly by first installing IC sockets at the appropriate locations on the component side of the board, guided by this parts-placement diagram. Note that pin 1 at each IC location is denoted by a square foil pad.

lows us to erase, program, verify, and secure the PEEL.

The keyboard and display provide the human interface. The IC Designer has many prompts to simplify interfacing. The prompts are given via a DL1414 intelligent alphanumeric display (DISP1), which contains built-in storage, decoders, and drivers for its four red 16-segment LED digits.

Twelve tactile-feedback type keyswitches—electrically arranged in four columns of three rows—make up the keyboard, which is scanned by port "A" of U5.

Assembling the IC Designer. The IC Designer was built on a double-sided printed-circuit board; templates for that board are shown in Figs. 3 and 4 for those who choose to and are capable of rolling their own. If, however, you prefer to not to go through the hassle of etching, drilling holes (530 of them),

and soldering through-the-board jumper connections, the board can be purchased from the supplier listed in the Parts List.

Once you've obtained the board and all the components listed in the Parts List, begin assembly by first installing IC sockets at the appropriate locations on the component side of the board, guided by Fig. 5. Pin 1 at each IC location is denoted by a square foil pad. Orient the sockets accordingly, with the notched end of the socket located at the square-pad end of the IC location. Do not install any of the IC's at this point, except U7 and U8—the regulator IC's.

Cut a 24-pin socket in half to make a twelve pin socket for the display module. Except for the keyswitches, install the support components, beginning with the resistors and the capacitors, and then the diodes and the transistors. Be sure to check the orientation of the

electrolytic capacitors, the diodes, the transistors, and the voltage regulators.

The 7805 voltage regulator (U7) should be installed so that its metal tab faces the large foil area of the board, which will serve as a heat sink. Once installed, either a clip-on heat sink may be secured to the metal tab, or it can be bent down flat to the board and secured with a screw and nut.

Lay the board on a flat surface, component side up. Orient the keyswitches so that their flat sides are facing toward the Z80. The keyswitches are of different colors; the number keys are white, the enter (#) key is green, the ampersand (&) key is blue, and the exclamation (!) key is red; the functions of those keys will be discussed when we discuss using the Designer. Select the proper color and install and solder each switch. Using the keyboard layout (see Fig. 6) as a guide, label the keyswitches.

Install the RESET switch (S13), the op-

tional POWER switch (S14), and fuse F1 on the board. Connect the output of a 14-volt AC, 1-ampere wall-mounted transformer or a 19- to 24-volt DC power supply to the board, and you are ready for a "test flight."

With all of the IC's (other than U7 and U8) uninstalled, apply power to the circuit, and check for the appropriate DC voltages at the outputs of the regulators (U7 and U8). There should be +5 volts, ±0.25 volt at the output of U7. If so, we have an indication that the board may have been assembled correctly, and it should be safe to install the IC's and display.

Remove power from the board and allow a minute for the filter capacitors to discharge. Being careful to observe proper procedures to avoid static damage to the MOS (Z80-CPU, Z80-PIO's, and ROM) and CMOS (RAM, CG526 custom-PEEL) IC's, install the IC's in their sockets, while observing the proper orientation.

Plug in the display, making sure that it is properly oriented, with pin 1 of DISP1

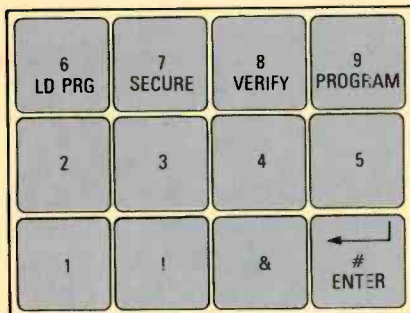


Fig. 6. This legend shows the physical layout of the keyboard switches (S1 through S12). The keyswitches (each having a specific function) are color coded: the number keys are white, the ENTER (#) key is green, the ampersand (&) key is blue, and the exclamation (!) key is red.

going to the square pad at the display location. When you're positive that all parts are installed correctly, in the correct place, and properly seated—no pins bent under any of the IC's—apply power again. Check the clock input at pin 6 of U1 for a 2-MHz square-wave signal if you have a scope; or for a fast pulse train if you're using a logic probe. "COMMAND?" should scroll repeatedly across the display. If so the IC Designer is ready for use.

Generating and Entering Design Equations. The following is the step-by-step design procedure for a BCD decade counter/latch seven-segment

decoder/driver with gated oscillator, which we'll use in lieu of a dry discussion of how-to-design with logic elements.

That design was selected to show-off most of the capabilities of the 18CV8 PEEL; our design makes use of features that would preclude the use of most other 20-pin PLA devices. Primarily the project IC design shows the following special features: registered and OR feedback into the array; output to the output pins from the OR gate, thus bypassing the register; and the direct clear input to the registers.

The counter portion appears fairly complex when first examined, and in truth, it's probably the most complex design you would want to put in a device of this type. With closer scrutiny, however, you'll see that it's easier to understand than you might think.

In addition, some typical equivalent circuits will be presented to further clarify how to prepare your designs for use with the 18CV8 PEEL. A printed-circuit foil pattern and schematic is also shown for a Lottery Number Selector made with the project IC.

Refer to Figs. 7, 8, and 9 (the decade counter, 7-segment decoder, and gated oscillator, respectively) as we go through this portion of our discussion. The schematics are included for clarity; a schematic is not needed to design your IC's.

It is important to note here, that although the following design was generated manually, there is a simpler way.

For those owning or having access to an IBM compatible PC, high-level compilers are available. One of the best and least expensive (nominally under \$100) among such devices is CUPL from P-CAD (Personal CAD), which is capable of generating programming data from TTL logic schematics, truth tables, and state equations.

Had the design of the project IC been done with CUPL rather than manually, the resulting equations would be very similar to those shown below. Also worth noting is the fact that those manually-generated equations were minimized (i.e., redundant and unnecessary terms were removed), as they were created. To illustrate, had the equation for Q0 not been minimized, the first equation for Q0 would look like:

$$Q0 = !Q0 \& !Q1 \& !Q2 \& !Q3 \# \text{Count } 0 \\ \text{to count } 1 \ Q0 \& !Q1 \& !Q2 \& !Q3 \# \text{Count } 1 \\ \text{to count } 2 \ !Q0 \& Q1 \& !Q2 \& !Q3 \# \text{Count } 2 \\ \text{to count } 3 \ Q0 \& Q1 \& !Q2 \& !Q3 \# \text{Count } 3 \\ \text{to count } 4 \ !Q0 \& !Q1 \& Q2 \& Q3 \# \text{Count } 4 \\ \text{to count } 5 \ Q0 \& !Q1 \& Q2 \& !Q3 \# \text{Count } 5 \\ \text{to count } 6 \ !Q0 \& Q1 \& Q2 \& !Q3 \# \text{Count } 6 \\ \text{to count } 7 \ Q0 \& Q1 \& Q2 \& !Q3 \# \text{Count } 7 \\ \text{to count } 8 \ !Q0 \& !Q1 \& !Q2 \& Q3 \# \text{Count } 8 \\ \text{to count } 9 \ Q0 \& !Q1 \& !Q2 \& Q3 \# \text{Count } 9 \\ \text{to count } 0$$

Clearly, all of those terms are not needed, since Q0 is just inverted from one count to the next. Therefore, Q0 equals !Q0...the same minimization technique applies to the rest of the equations. Not only does minimization

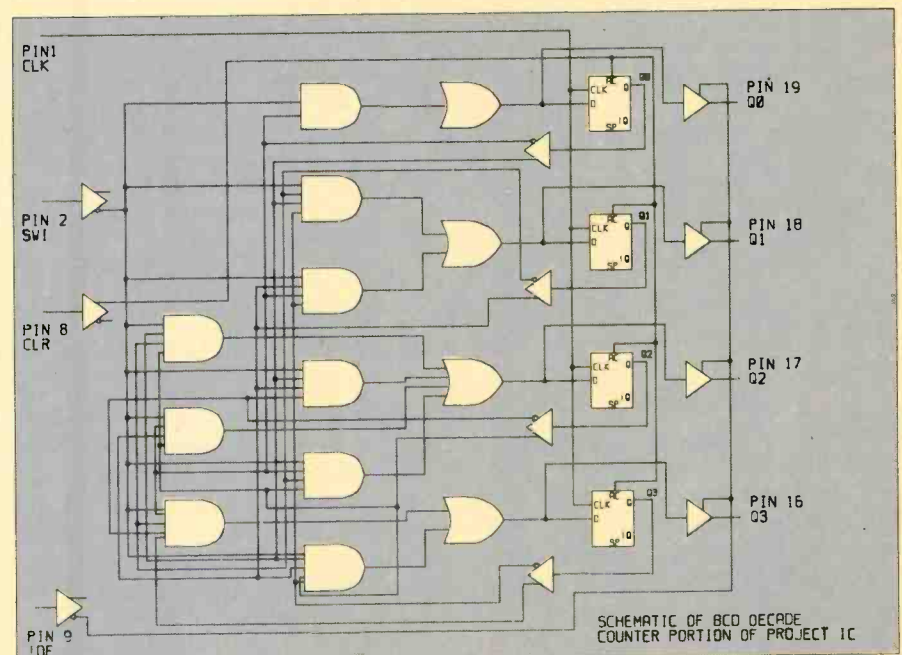


Fig. 7. In the BCD Decade Counter/Latch design, the Q outputs of the flip-flops are fed back to the inputs of the AND gates.

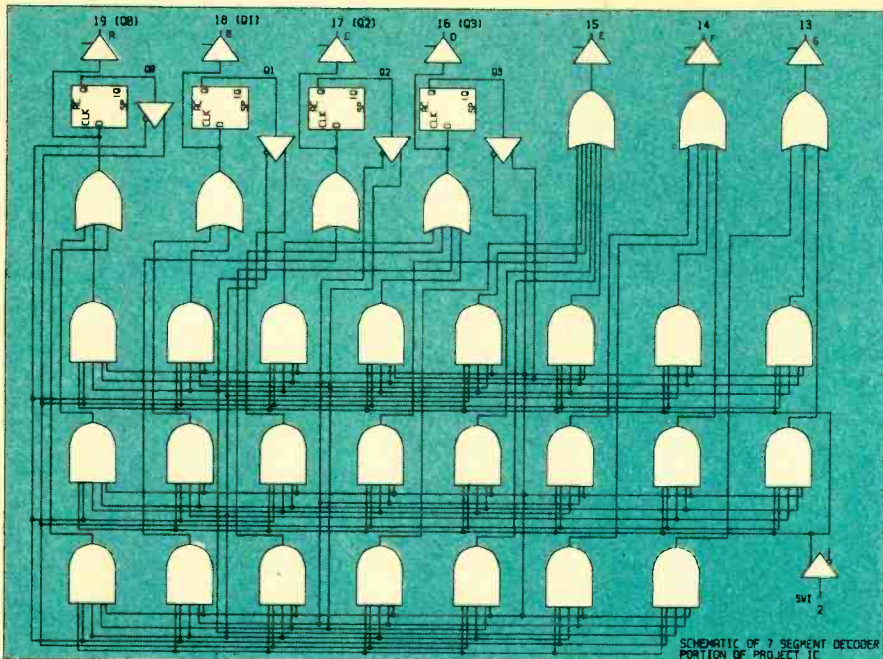


Fig. 8. In the 7-segment decoder/driver design, a 0 means the segment is on, and a 1 means the segment is off for common-anode display; the opposite would be true for a common-cathode display.

reduce keystrokes, but it also allow us to get far more into each PEEL. Because there are eight input terms for each product term (output pin), the ten equations would not fit into the 18CV8 PEEL, or (for that matter) any other similar programmable logic device.

BCD Decade Counter/Latch Design.

To write the logic equation for a circuit, we must first generate a truth table showing the state of all outputs as the result of all possible inputs combinations:

COUNT	CLOCK	Q3	Q2	Q1	Q0
0	0	0	0	0	0
1	C	0	0	0	1
2	C	0	0	1	0
3	C	0	0	1	1
4	C	0	1	0	0
5	C	0	1	0	1
6	C	0	1	1	0
7	C	0	1	1	1
8	C	1	0	0	0
9	C	1	0	0	1
0	C	0	0	0	0

(C = rising edge of Clock)

From the BCD decade-counter schematic (see Fig. 7), we see that the Q outputs of the flip-flops are fed back to the inputs of the AND gates, where the equations are implemented. Do each output one at a time, starting with Q0. For example, to get from count 0 to count 1, we invert Q0. From count 1 to 2, we invert Q1 and Q3 and don't invert Q0, and so on. (Output Q3 is included in the

equation to terminate the count at 9; without it, the count would continue to 11. Output Q2 is not required.)

Next generate equations to satisfy:

(Note: ! = invert; & = and; # = or)

- Q0 = !Q0 From count 0 to 1 Q0 is inverted.
- Q1 = Q0 & !Q1 & !Q3 # From count 1 to 2 Q1 & Q3 are inverted, Q0 is not.
- !Q0 & Q1 & !Q3 From count 2 to 3 Q0 & Q3 are inverted, Q1 is not.
- Q2 = Q0 & Q1 & !Q2 # From count 3 to 4 Q2 is inverted, Q0 & Q1 are not.
- !Q0 & !Q1 & Q2 # From count 4 to 5 Q0 & Q1 are inverted, Q2 is not.
- Q0 & !Q1 & Q2 # From count 5 to 6 Q1 is inverted, Q0 & Q2 are not.
- !Q0 & Q1 & Q2 # From count 6 to 7 Q0 is inverted, Q1 & Q2 are not.
- Q3 = Q0 & Q1 & Q2 & !Q3 # From count 7 to 8 Q3 is inverted, Q0, Q1 & Q2 are not.
- !Q0 & !Q1 & !Q2 & Q3 From count 8 to 9 Q0, Q1 & Q2 are inverted, Q3 is not.

Note: In the above equation, the exclamation mark (!) denotes an inversion; the ampersand indicates an AND function; and the pound symbol (#) denotes an ORing of terms. If you study the equations you will note that they describe just exactly what the table specifies. It's that simple!

Next, we present a 7-segment decoder/driver design (Fig. 8). In our design, a 0 means the segment is on, and

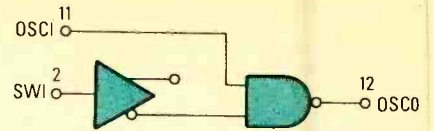


Fig. 9. In the oscillator, an AND gate is used as an inverter, which is gated off via SW1.

a 1 means the segment is off for common-anode display; the opposite would be true for a common-cathode display.

COUNT	Q3	Q2	Q1	Q0	a	b	c	d	e	f	g
0	0	0	0	0	0	0	0	0	0	0	1
1	0	0	0	1	1	0	0	1	1	1	1
2	0	0	1	0	0	0	1	0	0	1	0
3	0	0	1	1	0	0	0	0	1	1	0
4	0	1	0	0	1	0	0	1	1	0	0
5	0	1	0	1	0	1	0	0	1	0	0
6	0	1	1	0	1	1	0	0	0	0	0
7	0	1	1	1	0	0	0	1	1	1	1
8	1	0	0	0	0	0	0	0	0	0	0
9	1	0	0	1	0	0	0	1	1	0	0

- a = Q0 & !Q1 & !Q2 & !Q3 # The 'a' segment will always be '1' when these equations are true.
- b = Q0 & !Q1 & Q2 & !Q3 # The same applies to each segment in the remaining cases.
- c = !Q0 & Q1 & !Q2 & !Q3
- d = Q0 & !Q1 & !Q2 & !Q3 #
- !Q0 & !Q1 & Q2 & !Q3 #
- Q0 & Q1 & Q2 & !Q3 #
- Q0 & !Q1 & !Q2 & Q3
- e = Q0 & !Q1 & !Q2 & !Q3 #
- Q0 & Q1 & !Q2 & !Q3 #
- !Q0 & !Q1 & Q2 & !Q3 #
- Q0 & !Q1 & Q2 & !Q3 #
- Q0 & Q1 & Q2 & !Q3 #
- Q0 & !Q1 & !Q2 & Q3
- f = Q0 & !Q1 & !Q2 & !Q3 #
- !Q0 & Q1 & !Q2 & !Q3 #
- Q0 & Q1 & !Q2 & !Q3 #
- Q0 & Q1 & Q2 & !Q3
- g = !Q0 & !Q1 & !Q2 & !Q3 #
- Q0 & !Q1 & !Q2 & !Q3 #
- Q0 & Q1 & Q2 & !Q3

GATED OSCILLATOR DESIGN

OSC1	SW1	OSCO
1	0	1

$$OSCO = OSC1 \& !SW1$$

The oscillator (see Fig. 9) is a little different. The AND gate is used as an inverter, which is gated off via the SW1 input. If we were putting those equations in two IC's, we would be just about done. However they will fit in one 18CV8 PEEL if we

share some outputs. That's done by multiplexing Q_0 thru Q_3 onto segment pins "a" through "d." The SWI term controls the multiplexer, so we add it to the above counter and decoder equations, and combine them. When the SWI is high, the display is activated and when SWI is low, a count is initiated. The combination looks like:

$$Q_0(a) = SWI \& Q_0 \& !Q_1 \& !Q_2 \& Q_3 \#$$

Q0 (a) means the pin is multiplexed.

$$SWI \& !Q_0 \& !Q_1 \& Q_2 \& !Q_3 \#$$

$$!SWI \& !Q_0 \& Q_1 \& Q_2 \& !Q_3 \#$$

$$!SWI \& !Q_0$$

$$Q_1(b) = SWI \& Q_0 \& !Q_1 \& Q_2 \& !Q_3 \#$$

$$SWI \& !Q_0 \& Q_1 \& Q_2 \& !Q_3 \#$$

$$!SWI \& Q_0 \& !Q_1 \& !Q_3 \#$$

$$!SWI \& Q_1 \& !Q_0 \& !Q_3$$

$$Q_2(c) = SWI \& !Q_0 \& Q_1 \& !Q_2 \& !Q_3 \#$$

$$!SWI \& Q_0 \& Q_1 \& !Q_2 \#$$

$$!SWI \& !Q_0 \& !Q_1 \& Q_2 \#$$

$$!SWI \& Q_0 \& !Q_1 \& Q_2 \#$$

$$!SWI \& !Q_0 \& Q_1 \& Q_2$$

$$Q_3(d) = SWI \& Q_0 \& !Q_1 \& !Q_2 \& !Q_3 \#$$

$$!SWI \& !Q_0 \& !Q_1 \& Q_2 \& !Q_3 \#$$

$$SWI \& Q_0 \& Q_1 \& Q_2 \& !Q_3 \#$$

$$SWI \& Q_0 \& !Q_1 \& !Q_2 \& Q_3 \#$$

$$!SWI \& Q_0 \& Q_1 \& Q_2 \& !Q_3 \#$$

$$!SWI \& !Q_0 \& !Q_1 \& !Q_2 \& Q_3$$

$$e = Q_0 \& !Q_1 \& !Q_2 \& !Q_3 \#$$

The remaining pins are not multiplexed.

$$Q_0 \& Q_1 \& !Q_2 \& !Q_3 \#$$

$$!Q_0 \& !Q_1 \& Q_2 \& !Q_3 \#$$

$$Q_0 \& !Q_1 \& Q_2 \& !Q_3 \#$$

$$Q_0 \& Q_1 \& Q_2 \& !Q_3 \#$$

$$Q_0 \& !Q_1 \& !Q_2 \& Q_3$$

$$f = Q_0 \& !Q_1 \& !Q_2 \& !Q_3 \#$$

$$!Q_0 \& Q_1 \& !Q_2 \& !Q_3 \#$$

$$Q_0 \& Q_1 \& !Q_2 \& !Q_3 \#$$

$$Q_0 \& Q_1 \& Q_2 \& !Q_3$$

$$g = !Q_0 \& !Q_1 \& !Q_2 \& !Q_3 \#$$

$$Q_0 \& !Q_1 \& !Q_2 \& !Q_3 \#$$

$$Q_0 \& Q_1 \& Q_2 \& !Q_3$$

We can add some finishing touches such as output enable (!OE) to blank the display if desired and a reset (CLR) pin to reset the counter. There are no equations required to do that. Figure 10 shows the pinout of the project IC.

We need the pin numbers on the IC to convert the data for entry into the IC Designer. Had we started with pin numbers originally instead of labels (Q_0 , Q_1 , Q_2 , etc.), we could have saved this step, but the logic is easier to understand when written in logic terms rather than pin numbers.

There is a little more data to be add-

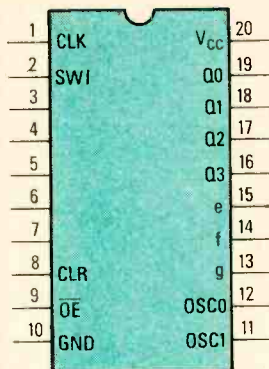


Fig. 10. Here is the pinout of the IC that we've designed, which is used in the Lottery Number Selector.

ed before we can program the IC. Refer to Fig. 11 for a list and description of the output configuration macro cells possible with the 18CV8 PEEL. We'll use Macro Cell 13 for the counter outputs,

Macro Cell 04 for the plain segment outputs, and Macro Cell 03 for the oscillator output.

In addition, because we've included clear (CLR) and output enable (!OE) pins, and their terms are not included in the logic equations, we have to tack them onto the data as it is entered. The information for all but the CLR is shown after each equation. The CLR data is at the end of the equations because it is entered only once and is prompted for after all other data is keyed into the IC Designer.

$$19 = 2 \& 19 \& !18 \& !17 \& !16 \#$$

Macro Cell = 13

$$2 \& !19 \& !18 \& 17 \& !16 \#$$

OE = !9

$$2 \& !19 \& 18 \& 17 \& !16 \#$$

$$!2 \& !19$$

PARTS LIST FOR THE IC DESIGNER

SEMICONDUCTORS

- U1—Z80-CPU, integrated circuit
- U2—2716 EPROM, integrated circuit
- U3—6116 Static RAM, integrated circuit
- U4, U5—Z80-PIO, integrated circuit
- U6—CG526 custom PEEL (see text), integrated circuit
- U7—7805 5-volt, voltage regulator, integrated circuit
- U8—LM317LZ positive, adjustable voltage regulator, integrated circuit
- Q1-Q8—MPS5172 general-purpose NPN transistor
- D1-D9—1N4001 general-purpose rectifier diode
- DIS1—DL1414 4-digit LED display

RESISTORS

- (All resistors are 1/4-watt, 5% units, unless otherwise noted.)
- R1—10,000-ohm
 - R2—330-ohm
 - R3—10-megohm
 - R4-R15, R18-R21—1000-ohm
 - R16—2550-ohm, 1% metal film
 - R17—220-ohm

CAPACITORS

- C1—1000- μ F, 16-WVDC, electrolytic
- C2-C11—0.1- μ F, 10-WVDC, monolithic
- C12—4.7- μ F, 24-WVDC, electrolytic

SWITCHES

- S1-S12—SPST momentary-contact keyswitch
- S13—SPST momentary-contact pushbutton
- S14—SPDT miniature toggle (optional)

ADDITIONAL PARTS AND MATERIALS

- FI—1-amp pigtail fuse (optional)
- T1—14-volt AC, 1-amp power

transformer or 20- to 24-volt DC power supply (optional)

XTAL—8-MHz crystal

Printed-circuit or perfboard materials, enclosure (optional), IC sockets, hardware, etc.

The 18CV8 PEEL is manufactured by International CMOS Technology, Inc., 2125 Lundy Ave., San Jose, CA 95131; 408-434-0678, and is second-sourced by Gould Semiconductor. They are available from some parts distributors. In addition they are available from the source given in the Parts List.

Note: The following is available from Lancelot, PO Box 541005, Merritt Island, FL 32954-1005; Tel. 407-454-3303. A complete kit of parts for the IC Designer is available for \$79.90, plus \$3.00 shipping and handling—kit includes all items in the Parts List except those marked optional; a partial kit containing the CG526 custom PEEL, pre-programmed EPROM, and the printed-circuit board, \$50.00, plus \$3.00 S/H; the CG526 custom PEEL only, \$12.00 (ppd); unprogrammed 18CV8 PEEL, \$5.00 each (ppd), or 5 for \$20.00 (ppd). Florida residents, please add 6% state sales tax. Canadian respondents, please add \$3.00 additional postage to all orders. All foreign orders add appropriate postage for air shipping and insurance.

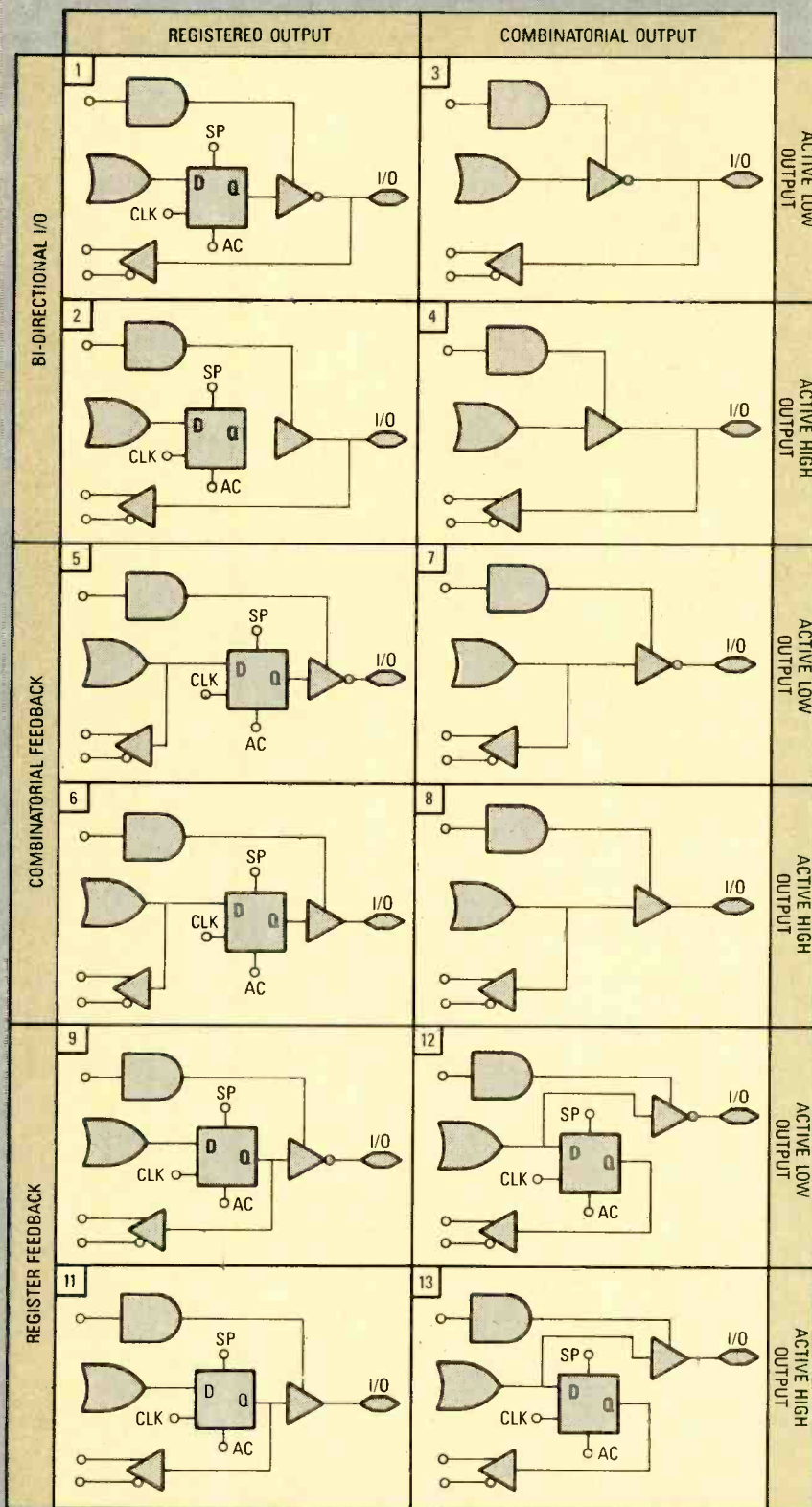


Fig. 11. This diagram shows the output configuration macro cells possible with the 18CV8 PEEL. In designing our project IC, we'll use Macro Cell 13 for the counter outputs, Macro Cell 04 for the plain segment outputs and Macro Cell 03 for the oscillator output.

18 = 2 & 19 & !18 & 17 & !16 # Macro Cell = 13
 # OE = !9
 2 & !19 & 18 & 17 & !16
 #
 !2 & 19 & !18 & !16 #
 !2 & 18 & !19 & !16

17 = 2 & !19 & 18 & !17 & !16 Macro Cell = 13
 # OE = !9
 !2 & 19 & 18 & !17 #
 !2 & !19 & !18 & 17 #
 !2 & 19 & !18 & 17 #
 !2 & !19 & 18 & 17

16 = 2 & 19 & !18 & !17 & !16 Macro Cell = 13
 # OE = !9
 2 & !19 & !18 & 17 & !16
 #
 2 & 19 & 18 & 17 & !16
 #
 2 & 19 & !18 & !17 & 16
 #
 !2 & 19 & 18 & 17 & !16
 #
 !2 & !19 & !18 & !17 & 16

15 = 19 & !18 & !17 & !16 # Macro Cell = 04
 # OE = !9
 19 & 18 & !17 & !16 #
 !19 & !18 & 17 & !16 #
 19 & !18 & 17 & !16 #
 19 & 18 & 17 & !16 #
 19 & !18 & !17 & 16

14 = 19 & !18 & !17 & !16 # Macro Cell = 04
 # OE = !9
 !19 & 18 & !17 & !16 #
 19 & 18 & !17 & !16 #
 19 & 18 & 17 & !16

13 = !19 & !18 & !17 & !16 # Macro Cell = 04
 # OE = !9
 19 & !18 & !17 & !16 #
 19 & 18 & 17 & !16

12 = 11 & !2 Macro Cell = 03
 # OE = ENTER #
 (Defaulted on)

AC = 8 (Asynchronous Clear—pin 8)
 SP = ENTER # (Synchronous Preset—
 defaulted off)

First a few words of caution are in order. Never insert the PEEL IC into the PROGRAM socket unless the IC Designer is on and "Command?" is scrolling across the display; conversely, never shut the IC Designer off when the PEEL is in the socket or the IC will be damaged.

The commands on the IC Designer are self prompting to ease entry of data. Press the keys deliberately, watching for the response in the display. The pound (#) key OR's the term; the ampersand (&) key AND's the term; and the exclamation (!) key inverts the term. The following is a description of what is entered on the IC Designer's keyboard and the prompts shown in the display:

(Continued on page 96)

Water with a high mineral content can shorten the life of a water heater or water softener. The minerals in hard water accelerate corrosion of the heater tank, which eventually leads to tank rupture. Glass-lined tanks survive longer, but also fail when thermal cycling results in microscopic cracks that allow mineral-laden water to begin corroding the tank wall. The life of a typical water heater in the Southwestern United States is between four and eight years. I have gone through four heaters in twenty years. That means they had an average life of slightly over five years. Loss of a heater is inconvenient, but water damage to carpets, floors, and other furnishings can be more serious, and costly!

Another source of water leaks are the supply hoses for washing machines. When a supply hose fails, if the washer is unattended the amount of water that gets on the floor is usually much more than a heater rupture would leave. Hose failures usually occur when the machine is being used so an operator may be nearby to control a leak. However, excessive water pressure in city water mains can cause a problem at any time. Age is the primary enemy of hoses.

In light of all this, a water-leak alarm would be a nice item to have around the house. The remainder of this article describes an economical alarm that can be assembled with a few hand tools in an evening.

Circuit Description. A schematic diagram of the circuit used is shown in Fig. 1. The central element in the leak alarm is an SCR (Silicon-Controlled Rectifier) that has the property of continuing to conduct once it has been triggered. It is

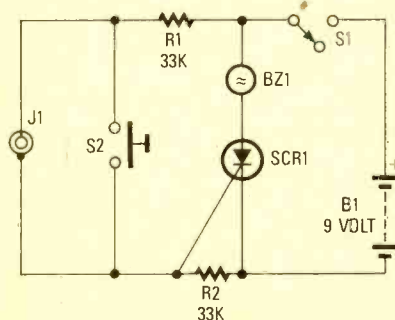
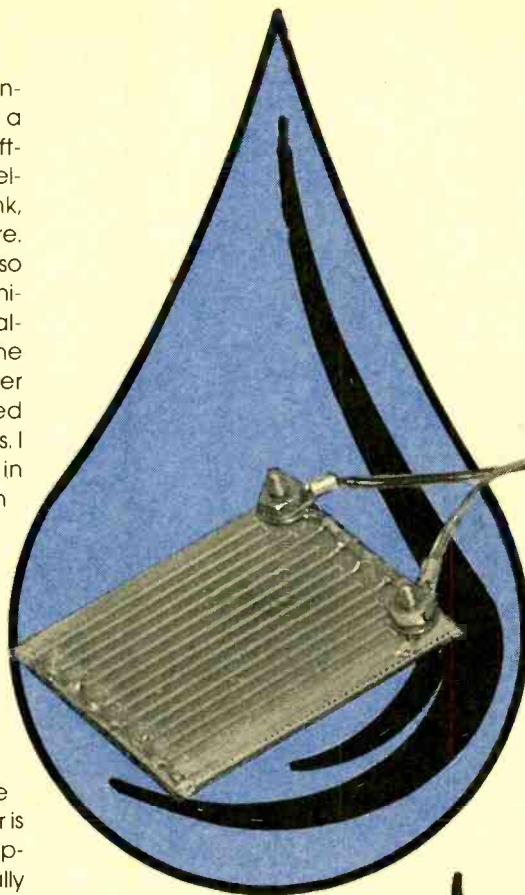


Fig. 1. The actual circuit is as simple as this. In fact, it will even work without S2 which is just used for testing.



WATER LEAK ALARM

The simplest means of ensuring peace of mind against the ravages of water is to protect your property with our simple alarm circuit.

BY EDMUND T. TYSON

triggered by voltage at its gate pin. Therefore, the gate is activated by pushing S2 or shorting J1.

Which brings us to the detector element: that goes to J1. It is a printed-circuit board that can be made specifically for the purpose (see Fig. 2), or you can use a scrap PC board. When water hits the board it completes the circuit, the SCR is triggered and sounds the buzzer, BZ1. The buzzer is a solid-state piezoelectric buzzer designed to cycle on and off at 3 Hz.

You can use as many detectors as you wish with the alarm. To add additional alarms, simply wire additional input jacks in parallel with J1.

The power source, B1, is a 9-volt alkaline battery that should last for one or two years if there is no alarm. The pushbutton is used to test circuit operation and battery status. A power switch, S1, is included to turn the alarm off if a leak occurs. The piezoelectric buzzer is loud enough

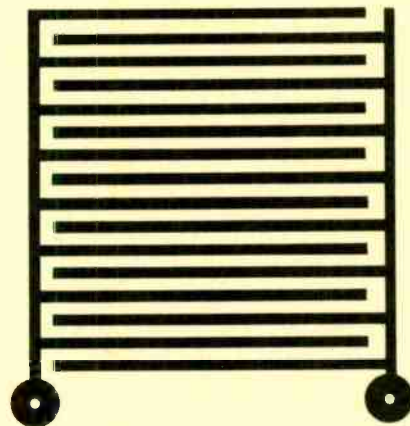


Fig. 2. If you choose to make your own moisture sensor, this foil pattern should come in handy.

to require ear protection if one remains in the vicinity for very long, so be careful.

Construction. Most of the components are mounted on a small PC board (see Fig. 3). An experimenter's IC perfboard from a local electronics store can be used if it is inconvenient to produce a PC board. The only point of caution during assembly is to be sure that the SCR is connected properly. Use Fig. 4 as a guide when installing the components.

Before going any further, inspect your work and correct any problems (solder bridges, incorrectly placed components, etc.) you may find.

PARTS LIST FOR THE WATER-LEAK ALARM

- BZ1—3–28 volt, 95-dB piezoelectric buzzer (Radio Shack 273-066 or similar).
- B1—9-volt alkaline battery
- J1—RCA phono jack
- R1, R2—33,000-ohm, ¼-watt resistor
- SCR1—200-PIV, 6-amp silicon controlled rectifier, (Radio Shack 276-1067, ECG-5431, or equivalent)
- S1—SPST toggle switch
- S2—Normally-open momentary-contact miniature pushbutton switch
- Experimenters perfboard, project box, battery holder, battery connector, wire, solder, screws, etc.

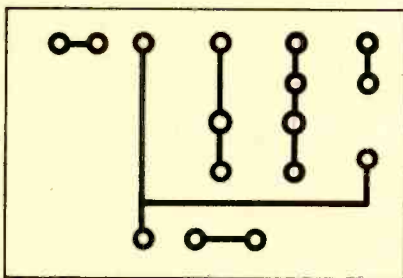


Fig. 3. Although not absolutely necessary, you can use this foil pattern to make a circuit board for the alarm.

When all of the parts have been mounted on the PC board, and soldered in place, the circuit can be tested by connecting a battery and shorting the detector leads or pressing the test button. A loud, piercing tone should be emitted by the buzzer.

The detector board can be made either using a copy of the pattern given

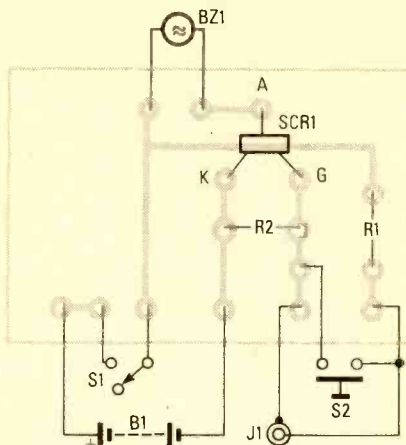


Fig. 4. If you decide to make the project's printed-circuit board, you can use this as a guide for mounting the parts.

in Fig. 2 or a specially adapted experimenters perfboard. Notice that alternate strips of the board are connected to form a grid. The detector board can be connected to the leak alarm via a cable to a front-panel RCA phono jack. Make the detector board cable(s) using a lightweight wire such as telephone extension wire. Two jacks have been used on the author's model to permit the use of more than one detector board at a time.

When you're ready to mount the circuit in an enclosure, you may wish to use Fig. 5 as a guide for your front-panel layout.

Installation. Mount the box containing the buzzer in an accessible lo-

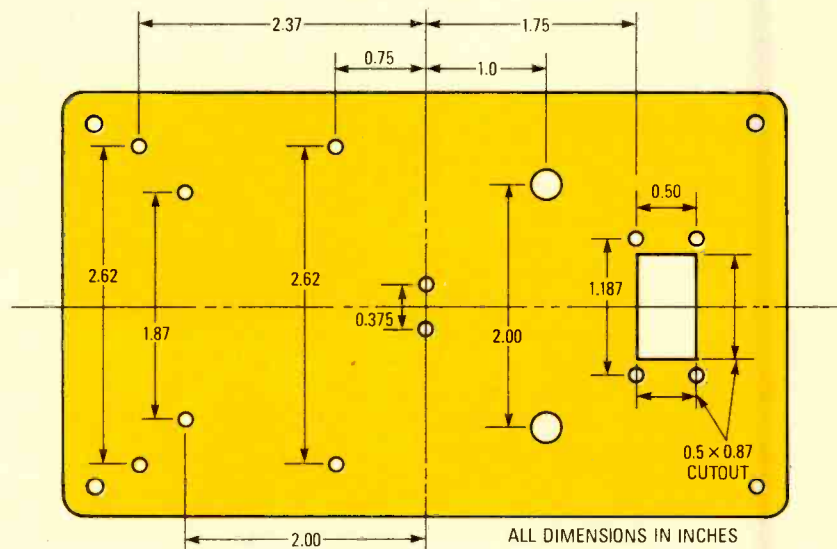
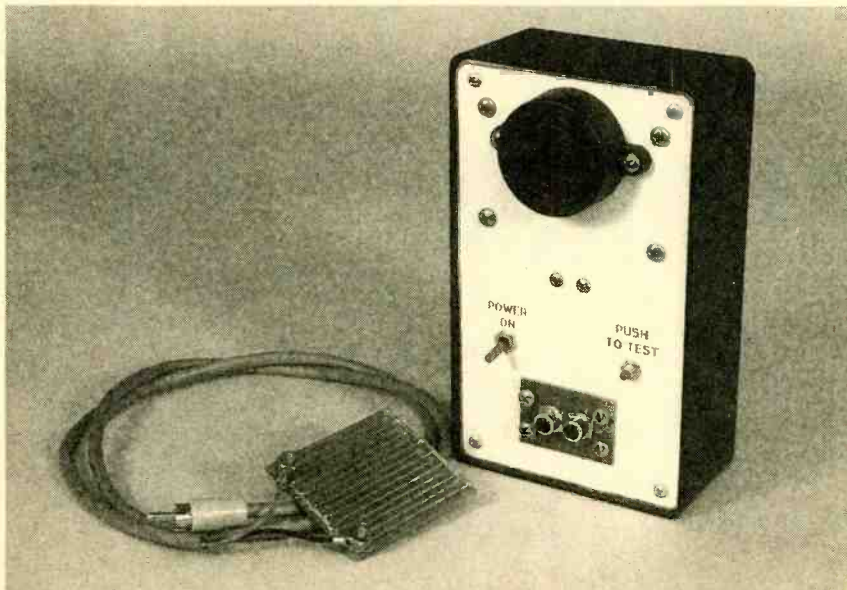


Fig. 5. The front-panel layout is not critical, but this diagram will help you arrange your device to match the author's.



The author's prototype was set up to accept two water detectors. You can have the unit accept as many detectors as needed by wiring additional jacks in parallel with J1.

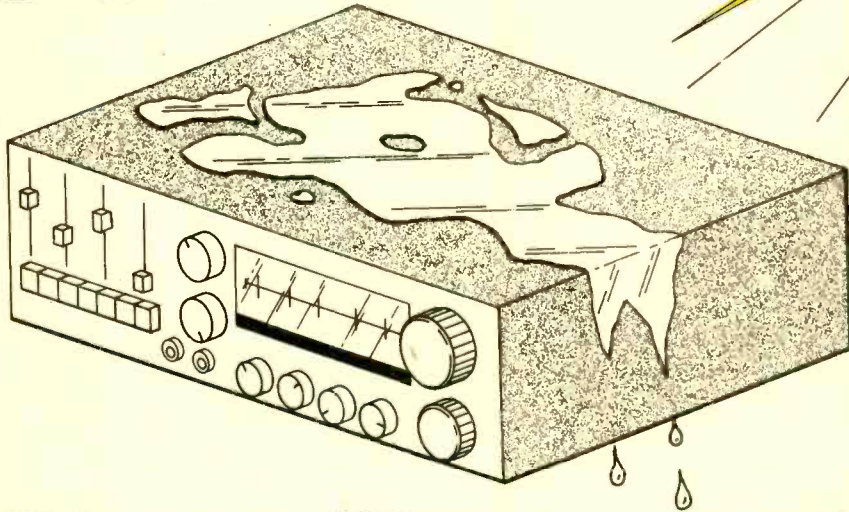
cation so the battery can be tested occasionally. If the box is in a noticeable spot, the chances you'll remember to test the battery are higher.

Locate places for the detectors near the water heater or washer that are unlikely to be trafficked. Make all your connections and test the operation with a drop of water before you make anything permanent. If all works well, then your alarm system is operational.

Of course, there are times when no amount of warning will suffice. For instance, when flooding occurs while you are away from home, or when the volume of water is large enough that items are damaged before preventive measures can be taken.

What can you do then? Well, if the items damaged are electronic in nature, all may not be lost. See the following article for some steps to take when disaster strikes. ■

DRYING OUT



If heavy rains or floods do damage to your electronic equipment don't give up hope. You might be able to easily salvage it with a simple series of steps.

BY JULIAN KERR

Flood-Damaged Equipment

Last fall five days of heavy rains pelted the East Coast. In our area, a river crested 11-feet above flood level. Eighty miles upstream in the mountains of West Virginia, it became a 54-foot high wall of water that overwhelmed the best efforts of hundreds of bone-tired volunteers. Despite back-breaking heroic efforts, the sandbag wall at the edge of one town gave way under the relentless pressure of an angry river. Over the next 24-hours the water rose, completely flooded basements, and gushed into the first floor of most homes and businesses to a height of six feet. As the waters receded, the governor called out the National Guard to prevent looting and people returned home to recover what they could. After cleaning out the water moccasins that inevitably come along with the flood waters, they found their possessions soaked and mudcaked. Among the damaged property was

electronic equipment. If it were yours, would you know how to salvage what was left?

Although most flood-damage scenarios are not as dramatic as that above, we nonetheless hear of electronic equipment that has taken a bath either from boating accidents, plumbing failures (Gee, was that plastic pipe running just above my stereo set?!), or any of a variety of possible scenarios. Fortunately, there are certain things that can be done to restore flood-ravaged equipment.

Why Bother? If the insurance company pays off well enough, then you can go out and buy a new product. But if the insurance company refuses to pay ("sorry...wind-driven water damage excluded..."), or if you don't have insurance, then you might want to take restorative action. Even if the insurance company does pay off, you can often

buy the equipment back from them for salvage value. One guy I know received \$325 for a two-year old ham radio set and bought it back from the insurance company for \$20. The company sent him a check for \$305, and he kept the carcass (Note: many insurance policies, including my friend's, don't cover replacement value, but a reduced value that depends on the amount of "use" you received from the insured property—he originally paid more than \$600 for the set).

Some of the steps that I recommend may sound a little bizarre to you from a normal perspective, but they are capable of restoring an expensive piece of equipment. Some of the steps might cause a little damage that will also have to be repaired (especially those involving baking the moisture out or using chemicals to clean the rig). If that makes you nervous, then please remember that if a component is defunct

you cannot harm it anymore: it is already a total loss. Any restoration is therefore pure gravy.

Before getting too excited however, make sure that you understand that you are undertaking heroic measures that may not be successful. One of the most frequently cited causes of bitter customer dissatisfaction is not your own poor performance, but rather *dashed expectations*. If you believe that the job will turn out much better than is possible, then you will not be in a self-forgiving mood when you fail to catch the bullet in your teeth. But if the job turns out a lot better than your expectations, then you will probably be very happy with your work.

Rinsing. The first thing to do is *refrain from turning the device on*, even to test it briefly to see if it's broken. Believe right now that even a short dunk will cause fatal damage. If it was immersed, then it didn't survive!

I once lived in an eastern seaport town where saltwater damage to electronic equipment was common. The shop where I worked part-time received an \$1800 FM UHF taxicab radiotelephone set that had been immersed the night before during a storm (it seems that the saltwater river tributary overflowed its banks just high enough to cover the radio mounted in the trunk well). The first thing the shop owner did was take the transceiver out on the back parking lot and give it a ten minute shower with a garden hose. He had lived in that town all his life, and therefore had much experience with water-damaged radio gear.

Incidentally, if the damage is due to saltwater, then rinse it immediately. The longer salt residue remains in a unit, the greater the corrosion damage will be, and the lower the chance of successful restoration.

In some cases, it will be necessary to follow the shower with an immersion bath. A technician I know uses a 25-gallon tub, the kind you might use to give a large dog a bath. He mixed two to four quarts of a product like *Lestoil*, a small bottle (2-4 fl.oz) of nailpolish remover or acetone (which is the same stuff, but cheaper) together in the tub along with enough tap water to fill it to the rim. If you do that, leave the set in the bath for an hour, pour out the solution, rinse the tub out thoroughly, and refill it with plain tap water (some people prefer distilled water, which is available in bottles in some areas). The

second bath removes the residue left by the chemicals in the first bath.

Please note that the chemicals may damage some plastics. If that worries you, then use plain soapy water. It isn't quite as effective a solvent, but it works somewhat.

Drying Out Equipment. The next step is drying the unit out *thoroughly*. If you live in Arizona (yes, they have floods there!), then simply leave the rig out in the sun for about a week; everyone else will have to use some other method. The kitchen oven is a good bet, provided that it can be regulated to maintain a temperature of 125 to 130°F

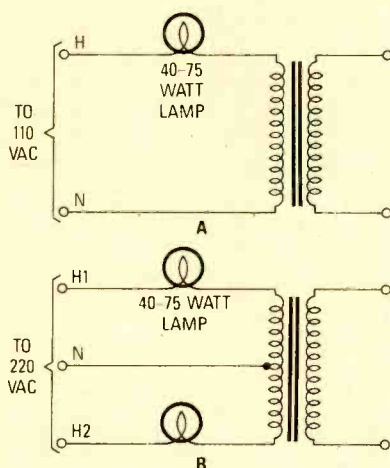


Fig. 1. High voltage transformers can be made to heat slightly without reaching their full potential by putting their primaries in series with a light bulb. For 110-VAC transformers only one lamp is needed (A), whereas 220-VAC transformers require two lamps (B), one for each hot lead.

fahrenheit. That temperature range is low for a kitchen oven, and some might not be able to remain that cool. Higher temperatures will dry the set out faster, but they will also melt some of the plastics used in it—so beware. complete drying takes several days, or perhaps as long as a week.

Another alternative is to place the unit in a large enough box made of cardboard or other material and use several hundred watts worth of incandescent lamps to provide heat. Use a thermometer inside the enclosure to ensure that the 130 degree "melt limit" is not exceeded, and that the box doesn't catch fire from neglect. Again, up to about a week is needed—although I have dried out a car radio that was dropped in fresh water (for a few minutes) in only one day.

The Big Test. In some cases, the only way to test a device is to turn it on and look for smoke. I prefer a more conservative approach: My first step is to disconnect the DC power supply. That can be absolutely essential to the future health of the item being repaired—especially those with high-voltage power supplies.

Without connecting the set to AC power, connect a bench-top variable power supply to the circuitry that was previously connected to the internal power supply. It is essential that you use a DC power supply that will provide the same voltage(s) as the original internal supply, and that is definitely current limited. Set the current limiting control for a short-circuit current only a little above the normal operating current of the circuit under test and slowly bring the DC voltage up to the operating voltage of the unit.

Why go to such trouble? The reason is prevention of secondary damage. There is almost inevitably a short circuit or other condition that draws lots of current. If such a condition exists in the equipment, then the internal power supply normally used would probably produce enough current to burn up components, and printed-circuit board traces. After the circuit is slowly brought up to its proper voltage level, then you can check out the unit's own power supply and (if working properly) reconnect it.

Power Supplies. The low-voltage DC power supply should be checked out separately, especially if it uses a series-pass regulator (many sets do these days). If the regulator circuit is not working, then several possible faults can connect the rectifier output to the regulator output; such as having a series-pass transistor shorted or hard biased to full on. Since the rectifier voltage is always higher than the regulator output voltage, it can damage circuits that were just pronounced healthy if connected without checking.

High voltage (or HV) power supplies have special problems all their own. Small amounts of moisture that are no problem in low voltage supplies will zap a HV supply into never-never land. One big trouble spot is the HV transformer. If moisture has penetrated it, then it may have to be replaced. It might help to provide some extra drying for the transformer, but be prepared to replace it. Figure 1 shows a method for drying a

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GIZMO[®]

VOLUME 3
NUMBER 1

A CHRONICLE OF CONSUMER ELECTRONICS

FYI, PDIS

RICOH PORTABLE DIGITAL INFORMATION SYSTEM. Manufactured by: Ricoh Corporation, 155 Passaic Avenue, Fairfield, NJ 07006. Price: \$540 (MC50), \$510 (IM-A), \$540 (IM-F50).

Imagine this: *Your one-man, high-tech, state-of-the-art expedition to the top of Mt. Kisco has at last reached the summit. You unslung your laptop computer from your shoulder, fire up the word processor, and type the words, "I MADE IT!" After printing out the message on "the world's smallest laser printer" (so small that you can carry it around strapped to your wrist, but you have to fold up the paper supply into little squares to get it in) you unclip your cellular phone from your belt and, connecting to it your portable fax unit, dial up your sponsor, The Gizmo Thrifty Nickel-Times-Picayune and Sun and transmit to them a copy of your triumphant announcement. Then, whipping out your sub-miniature ...*

Ricoh's PDIS (Portable Digital Information System) consists of four parts. Central to the system is the MC50 scanner/copier module. Connected to the IM-F50 fax module, or the IM-A image controller/scanner module, the first becomes a scanner for fax or image digitizing (and computer storage) or an output device for either of the two. If you also have the MP30 overhead projector, you can use the MC50 to prepare transparencies for it. We tried out everything but the overhead projector, and having seen that demonstrated by Ricoh we can attest that it, too, works. The PDIS system should be able to do everything we described in the situation we—somewhat facetiously—set up in the opening paragraph except the laser-printing part.

It would be easy to be cruel to the PDIS system by comparing it to other, full-scale, units for faxing, copying, digitizing, etc. However, the first letter in PDIS stands for "Portable," and the measures necessary to attain that portability must be taken into account. When that is done, the Ricoh PDIS meets most of its design goals. It is not intended for permanent



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installation in an office or even a home, where larger units will serve better. However, the PDIS' portability opens up areas of use that are not possible with those larger devices.

The MC50 scanner/copier measures 12 × 6 × 1¼ inches and weighs three pounds, battery included. It can scan a maximum area approximately four inches wide by six inches deep. The top and bottom of the unit are made of transparent material, and the scanning head faces down and moves between them. You look down through the transparent top to place the scanning "window" accurately over the area you intend to copy or otherwise process. A yellow border marks the bounds of the scanning area. Scans can be set for three lengths: 160 mm, 130 mm, or 65 mm. A shorter scan conserves consumables such as paper and the electricity stored in the unit's rechargeable battery pack.

The scanner is equipped with two print-

density controls, one marked READ and the other marked PRINT. While both can be used when the MC50 is used as a copier, the reason there are two controls is that when the unit is used as part of a fax system, one of them adjusts the density of the image being scanned for transmission, while the other adjusts that of the image being received. The "lighter" end of the scale is marked with a hollow (the body of the MC50 is gray) half circle and the "darker" end with a white-painted one. It sometimes took a good deal of effort on our part to remember that "white" was dark and "gray" was light; however, since we seem to be somewhat dislexic when it comes to icons, you'll probably have an easier time of things.

The MC50 accepts 30-foot rolls of thermal paper. That is not our favorite medium, since it tends to be fragile and somewhat volatile. However, "thermal" seems to be the word in faxing, and the

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Sound-on-Sound Video

JVC HR-S8000U SUPER-VHS VCR.
Manufactured by: JVC Company of America, 1111 W. Artesia Blvd., Compton, CA 90220. Price: \$1599.

While the video portion of home VCR's has constantly been improved through the years, progress in the audio section has lagged far behind. We have—or have had—Betamax, VHS, Super Beta, VHS-HQ, Super VHS, 8mm, Hi-8, and undoubtedly a few other video formats that escape us for the moment. The capabilities of the best of those systems surpass the standards set forth for broadcast video. And, as a convenience to the home producer, many decks (and even camcorders) today include features such as edit switches that bring into play peaking circuits to give the video a little tweak before it sets off on its trip from one tape to another. Even VCR's that were not designed to be "editing decks" have a few niceties that get them at least partway there.

VCR audio hasn't fared as well. To begin with, the speed of a videocassette tape at SP (Standard Play) speed is 1 1/4 inches-per-second—slower than an ordinary audio cassette's 1 7/8 ips—and at the EP (Extended Play) speed it is a third of that, or 7/8 ips. That does not lend itself to the cause of fidelity or signal-to-noise ratio. Early on, twin longitudinal tracks for stereo were added, as was Dolby B noise reduction to keep tape hiss at bay. That still did not, however, do anything to improve audio frequency-response, which typically has a range of from 70 Hz to 10 kHz.

Then came VHS Hi-Fi. (We'll ignore the Beta side of things for simplicity's sake.) That system records stereo sound at videocassette speeds with almost the fidelity and dynamic range of a compact disc—essentially flat response from 20 Hz to 20 kHz with a dynamic range of more than 90 dB. Wow! The VHS Hi-Fi signal is recorded along with the video—actually, underneath the video—on the large video portion of the tape. Usually, an "old-fashioned" longitudinal audio track is recorded as well, at the

edge of the tape, for compatibility with non-Hi-Fi decks.

Now, here come the "gotchas." First of all, video and Hi-Fi information are inextricably intertwined; you can't mess with one without messing with the other. If you erase the video, you also erase the Hi-Fi audio, and you can't change the audio without erasing the video. Second, on most Hi-Fi decks, the longitudinal track is mono only, and linked to the Hi-Fi track. It is a convenience only, put there just for those who may have to play the tape on a deck without Hi-Fi capabilities.

Now comes JVC, with its HR-S8000U. One of the things that sets this VCR apart from most of the rest of the pack of Super-VHS decks is that it provides you with independent control of the Hi-Fi and longitudinal audio tracks. You are still stuck with the inseparable video and Hi-Fi tracks, and if you want to change one you have to change the other as well. But with the HR-S8000U you can do something altogether different on the longitudinal mono track, and as you play back the video you can do so with your choice of tracks: Hi-Fi stereo, longitudinal mono, or a mix of both!

You can, for example, record a narration or commentary on the longitudinal track to complement the sound on the Hi-Fi one. If you don't like it you can erase it and start again without affecting what's on the Hi-Fi track. On playback you can listen to either of the tracks independently, or to a mix of the two that would superimpose your narration over the Hi-Fi track. You can also use that track-independence to record off-the-air SAP (Second Audio Program) sound on the longitudinal track while getting the main-channel audio on the Hi-Fi one. Provision is also made for recording simulcasts, where the video may come over the air or from a cable feed while the audio is derived from an FM radio broadcast (and presented to the VCR from your receiver as a line-level signal). Of course, if you don't need any of that, you can record the same audio signal on both tracks, although the longitudinal one will be monophonic.

Those independent audio tracks present the creative videotaper with a lot of flex-

ibility. It would have been nice had JVC included a level control for the longitudinal track, and maybe even made it stereo rather than mono, but perhaps that's asking too much of a VCR that wasn't really designed to be an editing/mixing deck. Still, would it have been *that* much trouble to ... ?

The HR-S8000U comes with all the usual S-VHS features (which you can read about in other magazines that specialize in presenting lists of such things), together with a few that you won't find everywhere else.

It is one of those VCR's with lots and lots of solid-state memory built into it, and as part of the "what-else-can-we-do-with-all-that-RAM?" game, JVC has included several novel features, some more useful than others. One of the more useless ones is a "zoom" effect that allows you to enlarge a portion of the picture on the screen. The first press of the ZOOM button blows up the center of the picture to fill the screen, and subsequent presses expand the corners in turn. The problem is that you can't use this technique on an image frozen in memory; you have to use it in real time. That, of course, means that if the camera moves or a cut is made from one scene to another, you find yourself suddenly looking into empty sky or at someone's eyebrow, or at something other than what you had been concentrating on a moment before. Well, if you don't like it, you don't have to use it.

Other digital features provide two levels of "mosaic" effects, where the picture is broken up into low- and lower-resolution versions made up of tiny squares (or of huge square pixels, depending on which end of the microscope you're looking through); and two levels of solarization, wherein a contoured "arty" effect is created by restricting the number of color shades and brightness levels that can be displayed on the screen.

The HR-S8000U uses its ability to put up to sixteen pictures on the screen at once (in a four-by-four array of small windows) to perform a function JVC calls "Multi-Screen Intro Search." You can have the deck run quickly through a tape and, when it encounters an index mark (either the one included automatically whenever a recording is started, or one of those you are permitted to add), slow down and display the picture it encounters in an on-screen window. After two minutes (or earlier if you give the command), the picture is automatically frozen in the window in memory until, at the end of the tape, you have as many as sixteen on-screen boxes displaying the beginning of each of the indexed segments on the tape. If you then leave the deck alone, it will rewind the tape to the beginning and record several seconds' worth of that multi-image picture at the beginning of the cassette, providing you with a kind of table of contents on tape. That feature will be of little value if your

tape contains nothing more than two weeks' worth of *Jeopardy* (which always opens the same way), but it can otherwise be quite useful.

The HR-S8000U's remote-control unit is a flat, square, cigarette-case-size box, most of whose controls (and there are quite a few of them) are normally concealed by a hinged cover. We especially liked the unit's remote-programming capability. That is, you can take the remote control and a copy of your favorite program-listing publication into a place where you can spread everything out, and program—on the remote, using its built-in LCD screen and built-in RAM—up to four recording sessions. Then, when it's convenient, you point the remote at the VCR and upload this programming information into *its* memory. A valuable feature, particularly for the nearsighted who can now push buttons and see confirmation of their programming without constantly having to put on and take off their glasses!

The HR-S8000U worked well for us, and it has some very useful features, particularly in its audio section, not to be found elsewhere. We're going to miss it when we have to return it to JVC. ■

Elsie, de TV

CITIZEN DD-P226 LCD COLOR TV. Manufactured by: Citizen America Corporation, 2020 Santa Monica Boulevard, Suite 410, Santa Monica, CA 90404. Price: \$249.99.

It used to be that you could tell you were in a New York taxicab by the pencils stuck into holes punched in the padded dashboard and by the transistor radio propped up on top of the dashboard. More and more frequently, it appears, that little radio is being replaced by an almost-as-little TV set.

One of those little receivers is Citizen's DD-P226, a 2.6-inch-screen color set that fits, albeit somewhat bulgingly, in the pocket of a typical sports jacket. If TV-on-the-spot is what you've been looking high-and-low for, the one-pound-with-batteries DD-P226 may be the answer to your prayers.

The DD-P226 tunes both the VHF and UHF bands; the channel is indicated by a small sliding bar (which is actually part of the display) that moves as you spin the set's convenient tuning knob. The color of the bar changes to indicate whether the band switch is set to receive VHF or UHF. Under some lighting conditions we found that we had difficulty in making out the indicator. The sensitivity of the tuner was very good, and much of the time we did not even have to extend the telescoping antenna when we were using the set in the upper



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portion (channels 7-13) of the VHF band.

There are two types of color-LCD screens in production—the active-matrix type, where each color pixel is individually controlled by a minuscule transistor fabricated on the LCD device itself, and a less-sophisticated type using older LCD technology. The Citizen set uses the older technology, and, while the picture is not bad under good conditions, it could be a lot better. For one thing, contrast is lacking—there just isn't enough *snap* to the picture and, in our unit at least, colors lacked richness and were not very well saturated. LCD's in general are not known for their contrast range, and although the screen of the DD-P226 is, without question, quite an improvement over the LCD TV screens of a few years ago, it is definitely not state of the art.

Another problem with the display arises from the fact that the picture elements of an LCD that doesn't use active-matrix technology are somewhat slow to respond to change. That results in an image lag that shows up on the screen of the Citizen set as both smear and flicker on moving objects. On such a small screen that won't give you a headache, but it is rather distracting and can be something of an annoyance if you watch for any length of time.

The screen is backlit by a very small fluorescent tube, which is on whenever the set is on—a source of extra drain on the battery. The backlit-only display makes it

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CIRCLE 53 ON FREE INFORMATION CARD

Ode on a Welsh Urn

CERCA 2000 OMNIDIRECTIONAL CERAMIC SPEAKERS. Distributed by: ANTECA (Asti Nikko Technology Corporation of America), 5816 Corporate Avenue, Suite 170, Cypress, CA 90630. Price: \$1699.95 per pair.

The inhabitants of the British Isles have, over the years, come up with quite a few products that we over here on this side of the Atlantic consider to be somewhat quaint and ... er ... novel. Among those can be counted the MG, haggis, and Monty Python's Flying Circus. A recent candidate for inclusion in that category might be a speaker system manufactured in Wales by *Pearl & Oakley Acoustics Ltd.* and distributed here by ANTECA.

What qualifies the *Cerca 2000* speaker systems for that honor are their enclosures. In the past (and perhaps still) speaker systems have been encased in such materials as concrete, wooden shells filled with sand (the original Wharfdales), and

Italian marble. Those unusual packaging have not been chosen so much for the sake of beauty or other artistic merit as they have for their acoustic properties, the idea being to enclose a system's speakers in a non-resonant housing to prevent the coloration of the sound they produce. If the speaker enclosure vibrates, it acts as a transducer in itself, but its "output" is far from true to the original waveform. That distorted version of the amplifier's output is what adds "color" to a speaker's sound, and the less an enclosure vibrates, the less affected the output of the system will be. In response to the quest for a non-resonant enclosure, the *Cercas* are housed in ceramic urns.

The system we auditioned is called the *Victoria*, and it is packaged in a 35-inch-high ceramic "ginger-jar" enclosure with an antiqued-glaze (crazed) finish available in off-white or black. (The *Cerca* literature hints that if you supply a piece of fabric from your present furniture, a pair of ceramic enclosures can be finished to match it. The price for that service is not mentioned.) The design is a rather pleasing one, although, with its 360-degree vertically striped grill cloth, the system at first

reminded us of what the result of a mating between R2-D2 and a very large mushroom might look like.

If ginger jars do not fit in with your decor, the *Classic* model is a more modern design. There is also a smaller system called the *Cerca Hi* that hangs from the ceiling like a planter.

According to Pearl & Oakley, the *Cercas'* urn-like ceramic enclosures have several advantages over more traditional, boxlike, wooden ones. For one, they say that, since there are no corners, "there are no parallel walls or right angles, which negates standing waves and sound coloration." They also say that, since the ceramic material is the world's second hardest substance next to diamonds (*But what about Carborundum?—Editor*), there is almost no flexing within the cabinet: "The sound comes out faster and much cleaner," and "phasing (phase interference) is eliminated because there is no sound delay."

While the quality of the sound output by the *Cerca* system is not bad at all, we beg to differ with Messrs. Pearl and Oakley on several of the above points. First, just because a material is hard does not mean it is inflexible. Hardness and flexibility are two entirely different concepts, and a "hard" material can flex quite a bit. For another, echoes and standing waves can occur just as easily in curved environments (especially those with hard walls) as in straight-line ones; to wit, the famous "whisper chambers" or "whisper lines" in a number of historic structures, such as the rotunda of the Capitol building in Washington, DC.

And ceramics, as well as other vitreous materials, both transmit sound and resonate very easily. That is in the nature of crystalline materials such as ceramics, and those qualities are not in the least desirable in a speaker enclosure. Snapping a finger sharply against the *Victoria's* "ginger jar" enclosure yielded exactly the result we expected—a sort of dull *ping*. A truly non-resonant material would have produced a flat *thud*, at most.

The output of the *Cerca* speakers was almost exactly what we imagined it would be. Although it was ample, it was not a massive sound. That is no doubt due in part to the speakers' relative inefficiency—sensitivity (one watt at one meter) is only 86 dB—and we took to setting the volume control on our amp somewhat higher than we would have with our usual speakers. The sound also acquired a ... well ... *ceramic* quality. That is, rather than having the "warmth" associated with the coloration added by wooden enclosures, the *Cerca* sound was a bit cool (to some ears that might represent a lack of coloration) and flat, a rather hard sound. To us it was the musical equivalent of the dull *ping* mentioned earlier. For some types of music (string quartets come to

mind) those sonic characteristics can be desirable.

The Cerca speaker systems are sold as matched pairs. The matching extends to the outputs of the speakers themselves, whose frequency responses are within 2 dB of each other, and to the color of the ceramic finish. Interestingly, part of the matching process is done by weight—the closer the weights of two of the 15mm-thick “urns” are, the closer their performances will match. Another curious fact is that the resonant characteristics, such as they are, of the ceramic vessels can be altered by changing the temperature at which they are fired. The version of the enclosure now in use exhibits a slight peak in response a bit above 400 Hz.

The Cerca speakers are equipped for bi-wiring, a popular method of speaker connection among audiophiles in the British Isles, and one that is gaining in popularity here among our own audiophile community. In a bi-wired system, the leads to the low-frequency driver, and those of the mid- and high-frequency ones, are brought out individually. Separate amplifiers are used to drive each section, thus eliminating at least one high-level crossover network where distortion can occur, and raising the quality of the sound output another notch. If you don't use the speakers' bi-wiring capability, the two sets of binding posts can be jumpered, as they are when you unpack the speakers.

The design of the Cerca system permits you to place the speakers near a wall or in the center of the room, perhaps flanking a sofa. Sound is radiated omnidirectionally. Bass from the system's 6½-inch low-frequency driver is emitted from the base of the enclosure (it's recommended that you not use the Cercas over a carpeted floor, which would absorb much of the low-frequency energy fired in its direction). Sound from the 5-inch midrange driver and the 1-inch metal-dome tweeter are dispersed through 360 degrees by ceramic deflector cones within the enclosure and exit through the striped grill cloth. While we generally do not trust “omnidirectional” speaker systems, we found that as we moved about the Cercas, which we had placed in a more-or-less central location in our listening area, the instruments remained surprisingly well localized.

That is as the designers of the Cerca system intended, for their initial goal was not to produce a piece of furniture, but to design an omnidirectional speaker system. (Indeed, the idea for a ceramic enclosure came about from that of using a ceramic material for the omnidirectional deflectors.) While the “ceramic” quality of the Cerca sound may take a bit of getting used to, the speakers' sound-dispersion characteristics make them worth looking into if you want a system that does not tie you into listening from a single location while it enhances your decor. ■



Something so Right

KENWOOD CP-C7 PORTABLE CASSETTE PLAYER. Manufactured by: Kenwood Electronics (Division of Kenwood U.S.A. Corporation), 2201 East Dominguez St., Long Beach, CA 90890. Price: \$259.

Sometimes the minute you lay your eyes on something, or take it in your hands, you know that *this* is it—that you have encountered an object of such *rightness* that the two of you were made for each other. That's the way we felt about Kenwood's compact portable cassette player, model CP-C7 as soon as we took it out of the box. Not only did it feel right in our hands, but use and examination proved it to be a superior performer into which a lot of thought and planning had obviously been invested.

To begin with, the CP-C7 is small—about the size of a lady's cigarette case. While not heavy (it weighs just under 6.9 ounces) the unit has a nice comfortable heft to it—it's encased in black anodized metal, not plastic. The CP-C7 is normally powered by one of the new generation of small rechargeable nickel-cadmium cells, shaped sort of like half a pack of Wrigley's chewing gum. That cell, which resides inside the player and recharges in about five hours, is said to be able to power the player for about three-and-a-half hours; our use gave no indication that that was not the case. If you need a longer running time between charges, the player comes with a

clip-on holder for a single “AA”-size alkaline (or other type of) dry cell. When attached to the player, that extends its useful life (it trickle-charges the rechargeable cell, we were told) to over twelve hours. While the Ni-Cad will handle most normal commutes, adding the dry cell will keep you in music even if your place of work is several time zones away.

The dual-capstan tape transport allows for auto-reverse operation. When the player reaches the end of the tape, it reverses direction, switches to the other side of the playback head to pick up the other pair of tracks, and plays the other side. That feature can be switched off with the remote control, which we'll discuss below. All tape-transport operation is logic-controlled. That is, there's no mechanical linkage between any of the pushbuttons and the transport mechanism. Instead, each button simply sends a signal to a decoder IC, and from there another signal is generated that causes the requested action to take place.

The CP-C7 includes several features not found on many run-of-the-mill portable cassette players. A “bass-boost” switch adds extra kick to the low frequencies. We did not expect that feature to be as effective as it was; we expect to *feel* those low frequencies in the gut, not in the eardrum. However, the extra bass was easily apparent, and did seem to be more than just an extra tickling of the tympanic membrane.

We really appreciated the inclusion of both Dolby B and Dolby C noise-reduction circuitry. Although prerecorded tapes usually don't use Dolby C, the ones we make for ourselves from CD's and other

sources do. It's a pleasure to be able to listen to them without experiencing any of the shrillness or hiss that are apparent when playing Dolby C material through a Dolby B circuit. (The Dolby C decoder, by the way, is an honest-to-God Dolby C circuit on a chip, not just a second Dolby B circuit run in conjunction with the first one.)

The bud-type earphones that come with the player are a story unto themselves. When we unpacked them we thought at first that whoever had assembled and packed them had been drinking on the job—the cord for the left earpiece was only a few inches long, while that for the right one was more than a foot-and-a-half in length. And, search as long as we might, we could not locate the foam covers that we felt sure should have gone over the earpieces' fine metal-screen protective covering.

A phone call cleared that up: Everything was as it was intended to be. There were no foam covers because they tend to absorb some sound energy that should be reaching the ear. To ensure purity of sound, it was explained to us, audiophile earbuds do not use such covers. While we can accept that explanation, we feel that for practical reasons such pads should have been included with the phones. Without them, there is a tendency for dust and small particles of dirt to get into the transducers through the metal screen, resulting in annoying rattles, buzzings, and distortion at medium-to-high sound levels. If you are in the habit of stuffing the player and phones into a lint-filled pocket, you might find that a particular problem. Fortunately, if you don't mind a small—and probably mostly undetectable—loss in frequency response, you can pick up a pair of foam covers for a couple of dollars in most places that sell audio equipment. Whatever loss in fidelity might result will be more than compensated for by the absence of rattle, etc.

The disparity in lead lengths results in the main part of the earphone cord hanging down the left side of your body, rather than straight down past your bellybutton. There are a couple of benefits from that, at least if you're right-handed (lefties like us will just have to put up with that minor inconvenience, unless we'd rather wear the left earpiece in the right ear and vice-versa). First, of course, is the fact that with the cord on the left, you have more freedom of movement on the right side. Also, the offset gives you more cable to reach to the player when it is in its case and attached to your belt. (We found the best position to locate the unit to be at the small of the back; that's where we experienced the least speed variation when walking.) And, it is said that the wire arrangement makes wearing the phones under a motorcycle helmet more convenient.

The phones have an in-line remote con-

trol partway down the cable. The lightweight box has a clip that allows you to fasten it to your shirt, blouse, or jacket. In addition to providing you with a volume control (which works in series with the one in the player itself) the remote has buttons marked *PLAY/DIR.*, *STOP.* and *FF/REV.* The second function, where two are indicated, is invoked by pressing the button twice in succession. When you press a button you hear a beep in the phones, indicating that the player has received the command from the remote.

Overall, we were quite pleased with the operation of the remote. Our only difficulty with it—aside from occasional confusion as to the direction in which the tape was moving and which side was being played, and wondering whether fast-forwarding when playing the flip side of the tape with it moving in the reverse direction took us to the beginning of the tape or to the end—came with using the player while lying down. There is a sort of ridged depression on the remote in which the buttons lie; that is intended to keep them from being depressed unintentionally. Unfortunately, the depression is not deep enough, and we sometimes rolled over or accidentally leaned on the remote and inadvertently stopped the tape or sent it into fast-forward. We soon learned to look out for the location of the remote before we made a move.

Our only other quibble with the CP-C7 concerns its case, which seems to have been designed by someone less ergonomically minded than the praiseworthy individual responsible for the player. First, though, the case, which has a loop for attaching it to a belt, does have a couple of nice touches. Enough room was built into it to accommodate the player with its clip-on dry-cell adapter. Also, the case's closure flap has a pocket in it. That may have been intended to hold the phones, but we used it to carry a second cassette. However, there are no holes in the case. That is not a problem for the earphones, whose jack is at the top of the player and whose cord can just slip under the cover, but there is no hole in the bottom of the case, where the power jack is. You have to take the player out of its case to recharge it, which we found to be a nuisance. It's really not such a big deal, but for \$250 you'd expect that Kenwood could afford to punch a little hole in a vinyl case.

Those few minor inconveniences aside, we found the CP-C7 to be an excellent performer in terms of sound and ease of use. With its price tag it is not for the kids, but it will certainly appeal to those of us who appreciate the finer things in life, both aesthetically and in engineering terms. While "class" is not a word encountered too frequently in the world of consumer electronics, it's certainly most applicable in the case of the CP-C7. It is first class in every sense of the word. ■

LCD-TV

(Continued from page 3)

nearly impossible to view a picture in direct daylight, although it does ensure consistency of color independent of ambient light conditions. A "brightness" control at first appears to control the intensity of the backlight, but actually affects the way light is blocked by elements in the LCD. The angle at which you view such displays is very critical, and the "brightness" control actually serves to optimize the contrast of the picture for the angle at which it is viewed.

While the DD-P226 can be handheld, of course, it is provided with an integral stand that can be set to provide a number of different viewing angles. Just right for dashboard propping.

For an itty-bitty TV, the sound from the 1-inch speaker was quite good. It was far from being high—or even middling—fidelity, but it was intelligible and did not grate on the ear. There's an earphone jack for those who prefer to listen that way. We had difficulty in remembering which of the two knobs on the side was for volume and which was for brightness, but since they are at different heights and since one is further forward than the other, a little practice should suffice to familiarize the user with which is which.

The DD-P226 comes with an AC adapter that plugs into a jack in its side, but it can also be operated from batteries or an automotive cigarette-lighter-receptacle adapter. The unit comes with five AA-size "test" batteries (it requires 7.5 volts for operation), which it drained completely dry in about twenty minutes. Citizen claims that a set of alkaline AA batteries will last 2½ hours, which proved to be pretty much on the mark in our tests. The receiver draws a substantial amount of current, and the batteries (and the back of the set) warm up a bit after it has been in use for a while. That condition, fortunately, turns out to be not nearly as alarming as it first appears.

The DD-P226 can also function as a video monitor, for use with a color camera, a camcorder, or a portable VCR. A jack allows the connection of an (optional) audio/video cable for that purpose. Another jack allows an external antenna to be connected for when the set is used in weak-signal areas.

With the exception of its somewhat wishy-washy screen, Citizen's DD-P226 is a pretty good portable receiver. And, given the fact that even the best of today's color LCD screens are far from being "great," even the picture from this set is not all that bad.

One thing puzzles us, though. The box the set came in claims it is an "LCD-TV for personal communication." That's nice, but with whom, pray tell, are we communicating? ■

Behind Closed Doors

HIDDEN LINK REMOTE CONTROL RELAY SYSTEM. Manufactured by: Video Link (a Division of Xantech Corporation), 12950 Bradley Avenue, Sylmar, CA 91342. Price: \$49.95.

"Building things in"—into the walls of your house, into closets, into furniture—seems to be the "in" thing to do today. Maybe it's because people don't want anything extraneous intruding on their carefully chosen decor. Whatever the reason, many decorators (and would-be decorators) have taken to locking up audio and video equipment in pieces of fine furniture such as antique armoires. Sometimes those cabinets—at least the ones specially designed for the purpose—have glass or plastic doors through which you can observe the operation of your equipment, and through which your equipment can receive signals from your remote control. But if your equipment's new and trendy home was not originally intended for the purpose to which you are now putting it, a couple of problems can arise.

The first is that, although solid-state equipment generates far less heat than its vacuum-tube equivalent would have (how many 12AX7's do you suppose would be required to build a frequency-synthesized tuner?) it can still throw off quite a bit. Unfortunately, Thomas Chippendale and his successors, in designing their antiques, neglected to take into account the possibility that you might be using them to house 120-watt-per-channel amplifiers and provided no facilities for ventilation in them. (In the 1950's, there was a short, but rather active, interest in building TV receivers—all tubes in those days—into walls. We don't think many of them lasted too long, although they may have cut down on heating bills while they still worked.) Make sure that you provide for air flow in such enclosures to ensure a long life for your equipment. There should be openings near the bottom for air to enter, and near the top for it to exit, and shelves should not block passage of the heated air as it rises.

A more immediate problem than overheating arises from the fact that, while your equipment is now cunningly disguised behind the facade of fine furniture, it is also now inaccessible to your remote control's infrared beam. The solution is a little device from the Videolink division of Xantech Corporation called Hidden Link. Hidden Link is an infrared repeater. A repeater, as its name may imply to you, is a device that listens for a signal and then retransmits, or repeats, it. Something, such as signal strength, is usually added in



CIRCLE 55 ON FREE INFORMATION CARD

the process. The use of a repeater may also involve such things as shifting frequencies or overcoming obstacles, as is the case with the TV translators used in many out-of-the-way parts of the country.

Hidden Link is housed in a tiny (1/8-inch-high by 3/8-inches-wide by 2-inches-deep) case with a semi-transparent red faceplate. You sit that little box atop the cabinet housing your equipment. From the case extends a cable about the same gauge as a piece of thin speaker wire to which are attached two infrared-emitting LED's. You thread the cable through a small hole in the equipment cabinet (or just around to its back if it is of open-back construction) and place the LED's, which are in self-adhesive mounts, so they can illuminate the infrared receptors on your equipment that normally receive signals from your remote(s). The Hidden Link's nine-volt AC adapter plugs into a convenient outlet. Its power consumption is minimal, so there's no ON-OFF switch.

The way the device works is very simple. You aim your remote control at the Hidden Link receiver sitting outside the equipment enclosure. The receiver winks a red LED at you to acknowledge that it is getting the signal from the remote, and converts the light pulses into a low-voltage electrical signal that causes the infrared LED's at the end of the cable to pulse in the same fashion as the ones in the remote. That signal is received by your hidden equipment and, *bingo!*, there you are.

The two infrared LED's that come with the unit seem quite powerful. We tried them outside an enclosure and the operating range—both of the receiver and of the LED's—was at least as good as what we got from our unassisted remote control.

The LED's seem quite powerful, and you could probably get good coverage and operation inside a cabinet by bouncing their light from an interior surface rather than trying to aim them directly at the equipment you want to control. Having two LED's at the end of the cable is a nice convenience; if there's an obstacle in your equipment cabinet you can put one emitter on one side of it and the other one on the other. If you need a longer cable than Video Link provides between the receiver and the LED's, it is a simple matter to cut the original and splice in an extra length of speaker cable.

You can even put the Video Link receiver in one room and the LED senders in another if you want to control equipment *that* remotely. And, if the sight of even the small black receiver cabinet upsets you, you can mount it inside your furniture along with the equipment it is to control, looking out at you through a small peephole. (In fact, Video Link also manufactures an in-the-wall version of Hidden Link, called *Xtra Link Custom System*, for house- or apartment-wide routing of infrared command signals.)

Hidden Link performed well for us, but we wish the manufacturer hadn't used identical connectors (ordinary miniature phone plugs and jacks) for power and the LED cable. It's too easy to plug in the wrong thing and, although the instructions imply that no harm will be done if you do so, it would have been extremely simple to avoid the possibility of a mixup by using different-type connectors in the first place.

The receiver is also susceptible to triggering by bright light: as we accidentally pointed it out the window the red "confirmation" LED began flashing madly, in-

dicating that the unit was receiving something (not from us!) and retransmitting some kind of garbage. In all likelihood you will not encounter that problem in the usual subdued-light interior installation, and even if you do it probably won't affect the operation of your equipment.

But that flashing red LED can be annoying, so we modified our Hidden Link receiver to blind it to light other than infrared and thus eliminate at least most of the spurious signal reception and retransmission. We did that with a small piece from the black tail of a roll of Kodachrome film we found in a box of transparencies, placing it inside the receiver's case in front of the IR receptor. That material, while opaque to visible light (that's why it's black) is transparent to infrared and makes an excellent filter. If you try that trick, remember that the material *must* be Kodachrome—other types of slide- or black-and-white film won't work.

And that's how to use your remote control even with equipment you've hidden stylishly out of sight. Now what you need is a digital-clock repeater so you can read the time that's displayed on the front panel of your VCR. ■

FYI

(Continued from page 1)

process certainly is quiet and does not demand excessive power. The MC50 also accepts special 4 × 6-inch sheets of "real" paper, which come with a thermal transfer sheet akin to carbon paper, attached. To use that material you have to unthread the thermal paper and feed the sheets individually into the print mechanism. When the transfer sheet emerges, you discard the black "ink" sheet after use and are left with a "plain paper" copy or fax. In view of the thermal medium's fragility, you might want to use it to receive faxes conveniently, and then copy the ther-

mal faxes onto the transfer-type medium for permanence. The reproduction was quite good, particularly in large black areas.

The maximum four-by-six scanning and reproduction area places some restrictions on the use of the MC50. To copy standard 8½ × 11-inch paper you have to make two passes over the original and then tape the two pieces of output together. Similarly, two passes are required to send a fax of a document that size. However, when you receive a fax from a full-size system, it is reduced in size and the whole page fits on the thermal paper or transfer medium at once. Ordinary typewritten output is easily legible at that reduced size. The results when you send a fax depend on the machine receiving it. Some enlarge the image to fill an entire page, while others sense the original size and reproduce it on the same scale.

In discussing the functions of the MC50 we seem to have strayed somehow into the province of the IM-F50 fax module, which is packaged in a small flat 6 × 6 × 2-inch case, and permits manual or auto-answer operation. It can be connected directly to a modular phone jack (and the phone plugged into it) or it can be inserted in the line at the point where a modular cord plugs into a phone. That latter option may prove convenient if you find yourself wanting to fax something to or from your hotel room. You have to be careful to press the START button on the fax unit, rather than the similar one on the MC50, to start transmitting an image. If you press the wrong one, the system may lock up on you, as it did on us (the manual warns about that, but who remembers such things?)

The final piece of PDIS equipment we tried was the IM-A image controller/scanner. In a case the same size as that of the IM-F50 fax module (which cannot be connected to the MC50 at the same time) is 256K of CMOS RAM for image storage,

the same amount used for faxing. Controls on the digitizer module allow you to manipulate the magnification (from 0.5 × to 2.0 ×) and density of an image, to flop it for a left-to-right reversal, or to store it as a negative or as a halftone with 16 shades of gray for reproduction. You can use the MC50 to output the digitized image directly but there is little sense in that. The IM-A comes with a piece of software called "PDSCAN" that allows to you control it from an IBM-PC-type or Macintosh computer. IM-A images can be stored on disk in several popular image-storage formats and recalled later for printout or for inclusion in a document prepared on Page-Maker, Ventura Publisher, or another desktop-publishing program.

All the PDIS modules operate from rechargeable nickel-cadmium battery packs. The one for the MC50 is removable and can be recharged while you are running the unit from another; the others are built into the modules they power. A full charge is good for about 30 scans.

The MC50 and its associated hardware and software fit into a special niche. They are not for everyone. However, as they are used, new and novel applications are being found for them. For example, in areas where records of migrant workers must be kept, copies of immigrants' "green cards" can now be made right out in the fields, conserving valuable work and travel time.

That opening scenario, which popped into our mind as we were trying out the PDIS, is not as far fetched as it seems. We mentioned it to someone at Ricoh, and he replied that Ricoh really was sponsoring an expedition to climb Mt. Everest (which should have taken place by the time you read this), and that the expedition would be equipped with a PDIS system as well as with other Ricoh electronic and photographic equipment. Ricoh really intends to show that this portable system can be used anywhere. And, apparently, it can. ■

ELECTRONICS WISH LIST

For more information on any product in this section, circle the appropriate number on the Free Information Card.

See Phone

The *VisiTel* visual telephone, a blend of advanced communications technology and easy-to-use features, is as well adapted for home use as it is for business. A product of *Mitsubishi* (5757 Plaza Drive, PO Box 6007, Cypress, CA 90630-0007), the *VisiTel* is capable of transmitting a good quality black-and-white image over standard telephone lines in 5.5 seconds. The 7 × 7 × 7-inch unit contains a video camera, 4.5-inch black-and-white monitor, and several user controls. Its 3¼ × 2½-inch screen can display a 96 × 96-pixel image in 32 shades of gray. To use the *VisiTel*, you pose in front of the camera while observing your image in the monitor. If you're satisfied with what you see, you store it in the system's memory using a VIEW/POSE button. Pushing the SEND button then transmits the stored image to the receiving party. Audio transmission is interrupted during image transmission and resumes afterward. The *VisiTel* stores in its memory the last three images received, allowing you to scroll through them and even to resend them. Price: \$399.

CIRCLE 56 ON FREE INFORMATION CARD



Mitsubishi Visual Telephone

For more information on any product in this section, circle the appropriate number on the Free Information Card.

ELECTRONICS WISH LIST

Macintosh Finder Minder

The publishers of XTree and XTreePro, file-management software for MS-DOS computers, have now released *XTreeMac* for the Apple Macintosh. *XTree Company* (4300 Santa Fe Road, San Luis Obispo, CA 93401) says that XTreeMac "... is not just a collection of separate disk management utilities, or a set of individual tools designed for the PC and transported to the Macintosh, but a completely integrated utility that takes full advantage of the intuitive Macintosh user interface." The program shows a graphic tree-like display of the files on a disk and permits users to locate, copy, move, and delete files from multiple folders, and on multiple volumes, without having to click their way through a series of windows. Using a split-screen display, XTreeMac shows the directory tree on the right side and, on the left, a "visual work surface" called the Deskpad, where files can be gathered and folders manipulated. In addition to its manifold file-management capabilities, the program also provides security features such as the ability to hide, lock, or protect files from being copied. On the Macintosh II, files can be color coded to add another level of organization. XTreeMac also permits users to recover deleted documents, folders, and applications even after an application has been launched, trashed, or the power turned off. Requirements are an Apple Macintosh 512e, Plus, SE, or II with at least one 3.5-inch floppy drive, System Version 4.2, and Finder Version 5.3 or higher. Price: \$99.

CIRCLE 57 ON FREE INFORMATION CARD

Stylish Music Systems

Dual's (122 Dupont St., Plainview, NY 11803) *Manhattan, Atlanta,* and *Queens* integrated sound systems offer European styling combined with high quality and performance. The top-of-the-line Manhattan system (pictured) includes an AM/FM stereo tuner, a 50-watt-per-channel amplifier, a dubbing cassette deck, and a 4× oversampling CD player in a "tower" configuration (that's what gives the system its name). It has full remote control and uses a pair of matched satellite loudspeakers working with a self-contained subwoofer that has its own 50-watt amplifier. The Atlanta is a slim-profile system consisting of a 50-watt-per-channel amplifier, an AM/FM stereo tuner, a double cassette deck, and a CD player. The Queens system also has an AM/FM stereo tuner, a 50-watt-per-channel amplifier, a double cassette deck, and a CD player. It uses a pair of three-way satellite speakers with a separate enclosed subwoofer. Price: \$2500 (Manhattan), \$1095 (Atlanta), \$1095 (Queens).

CIRCLE 58 ON FREE INFORMATION CARD

Talking Translator

Many a traveler has discovered that the phonetic transliterations provided in foreign-language phrasebooks ("*deux œufs, s'il-vous-plait*"—"duh zerfs, sil-verplate") do not make for instant intelligibility. *Seiko Instruments* (2990 West Lomita Boulevard, Torrance, CA 90505) has a product that may let you express yourself more clearly. Its *Voice Station Talking Translator for Travelers*, initially available in French and Spanish versions, contains more than 300 useful phrases for foreign travelers stored in ROM in the form of a digitized voice. The user finds the phrase he needs in a pocket-sized phrase guide, enters the accompanying number on the translator, and listens to the correct pronunciation through a single-earpiece. He then attempts to reproduce with his own voice what he has heard. A REPLAY button allows the phrase to be repeated until the user has the pronunciation perfected, or at least makes himself understood. Price: \$129.95.

CIRCLE 59 ON FREE INFORMATION CARD

Acoustic Space Simulator

Four different types of acoustic space—chamber, church, concert hall, and stadium—can be simulated by a new surround-sound processor/amplifier from *Sherwood* (13845 Artesia Blvd., Cerritos, CA 90701) by means of a variable signal delay to the rear speakers. In addition to those four emulations, the *ES/280* has Dolby Surround Sound, "synereo" (Sherwood's term for "synthetic stereo"), tape monitor, and bypass modes. The 15-watt-per-channel amplifier—which is intended to supplement, rather than replace, existing equipment—has a signal-to-noise ratio of 86 dB in both "synereo" and bypass modes. Price: \$189.95.

CIRCLE 60 ON FREE INFORMATION CARD



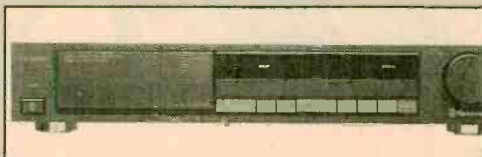
Xtree Company's XTreeMac



Dual Music Systems



Seiko Talking Translator



Sherwood Surround Processor/Amplifier

ELECTRONICS WISH LIST

For more information on any product in this section, circle the appropriate number on the Free Information Card.



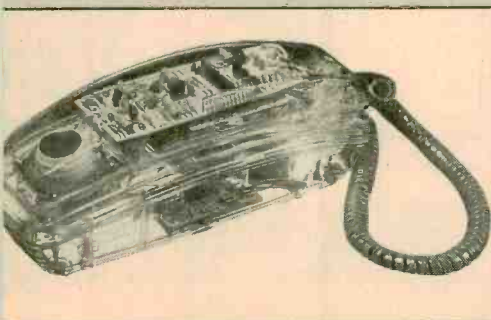
Philips Amplifier



Philips TV-Screen Cleaner



Denon Earphones



Lonestar See-Through Telephone

Super Amp

As part of a limited edition of top-of-the-line audio equipment, *Philips* (One Philips Drive, P.O. Box 14810, Knoxville, TN 37914-1810) is offering its model *DFA 1000 Reference Digital Integrated Amplifier*. This unit, which can accept either analog or direct digital inputs, is rated at 150 watts per channel into 4-ohm loads and 120 watts per channel into 8 ohms when operating in its "Class-AB" mode. Up to 500 watts per channel into 2-ohm loads is also possible. In addition, the DFA 1000 can deliver 20 watts per channel into 8 in "Class-A" operation. The DIGITAL DIRECT function of the amplifier bypasses most controls, thus resulting in a 106-dB signal-to-noise ratio and channel separation of 100 dB. There are 13 inputs and 9 outputs available, including coaxial analog and optical digital inputs. The dual-monaural preamplifier and amplifier sections use separate heat sinks to reduce interference in the power transistors. To further minimize signal degradation, components are placed on a heavily shielded copper-plated chassis with cast-alloy side panels. The DFA 1000 comes with an LCD wireless "universal" remote control that can learn the commands of, and control, ten audio/visual components. Price: \$2,500.

CIRCLE 61 ON FREE INFORMATION CARD

Projection-TV Cleaner

You may not notice it as it happens, but the picture on the screen of your rear-projection large-screen TV gets a little dimmer every day, particularly if you live in an area where the air contains a lot of dust, smoke, or other particulate matter. *Philips Consumer Electronics* (One Philips Drive, P.O. Box 14810, Knoxville, TN 37914-1810) has a way to restore that picture to its original brightness. Its *SBS4100A01 Projection TV Cleaning System* consists of a solid-walnut-handled cleaning brush and a specially formulated cleaning solution. Cleaning solution is applied to the brush, which is then wiped over the screen in the direction of the small grooves molded into it. (Those grooves are where a lot of the dirt accumulates.) The bristles on the brush loosen and remove the ingrained dirt—dust deposits and greasy fingerprints—that have been dissolved by the cleaning solution. Because only one pass is required, the unwanted residue is removed cleanly, not smeared around the screen as it would be by a cloth. The result is a sharp, clear picture. Price: \$29.95 (refill solution, \$9.95).

CIRCLE 62 ON FREE INFORMATION CARD

High Performance Earphones

Two new in-the-ear earphones, the *AH-C6* and *AH-C30*, have been announced by *Denon America, Inc.* (222 New Road, Parsippany, NJ 07054). Both utilize 15-mm complex-polymer diaphragms only six microns (0.000236-inch) thick. Each diaphragm is driven by a voice coil wound from low-mass, high-conductivity, copper-clad aluminum wire. Magnets are fabricated from a samarium-cobalt material. Frequency response of the phones extends up to 22 kHz, and down to 16 Hz for the AH-C6 and 18 Hz for the AH-C30. To attain that low-frequency response, a sound tube and sound board at the rear of each driver are employed. The phones' high efficiency of 106-dB SPL/mW means that an input of 100 mV into their 16-ohm impedance can produce concert-level sound. The phones, which weigh just five grams (not including the oxygen-free Litz-wire connecting cable) come in compact cases designed with an internal cord reel and storage facilities for the phones and their gold-plated connector. Price: To be announced.

CIRCLE 63 ON FREE INFORMATION CARD

See-Through Phone

"The Lonestar Inner Works meets a market demand," says Lawrence Richenstein, president of *Planned Technologies* (485-31 South Broadway, Hicksville, NY 11801). The slim-style telephone, also designated *Model 911*, is encased in clear virgin polycarbonate plastic. Taking advantage of the see-through case, all internal components including the mechanical bell ringer are finished in vibrant colors. LED's that light when the phone rings and a lighted keypad add to the phone's aesthetics. We weren't sure we knew what the market was demanding, but this must be it. Price: Under \$30.

CIRCLE 64 ON FREE INFORMATION CARD

For more information on any product in this section, circle the appropriate number on the Free Information Card.

ELECTRONICS WISH LIST

Built-in Music System

Reminiscent of the old Boulton music system is a new introduction from *Bose Corporation* (The Mountain, Framingham, MA 01701). The *Bose Acoustimass Built-in Music System* is a wired multi-room, high-fidelity, home stereo system that is almost completely hidden from view. The heart of the system is Bose's *AMP-5BP* speaker system. Very small cube speakers, which cover the midrange and high frequencies, are mounted unobtrusively on the ceiling or walls. Low frequencies are generated by a bass module that uses the Acoustimass design to provide good response from a reasonably sized speaker. That module can be installed in a floor, wall, or ceiling—its placement is not critical—with sound output entering the room through apertures such as air-conditioning or heating vents (not supplied). The "front-end" of the system—amplifier, tuner, and playback equipment—is housed in an in-the-wall enclosure that can be included easily in the space available from 2 × 4 frame construction. Volume of each room's speaker system is governed by an in-the-wall control resembling a light dimmer. Speaker placement for optimum performance is calculated in advance by Bose dealers or installers using a CAD program, "Residential Modeler." Price: Typically \$6500-\$8000.

CIRCLE 65 ON FREE INFORMATION CARD

Bag with Headphones

Now you can pack some sound in your picnic basket! *Randix Industries, Ltd.* (Granite Park, Fortune Boulevard, Milford, MA 01757) has premiered the *Model BR 30 Sounds Cool* insulated bag-radio. Bearing the Coca Cola logo on its three sides, the bag-radio holds hot or cold foods and drink. Its built-in, battery-operated, AM/FM radio includes a water-resistant speaker with mesh grill and a headphone jack. Stereo headphones are included. Price: \$49.99.

CIRCLE 66 ON FREE INFORMATION CARD

Wireless Radar Detector

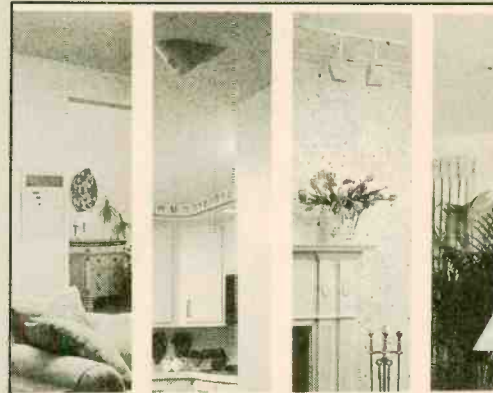
Easier installation is one of the claims made for the *RD-30 Radar Detection System* being marketed by *Maxon Systems Incorporated* (10828 NW Air World Drive, Dept. 777, Kansas, City, MO 64153). The unit's receiver is mounted behind a vehicle's grille and transmits its signals directly on the 49-MHz band to the control module located at the driver's position. That makes it unnecessary to go through the usual laborious cable-routing process associated with conventional remote-mount systems. The detector senses X- and K-band transmissions, including instant-on radar-gun "pulse" signals, and alerts the driver in just 1/8 second. The RD-30 features a dual-conversion superheterodyne receiver with digital signal processing. Radar-signal strength is indicated by a flashing LED and pulsing audio alarm. An audio jack in the portable control module contains an AUDIO jack for an earphone or external amplified speaker. The wireless receiver is powered by three nickel-cadmium cells that can be recharged overnight when it is not being used, or even while the detector is in operation. Price: \$199.95.

CIRCLE 67 ON FREE INFORMATION CARD

Smart Student's Typewriter

Royal (200 Sheffield Street, P.O. Box 1038, Mountainside, NJ 07092) has introduced a lightweight portable electronic typewriter, the *TQ620*, designed specifically to meet the needs of students and for home or small-business use. It features a dual-function keyboard that permits the printing of international language characters and other special symbols. The typewriter also allows printing at three different pitches (10-pitch Pica, 12-pitch Elite, and 15-pitch Micron) for a variety of type appearances, as well as providing automatic underlining, centering, and boldface. Other word-processing features include insert, delete, a one-line lift-off correction memory, and Royal's "Word Correct" feature. Price: \$259.95.

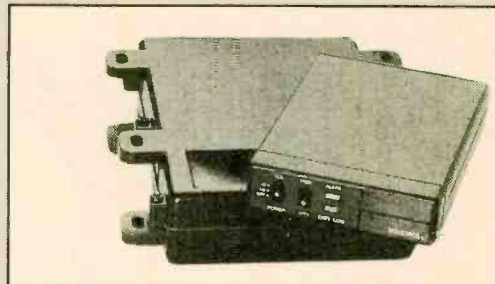
CIRCLE 68 ON FREE INFORMATION CARD



Bose Built-in Music System



Randix Bag-Radio



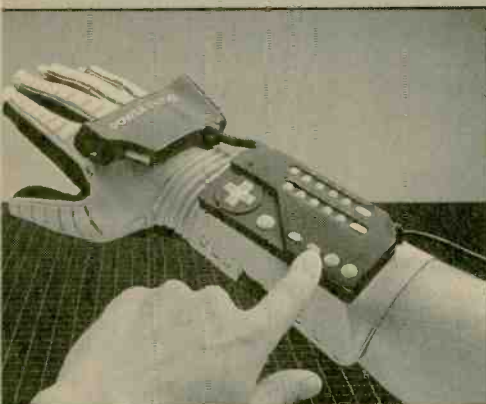
Maxon Wireless Radar Detector



Royal Electronic Typewriter

ELECTRONICS WISH LIST

For more information on any product in this section, circle the appropriate number on the Free Information Card.

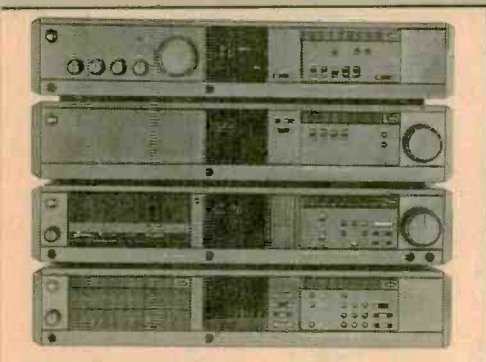


Mattel Power Glove

Power Glove

Shades of Robert A. Heinlein's *Waldo!* *Mattel Toys* (5150 Rosecrans Avenue, Hawthorne, CA 90250-6692) has introduced a *Power Glove* for the Nintendo Entertainment System, an alternative in videogame control it bills as "a better link between man and machine." An adaptation of NASA's original Data Glove system, *Mattel's Power Glove* allows control of all Nintendo joystick-directed games without the use of a joystick. Wearing the glove, the player moves his hand to dictate the action of objects and characters on the screen. Hand movement is transmitted via sensors in the glove that perceive hand and finger positions in three-dimensional space. The *Power Glove* is programmable and allows players to "customize" games by using the hand gestures of his choice to represent joystick motions. The glove can be reprogrammed as often as desired. The glove also contains a keypad that provides such functions as quick access to "slow motion" for difficult games, and "turbo" for rapid repeat action. The *Power Glove* will be available in two sizes. Price: To be announced.

CIRCLE 69 ON FREE INFORMATION CARD

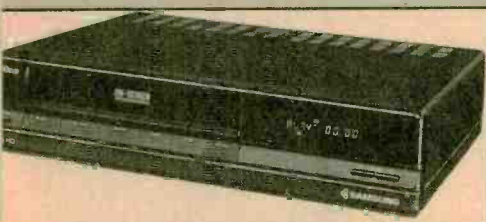


Proton 600 Series

New Audio Components

Human engineering is at the heart of *Proton Corporation's* (5630 Cerritos Avenue, Cypress, CA 90630) new *600 Series* line of audio components. Included are an integrated amplifier with *Proton's Dynamic Power on Demand (DPD)* circuitry and the *Aphex Aural Exciter*; a stereo tuner featuring *Schotz noise reduction*; a *Schotz II* tuner with increased sensitivity and selectivity and better overload handling; a stereo cassette deck with *Dolby B, C, and dBX noise-reduction systems*; a compact-disc player; and an integrated AM/FM stereo receiver with *DPD*. All controls are grouped logically for ease of operation and seldom-used controls are concealed behind motorized panels. A single remote-control unit controls all components of the system. Price: To be announced.

CIRCLE 70 ON FREE INFORMATION CARD



Samsung VCR

Four-Head VCR

The *VR5509* is a VHS-HQ VCR from *Samsung Electronics* (301 Mayhill Street, Saddle Brook, NJ 07662) whose four-head, double-azimuth design permits variable-speed special effects without noise bars. Using the VCR's remote control, it is possible to view noise-free pictures from (continuously variable) slow motion to freeze-frame. To augment its "noiseless" operation, the *VR5509* uses a noise-elimination system that generates a gray screen when a channel signal is not detected. Another of the VCR's features, named "Encore," allows instant review of the last five seconds of tape when the *REVIEW* button on the remote control is pressed. More conventional functions include a one-year/eight-event programmable timer, one-touch recording, double-speed playback, and on-screen programming. Price: \$399.

CIRCLE 71 ON FREE INFORMATION CARD



Technics Horn Speaker

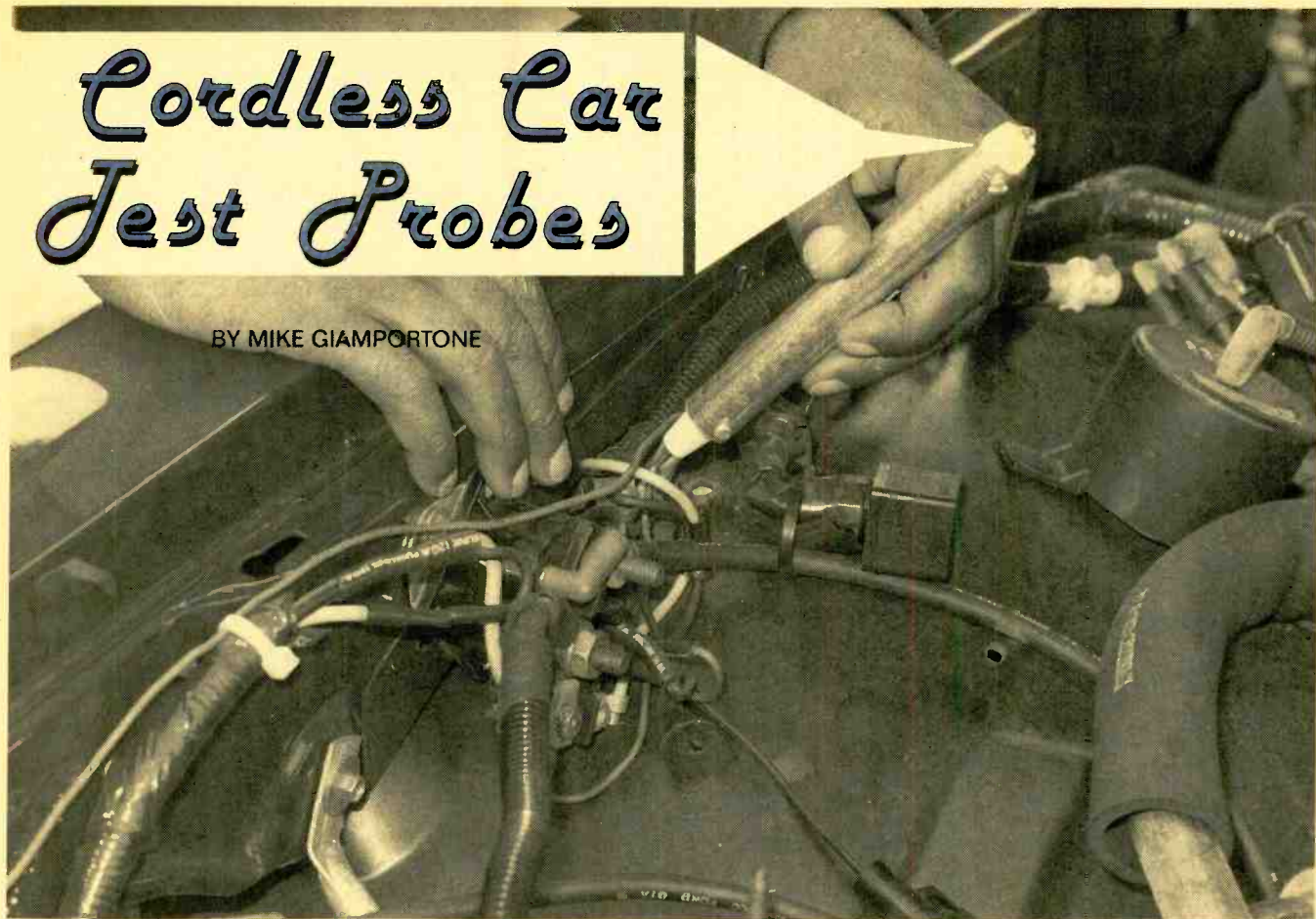
Horn Speakers

To the uninitiated, the term "horn speaker" may conjure up an image of a speaker shaped like a tuba. But to *Technics* (One Panasonic Way, Secaucus, NJ 07094) the term conjures up an image of a speaker shaped like a tuba. What? Yes! The company's futuristic *SST-1* horn speaker system ("SST" stands for "Sound Space Twin-load") was computer-designed to reflect its name. The unit features a "twin-loaded" horn design in which two horns of different lengths (3.2 and 2.6 meters) are joined to form a common opening. "The horns," says *Technics*, "are folded to effectively mirror the shape and function of a fine musical instrument." Not a harpsichord, obviously. The twin-horn design is intended to eliminate the periodic peaks and dips found in conventional back-loaded horn systems. An acoustic filter uses a narrowed central chamber to increase sound pressure radiating from the horn opening, tapers higher-frequency sound, and improves mid- and high-range response. That is said to add extra brilliance to the sound. The system's woofer diaphragm employs chitin-reinforced pulp for high rigidity. The *SST-1* system is available in glossy metallic-black, pearly silver, and metallic-red finishes. Price: To be determined.

CIRCLE 72 ON FREE INFORMATION CARD

Cordless Car Test Probes

BY MIKE GIAMPORTONE



Test the electrical wiring in your car before taking it to the auto doctor; it could save you from a costly repair bill

You've just finished your latest electronic project for your wheels, built from an article in last month's edition of **Popular Electronics**, and you need to identify your auto's ground and hot leads. You go to your tool box, pull out your test light, untangle the wire, clip it on the vehicle and touch the tip to a fuse, and nothing: your test light didn't light! So you open the hood and check your test light right on the battery, it lights.

You go back to find that you need to wiggle your alligator clip a little to ensure that you've made a good ground connection. After getting that straight, you poke around trying to find a fuse that is "on" only when the auto-ignition switch is in accessory or ignition positions, but the test light clip pulls off because the wire was too short and too far from your fuse box.

After finding a closer grounding point to which to attach your clip lead (having found that not all screws in the vehicle are metal), you once again poke-

away. This time as you reach for the key to turn it, you get caught in the test-light wire and again pull the clip lead off the grounding point. Now, thoroughly frustrated, you remember this article in **Popular Electronics** and sit down to build the *Cordless DC Test Light*.

The Cordless DC Test Light can be used to check for the presence of from 6- to 24-volts DC, and does not require a wire with an alligator-clip to hook to ground—i.e., no cord(s) whatsoever. The circuit can be put together in one evening, using readily available parts, for less than \$5.00.

With the Cordless DC Test Light all you have to do to find the ground and power leads is hold the test light with your bare hand and probe for the "hot" wire with the probe tip, while your other hand is touching chassis ground, even if it's rusty!

Nothing to It. Figure 1 shows the schematic diagram of the Cordless DC Test Light. As can be seen, the circuit is

nothing more than a pair of resistors, a BS-170 N-channel T-MOSFET, a pair of "AAA" or "AA" cells, and a 2.25-volt DC lamp. The batteries (B1) and lamp (I1) are connected across the source (S) and drain (D) of the FET (Q1). A resistor (R2) is connected from Q1's gate to its source. Another resistor, R1, connects

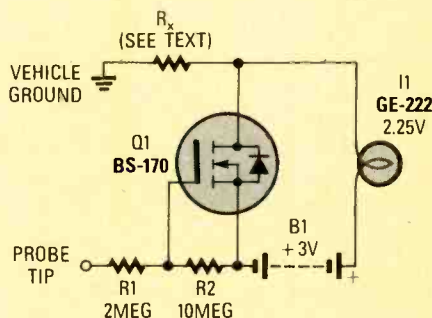


Fig. 1. The Cordless DC Test Light is comprised of a pair of resistors, a BS-170 N-channel T-MOSFET, a pair of "AAA" cell batteries, and a 2.25-volt DC lamp. Body resistance (represented in Fig. 1 as R_x) forms a part of the current loop through which Q1 is triggered.

transistor Q1's gate terminal to the probe tip.

Body resistance (represented in Fig. 1 as R_x)—by touching the circuit's metal enclosure and the auto's chassis ground—forms a part of the current loop through which Q1 is triggered. When the probe tip is touched to a live wire, a small current flows through the probe tip and R1 to the gate of Q1. At the same time, the user's hand on the metal body of the circuit's enclosure grounds the drain (D) of Q1.

PARTS LIST FOR THE CORDLESS DC TEST LIGHT

Q1—BS-170 N-channel T-MOSFET
 R1—2-megohm, ¼-watt, 5% resistor
 R2—10-megohm, ¼-watt, 5% resistor
 B1—"AA" or "AAA" cell battery (2)
 I1—GE-222 (or similar) 2.25-volt incandescent lamp
 Conductive metal tubing, glue, solder, hardware, etc.

Your body is used because your body (even though it exhibits some resistance or opposition to current flow) does conduct electricity, and since the gate has no electrical contact between the source and drain, the resistance in Q1 is almost infinite. That allows a small voltage to be applied to Q1, triggering it into conduction through the human body!

The 10-megohm resistor (R2) was placed between the gate and source to keep Q1 from latching on and to prevent static damage. A 2-megohm resistor (R1) is connected between the probe tip and the gate of Q1 because without that unit the gate threshold voltage of Q1 is 0.8-volt and 3-volts maximum. The 2-megohm resistor may be replaced with up to 5 megohms, depending on what you have in your junkbox.

Other MOSFET's will work for Q1. For instance, the IRF511 (Radio Shack 276-2072) will work, but because the IRF511 comes in a TO-220 type package and the BS-170 has a much smaller TO-92 package, the BS-170 is the more convenient way to go. (In this circuit, the smaller the component the better.)

Construction. Four different Cordless DC Test Lights were made in various outside diameters. The diameter of the unit is dependent upon the casing material used—¾-inch outside diameter (OD) pipe, ½-inch OD conduit tubing, and ⅜-inch OD rigid-copper tubing or steel pipe. The casing material also deter-

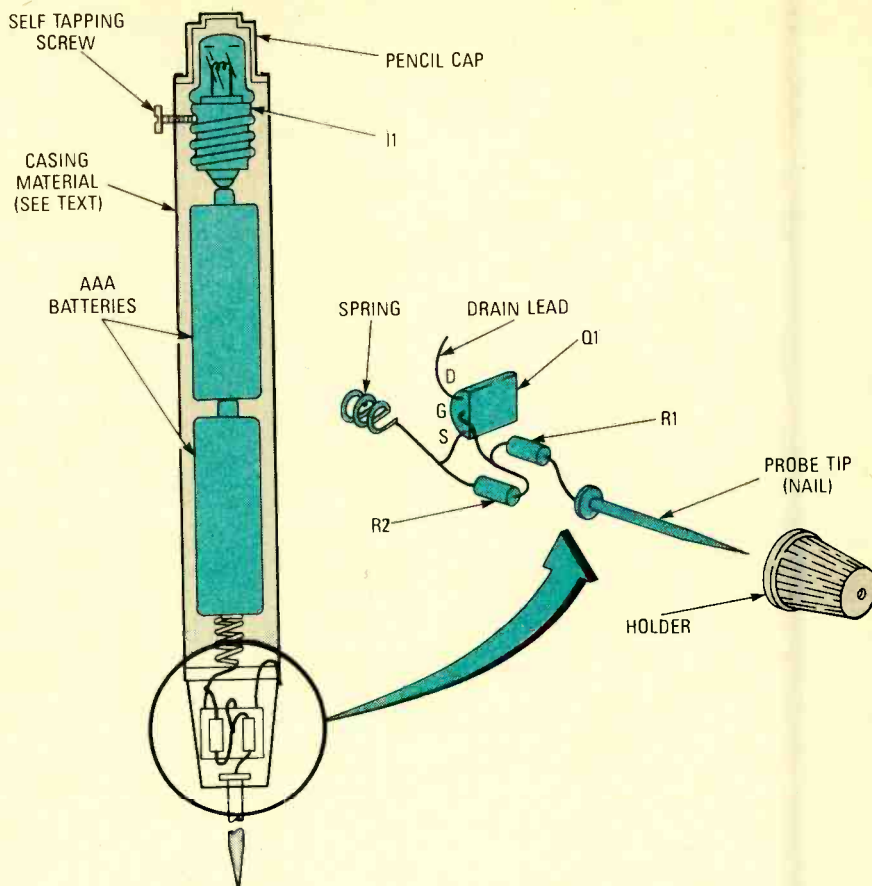


Fig. 2. There are no printed-circuit or perfboards involved with the construction; R1, R2, and Q1 are hard wired together and placed at the tip end of the tester, with the batteries and lamp positioned on top of the hard-wired components.

mines the battery type—"AA" or "AAA"—used to power the circuit, and the length to which the casing material must be cut—4¾ inches for rigid copper tubing and 4½ for ⅜-inch steel pipe.

Figure 2 shows an assembly diagram for the Cordless DC Test Light. The transistor and two-resistor portion of the circuit should be assembled first. Start by twisting the gate lead of Q1 and one lead of both R1 and R2 together. Then do the same for the source lead of Q1 and the other lead of R2. Those two leads are then connected to a spring—like those used in retractable, ballpoint pens—which will go to the negative end of the series connected batteries.

Connect the uncommitted lead of R1 to the probe tip, which can be any thin, rod-like, conductive material (a nail, or piece of wire coat hanger, for instance). The probing end of the rod should be ground to a nice sharp point prior to being connected to R1. Doing so allows the tip to easily pass through wire insulation without having to create an opening in the insulation to allow the probe tip to touch the wire inside.

The entire assembly can then be in-

serted in some sort of a holder. In the author's prototype units, the holders were fashioned from materials that can be found in most households. For instance, the nozzle from an empty caulking material canister, or the cap from a large felt-tip marker, etc., may be used. Make absolutely sure that the drain lead of Q1 and the spring protrude from the holder. The drain lead of Q1 will touch the metal casing when the two are fitted together. If desired, silicon cement can be force fed into the holder to seal the components in place.

Next insert the probe-tip assembly into the casing material (as shown in Fig. 2), making sure that the drain lead of Q1 is wedged between the holder and metal casing, and secure in place with glue or tape. Insert two "AA" or "AAA" batteries—use whichever type fits best. The batteries should fit into the casing so that there is not so much room that they "dance" around when the unit is moved, but not so tight that replacing the batteries becomes a major chore.

Temporarily insert lamp I1 into the top
(Continued on page 94)

Serial Cable Tester

BY JAMES E. TARCHINSKI

Keeping two RS-232 equipped computers in the same house is a little like keeping a pair of mating rabbits in the same cage. Just as the rabbits will surely reproduce, the computers are virtually guaranteed to spawn large numbers of unmarked RS-232 cables. It's a fundamental law of computers, one to which I can certainly attest—start with one or two cables, and pretty soon you've got a house full.

Let me illustrate what I mean: I have one RS-232 cable to connect my Apple computer to my PC clone; two more to connect each machine to the modem; and three more to tie my printer to each computer via a crossover switch. Extension cables, null modems, and gender changes also add to my cable arsenal. My problem is not too few cables, but too many.

Under those circumstances, connecting additional RS-232 devices to a computer was guaranteed to be a time consuming task. First, I'd try to find a ready-made cable with the correct pinout. When that strategy would fail, I'd be forced to warm up the soldering iron and prepare a new cable from scratch. In either scenario, I'd end up juggling both a cable and a pair of ohmmeter probes, either decoding the pinout of an existing cable or trying to sound out a new one.

If you have more cables than you can track, or if you're simply tired of testing new cables with a meter, the *RS-232 Cable Tester* is for you.

The Circuit. The schematic diagram for the RS-232 Cable Tester is shown in Fig. 1. It uses a total of eight pushbutton switches and eight LED pairs to test the continuity of the eight most important lines of an RS-232 cable.

Why juggle two cable ends and two ohmmeter probes just to test your RS-232 cables, when this one-evening project makes untangling your RS-232 nightmare a snap?

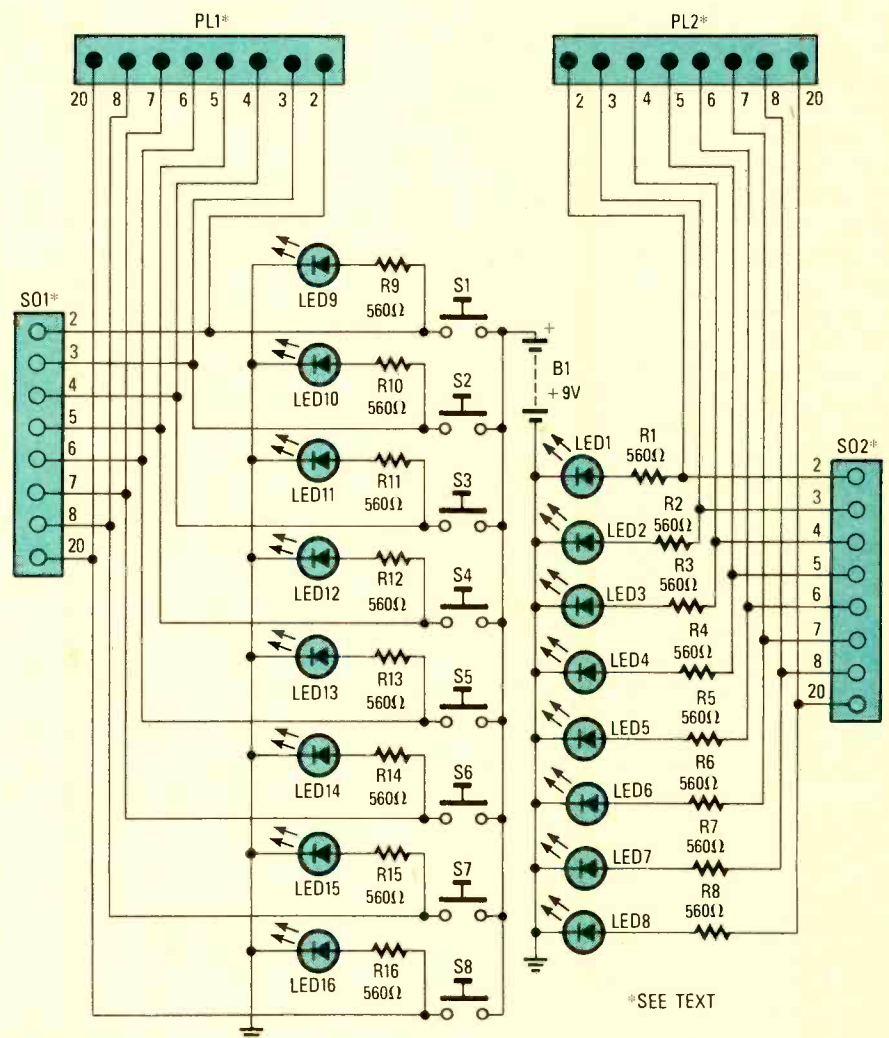


Fig. 1. Because of its low component count, the RS-232 Cable Tester makes a nice one-evening project.

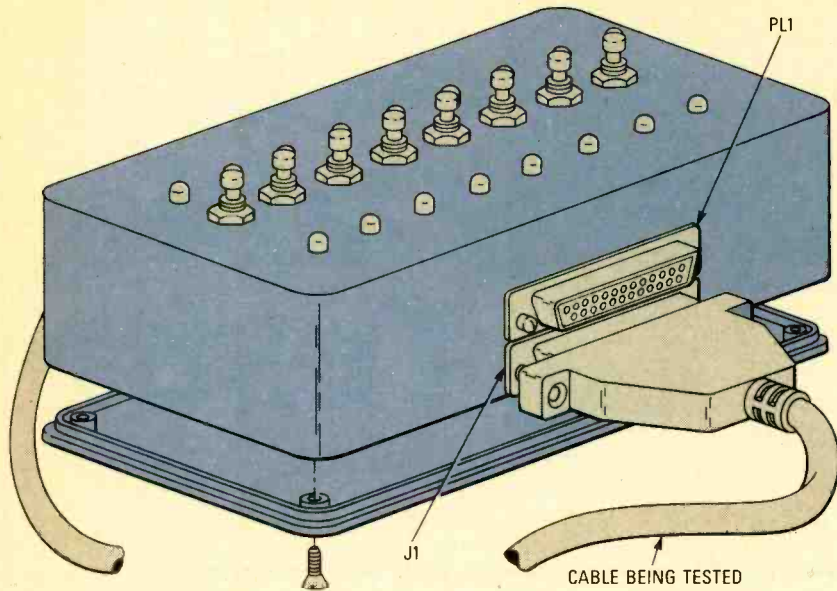


Fig. 2. By enclosing the Cable Tester in an inverted case, you will be able to easily remove the cover without having to deal with connecting wires.

To determine the pinout of the "mystery" cable, all you need do is connect the cable as shown in Fig. 2—both ends of the cable connect to the circuit. Then, by just activating the pushbutton switches one at a time, you can determine how the cable is wired and if there are faults. For example, if you were to press switch S3 (which is connected to pin 4 on the left) and LED3 and LED4 (pins 4 and 5 on the right) and LED11 and LED16 (pins 4 and 20 on the left) were to light, you would know that all four pins were connected.

Table 1 lists the names of the eight RS-232 lines used in this project (which happen to be the eight most commonly used lines of the standard, 25-pin, D-connector RS-232C specification). Although some older serial equipment may use some of the connector's other 17 pins, the vast majority of today's devices can be connected with some combination of the eight lines used by the RS-232 Cable Tester. If you have to work with cables for those older devices, you may want to wire in additional connector pins.

TABLE 1—RS-232 LINES

Signal	Abrv.	Pin
Transit Data	TX	2
Receive Data	RX	3
Request To Send	RTS	4
Clear To Send	CTS	5
Data Set Ready	DSR	6
Signal Ground	GND	7
Data Carrier Detect	DCD	8
Data Terminal Ready	DTR	20

Construction. Before you decide on a method of wiring the RS-232 Cable Tester, you should first decide what type of enclosure you'll be using to house the project. My prototype unit was housed in an inverted plastic enclosure (see Fig. 2), measuring about 6 by 2 x 3 inches. The switches, LEDs, and protoboard-mounted resistors were mounted to the inverted bottom of the enclosure. By mounting those components in that manner, I was able to install the four DB-25 connectors on the two larger sides. A pinout diagram for both male and female DB-25 connectors is shown in Fig. 3.

In addition, that configuration allows me to remove the lid of the case without having to deal with the maze of connecting wires between the components and the connectors.

Because I was unable to find any appropriate (read that "cheap") printed-circuit-board mountable pushbutton switches, I connected the switches and the 9-volt transistor-radio battery in space. The LEDs and resistors were mounted on a standard predrilled, copperclad protoboard, and hung below the upper face of the enclosure.

Notice that the Cable Tester has two DB-25 connectors on either side of the enclosure (which correspond to the left and right side of the circuit shown in Fig. 1). A male and a female DB-25 connector are tied in parallel and connected to the circuit, as shown. That configuration allows you to test a cable regardless of the gender of its end connectors.

PARTS LIST FOR THE RS-232 CABLE TESTER

LED1-LED16—0.3mm light-emitting diode
 R1-R16—560-ohm, 1/4-watt, 5% resistor
 B1—9-volt transistor-radio battery
 SO1, SO2—DB-25 connector, female
 J1, J2—DB-25 connector, male
 S1-S8—SPST, normally-open pushbutton switch

Printed-circuit or perfboard materials, plastic project enclosure, battery holder, battery connector, wire, solder, hardware, etc.

If any of your computers or peripheral equipment uses the newer 9-pin RS-232 specification, you may want to add two more connectors in parallel on either side of the circuit. That would give the RS-232 Cable Tester the greatest possible flexibility for handling different connector formats and genders. If appropriate, consult your computer manuals to determine the appropriate pin connections for your 9-pin serial connector.

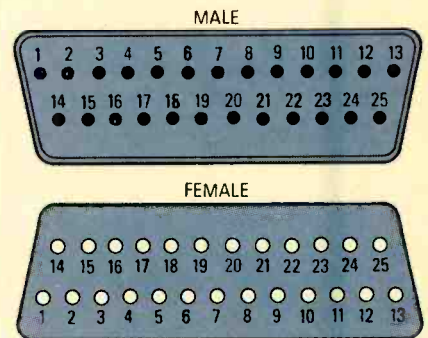


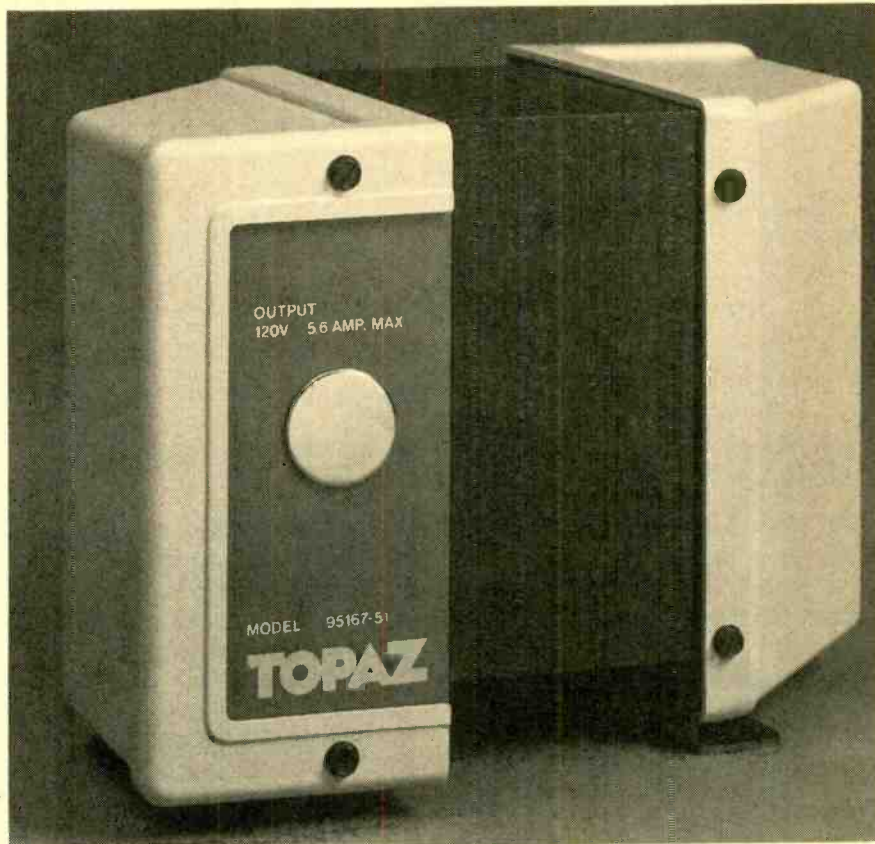
Fig. 3. The DB-25 connectors used in this project should be able to satisfy most RS-232 formats used for today's PC clone computers and their peripherals.

Final Thoughts. Admittedly, the RS-232 Cable Tester is a fairly simple circuit. Like most electronics projects that I've seen, however, the usefulness of the Cable Tester is directly proportional to its simplicity.

You may not currently have enough serial cables sitting around the house to justify the project, but as long as you have an RS-232 equipped computer, it's a good bet you'll be wiring cables in the future. By spending just an hour or so now, you'll ultimately save time on testing cables.

After all, why waste time juggling cable ends and meter leads when you could be working on your next electronics project? ■

Using your electronic gadgets and gizmos overseas requires a little preparation. Learn exactly what you need to know to have a trouble-free time.



USING APPLIANCES OVERSEAS

BY JOSEPH J. CARR

Modern airlines have made international travel a lot more accessible than it used to be. More and more people are going overseas today than ever before. Not too long ago I made a business trip to the United Kingdom and the Republic of Ireland, and intend to go back as soon as circumstances and money permits. One thing that you might notice quickly overseas (as I did) is that the electrical outlets are not quite the same as they are in the United States, and more than the plug style is different. Electrical services in most countries is significantly different than the service that we use in the U.S. The voltages may be different, and the AC frequency might not be 60 Hz, but rather 50 or even 25 Hz.

But take heart; it is quite possible to take your electronic gadgets overseas and use them quite safely. But first, let's take a look at the standard U.S. residential electrical system.

Standard U.S. Electrical Power. The standard U.S. electrical system provides either 117 volts AC (denoted VAC) or 220 VAC, depending upon the outlet and how it is wired, at a frequency of 60 Hz. The standard wall outlet provides 117 VAC, and that is what most electronic devices and electrical appliances require for proper operation. The actual voltage on a "117-VAC" line may actually be somewhere between 105 and 127 VAC and still be normal. At my home, the voltage tends to hover around 123 VAC. But on hot summer days, when zillions of kilowatts are powering air conditioners, the "brown-out" voltage might be as low as 95 VAC (although that condition is "pathological" and customers are warned).

A 220-VAC outlet is used for heavy appliances and ham radio linear amplifiers. If you have a large window air conditioner, an electric clothes dryer, or other heavy-duty appliance, then a 220-VAC outlet is probably not far away.

Figure 1 shows the wiring for the now obsolete (but still very much in evidence) residential system that uses two-wire outlets. The power is distributed from the generator plant and local substation in high-voltage form. That allows the power company to transmit a large amount of volt-amperes (which can be measured in "watts" if the load is resistive) over relatively small wires. If the voltage were lowered, then the amperes would increase (for a given wattage level) and that means having to use larger diameter copper or aluminum wires in order to prevent resistive losses in the lines. When the power lines get into your immediate neighborhood the voltage is stepped down in a transformer (T1) affectionately (perhaps disdainfully) called a "pole-pig." They are the transformers that you see mounted on utility poles in older neighborhoods (new construction standards now require them to be located underground).

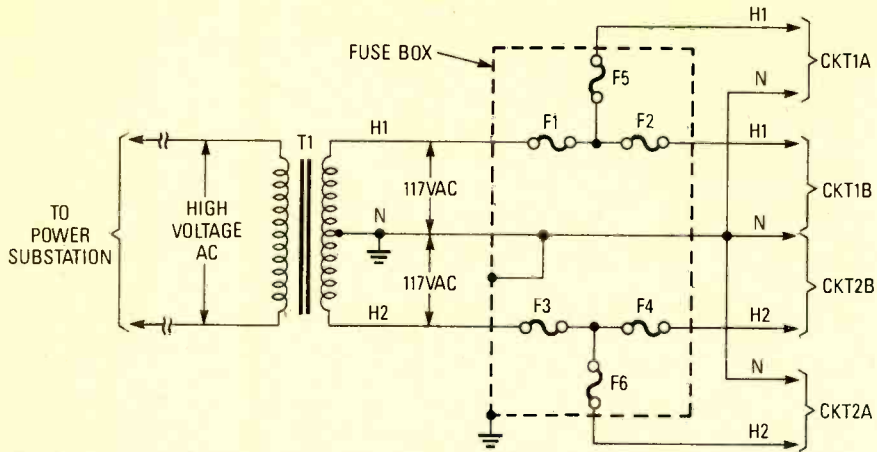


Fig. 1. This is a schematic of the old two-wire standard household electrical system (now obsolete). Note the absence of a proper ground.

The secondary winding of the pole-pig is center-tapped, and the center-tap is grounded. That line is called the neutral. The other lines from the transformer are hot lines. The voltage between the grounded neutral and either hot wire (N-H1 or N-H2) is 117 VAC, while between the two hot wires (H1-H2) it is 220 VAC (the voltage is not $2 \times 117 = 234$ because of losses in the system). The three lines (N, H1 and H2) are brought into your house by the power company. If you are in a neighborhood that is wired above ground, go out and count them; there are three.

The three lines are connected to a fuse or circuit-breaker junction box, from which the lines are distributed to the various branch circuits in the building. In addition to being connected to the neutral bus inside the fuse or breaker box, the neutral is also connected to the box itself so that the box is grounded. Fuses or breakers serving the various branch circuits (e.g. F3, F4, F5, and F6) are connected to the two hot busses inside the fuse box, and the wires to branch circuits (e.g. CKT1A, CKT1B, CKT2A, and CKT2B) are distributed from there. Each circuit has one hot line (H1 or H2) and the neutral line (N).

The two-wire method of electrical construction can still be found in many older houses (including mine), but it is not the best and does not meet current electrical-code standards.

In the modern three-wire branch circuits (see Fig. 2A), the hot and neutral wires are still used, but there is a third wire connected to ground. That third wire (usually colored green in electrical cords) is connected to the ground back at the fuse box. At the outlet junction box, the third wire is connected to the ground but not to the neutral at any point until the line

reaches the fuse box. I've seen some odd problems on digital computer equipment caused by electricians who connected the neutral and ground together at a local outlet box.

The purpose of the third wire is safety. It is a path for current in case the hot wire inside of the appliance or electronic device comes in contact with the cabinet (grounded through the third wire), then it will force the fuse to blow instead of zapping anyone who touched the cabinet.

Each ordinary wall outlet is connected to a 117-VAC source consisting of a hot line and the neutral. But what if you need 220 VAC for, let's say, a 2-kW linear ham-radio amplifier, a heavy window air conditioner, or other heavy-

duty appliance? In that case, the outlet is wired so that both hot lines (H1 and H2) and the neutral are connected (Fig. 2B). Note that the outlet is shaped differently than a standard 117-VAC outlet. That's to keep someone from inadvertently plugging a 117-VAC appliance into a 220-VAC outlet.

Overseas Operation. When you arrive overseas, you will find one of a variety of outlets depending upon where in the world you go. Preparation to use those outlets with their idiosyncrasies should be made in advance—well before you leave home. Some hotels, especially those that cater to American tourists or business travelers, will offer special 117-VAC outlets in the rooms for the convenience of their guests. Small, low-wattage appliances such as electric razors can be run from such outlets, but hair driers and some hair setters often cannot (check the wattage or volt-amperes rating of your appliance, and compare it with the listed rating for the 117-VAC outlet). The hotel staff can usually supply information about what can and cannot be accommodated by the in-room outlets.

One good source of electronics information about any specific country or region within a country is a U.S. Department of Commerce publication titled "Electric Current Abroad" (write to Superintendent of Documents, U.S. Government Printing Office, Washington DC, 20402). It is a small paperback

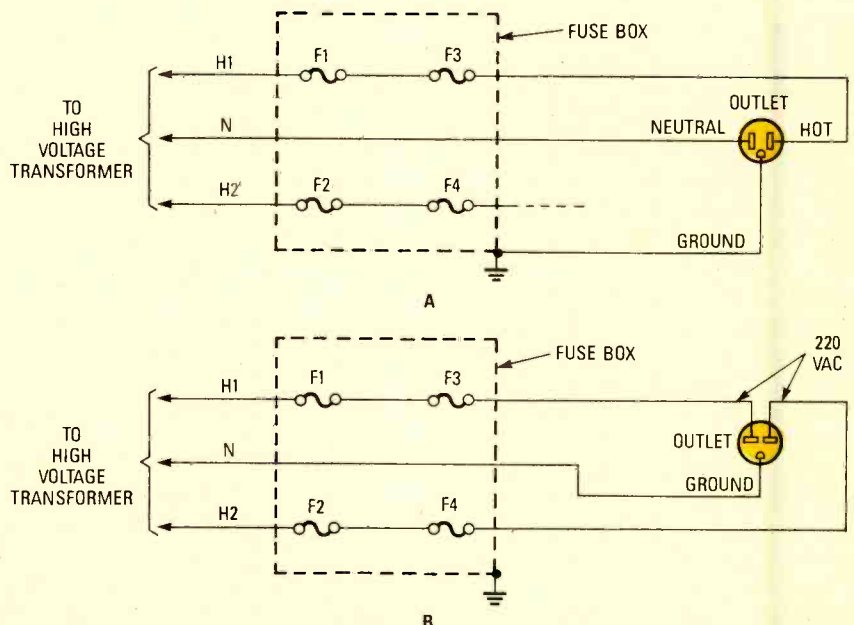


Fig. 2. Three-wire circuits, prominent in modern construction practice, are safer than two-wire circuits because they blow a fuse or trip a circuit breaker if a device's case becomes electrically hot. Shown are the 117-volt (A) and 240-volt (B) versions of the circuit.

booklet, and is sometimes found in local libraries (especially those that are designated repositories for government publications). You can look up the region of interest and find the type of plug used, the voltage or voltages, whether it is AC or DC (some areas of the Third World still use DC), the frequency in hertz, the number of phases, and number of wires used. It'll also tell you whether or not the AC frequency is stable enough for non-quartz electrical clocks, phonographs, and other appliances that use a frequency-sensitive synchronous motor for proper operation. There are also a number of notes that apply to specific countries or cities that deviate from the regional standard.

For appliances up to 50 watts, you can use a small adapter. Often they consist of a 2:1 wall transformer that steps the voltage down by half, and adapter plugs. If you are in an area where 240 VAC is used (a common voltage), such a device will drop the voltage to 120 VAC; well within the range tolerated by small appliances. I used one to operate my electric shaver in England. The local shop where I bought the razor sold me the kit for about \$15.

If you are making an extended trip, or are intending to move overseas for several years, then you might want to take a heftier step-down transformer so high-power devices can be accommodated. It is relatively easy to obtain a model with a volt-ampere rating of 400, 500, 750, 1000, or 1500 VA at local electrical and electronic supply houses. Keep in mind that the higher-power transformers are both more expensive and quite a bit heavier than the low-power types. Don't buy too much more capacity than you need unless you can afford the cost of purchase and the additional shipping cost.

Special Cases. There are some locations where the local voltage is either unstable (tends to vary from day to day or hour to hour), or is not easily converted to the normal range of 105 to 127 VAC required by U.S. appliances. There are a couple tactics that will help in such cases. First, you can specify a step-down transformer in which either the primary or secondary is tapped as in Fig. 3. You can then select the tap that produces the right voltage. Some step-down transformers are equipped with a switch that allows you to easily select the proper tap. In other cases you will have to rewire the unit.

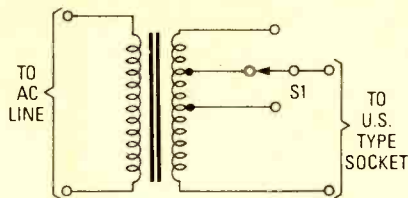


Fig. 3. A switch-selectable transformer allows you to customize output voltage. That is handy when traveling to more than one country or region; instead of having an adapter for each voltage, you can carry one that'll do them all.

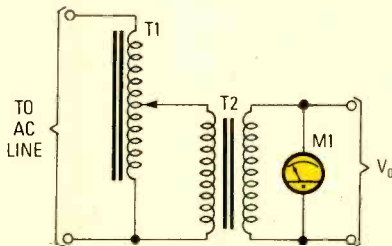


Fig. 4. A very accommodating variable voltage system can be made from an autotransformer connected to an isolation transformer. A voltmeter at the output can be used to help set the desired voltage.

If you will make a number of moves back and forth between the U.S. and overseas, then it might be better for you to select appliances and electronic devices that already have that feature built-in. I found that the power supply for my Kenwood ham-radio transceiver is switch selectable for either 220- or 117-VAC operation. By examination of the schematic I found that the power transformer has additional taps that can be substituted for those presently connected to the selector switch. That feature allows the rig to be wired for almost any power system around the world. A former *Voice of America* engineer once told me that he preferred European electronic products because they usually have voltage selector switches on the back panel.

Another tactic for the unusual-voltage situation is to connect a variable voltage autotransformer (such as a Variac) into the circuit. An autotransformer has only one winding, and uses a sliding contact to select the turns ratio. In Fig. 4 the autotransformer (T1) is shown connected between the local power system and the primary 2:1 step-down transformer (T2). It can also be connected between the secondary of T2 and the appliance, if that is preferred. The AC voltmeter (M1) will help you set the output voltage to the level required by your device. Like a step-down transformer, an autotransformer

is rated according to its volt-ampere capacity. Models from 250 to 5,000 VA are available.

Other Problems. Even in the U.S. power lines tend to be overly noisy. According to some of my friends who spend a lot of time working with electronics overseas, the problem is worse in some countries. While it is unlikely that western countries or Japan will have noisier lines than the U.S., it is more likely in Third World nations.

Power-line noise does not bother most appliances that use motors, or other electromechanical components, because the noise transients are too short in duration. Similarly, analog electronics, ordinary radio and TV receivers, and other devices may be relatively immune to power-line noise (or the effects are so short-lived as to be ignorable). But digital electronic devices, including personal computers, are highly susceptible to power-line noise, especially high-voltage transients. For those devices, either connect a metal-oxide varistor (MOV) device across the power line inside the cabinet, or buy a power-line protector of the sort used to protect personal computers.

One final problem pertains to the use of devices and appliances that depend on the frequency of the AC power lines for proper operation. Any device that uses a synchronous AC motor (such as a tape recorder, non-quartz electric clocks, etc.) may be a candidate for improper operation. Look on the label of the device (usually found on the back or bottom) to determine whether it is intended for 60 Hz only, or 50/60-Hz operation.

Although a clock cannot easily be helped (and are low enough in cost to be obtained locally overseas), some of the other appliances can be mechanically modified to accommodate 50-Hz AC lines. The modification kits usually have either bushings to fit over existing idler and capstan wheels, or entirely new parts that are sized for 50 instead of 60 Hz. Fortunately, the design trend in modern entertainment electronics is away from frequency-sensitive motors.

Conclusion. Electrical power throughout much of the world is not compatible with many U.S. bought devices. However, a little pre-planning and knowledge goes a long way toward adapting to overseas power lines, and the time to think about compatibility problems is before you leave home. ■

The average human body has between two- and three-million sweat glands. Most of those glands are located on the forehead, the chest, the soles of your feet, and the palms of your hands. Sweat glands are very small—about 370 of them per square centimeter on the palms and fingertips.

Sweat glands serve an important homeostatic function known as thermoregulation: they help keep the body cool when it begins to overheat, like in hot weather. But, as we all know, sweating occurs under other circumstances as well. People sweat when they are for some reason aroused, under stress, or just plain nervous. Sweating, therefore, can have a psychological dimension.

Since moisture lowers the electrical resistance of the skin, such psychological perspiration is sometimes called the psychogalvanic reflex or the galvanic

than that. While there is a chain of cause and effect connecting deception to variations in skin resistance, it isn't the only chain: many other kinds of stimuli can cause the same physiological reaction.

So, a lie detector based on the psychogalvanic principle (as well as other principles) is, in fact, biased against the person telling the truth. For example, the truthful person may become anxious and disturbed by the process of interrogation itself. In other words, there is no such thing as a specific lie response, or at least none that we now know of.

The Project. It is safe to conclude that the lie detector is, at best, a dubious device. But, the psychogalvanic reflex is real and it's easy to measure. The *Galvanic Skin Response Monitor* described in this article does just that.

When the charge on C1 is sufficient to overcome skin resistance, Q2 is biased off. That, in turn, removes the bias from the base of Q1, turning it off.

When the charge on C1 has decreased sufficiently, Q2 is again triggered and the cycle begins anew. The frequency of the tone varies with the resistance across the metal contact rings. The variable resistance is provided by changes in skin moisture.

Construction. This is the kind of project whose quality and appearance is limited only by your imagination. The Galvanic Skin Response Monitor can be put together quickly on a small piece of perfboard. You can also etch your own printed-circuit board from the pattern shown in Fig. 2 or purchase a kit from the supplier given in the Parts List. (See the Parts List for ordering information.)

A word of caution; if you opt to go the

BUILD A LIE

Lie detectors are thought by many to be fairly accurate truth indicators. Here's your chance to learn about how they work, discover their limitations, and build a simple unit that you can experiment with.

skin response (GSR). Another common term is the electrodermal response (EDR).

The galvanic skin response (along with other physiological reactions) has led many people to believe that certain mental states can be determined with the proper electronic technology. One such state is the intent to deceive, the result of which is lying, and one such technology is the lie detector.

Deception and Detection. The idea behind the lie detector is simple. The skin of a relaxed person has a high electrical resistance. The skin of a person under stress has a lower resistance. Because the intent to deceive usually causes stress, and stress increases the activity of the sweat glands, it follows that the internal mental state can be monitored with a device sensitive to variations in skin resistance.

Sounds good! However, the situation is actually much more complicated

The monitor (see Fig. 1) is a simple battery-operated, two-transistor tone generator. Note that the two transistors (Q1, which is an NPN unit, and Q2, which is a PNP unit) are complementary. To understand the operation of the circuit, recall from basic electronics theory that for a PNP transistor to conduct, its collector must be more negative than its base, and its base must be more negative than its emitter. The opposite holds true for NPN units; e.g., its collector must be more positive than its base, and its base must be more positive than its emitter.

When switch S1 is closed and there is no current path between the two ring contacts, the circuit is in an idle state, and both transistors act as open circuits. But when the gap between the two ring contacts are bridged, the base of Q2 is pulled to ground potential, triggering it into conduction, and therefore producing a tone in speaker SPKR1. That also causes C1 to begin charging.

perfboard route, make sure all components are properly connected; it's easy to make a mistake.

You will note that the foil pattern

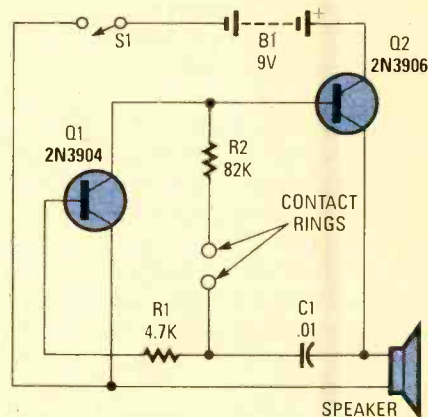


Fig. 1. The monitor is a simple two-transistor tone generator. The frequency of the tone varies with the resistance across a couple of metallic contact rings. The variable resistance is provided by the variable moisture of your skin.

shown in Fig. 2 has two exceptionally large pads; those pads are not used in the final assembly; however they do come in handy when trying out your circuit prior to sealing it in its enclosure.

Once you've obtained all the necessary components (there aren't many), assemble the circuit using Fig. 3 as a guide. The monitor requires two metallic contact surfaces. In the author's prototype, a pair of brass rings with an inside diameter of about $\frac{3}{4}$ inch were used as the contacts. The rings should be large enough to accommodate your fingers and sturdy enough to withstand slight pressure and a bit of moisture.

The author found some heavy brass rings, complete with holes for mounting, in his hardware collection; perhaps you can locate something similar. If not, you can make a couple of rings by cutting a piece of brass, copper, or alumi-

num tubing. Smooth any rough edges with a file or grinder. A pair of small metal touch plates is another alternative. You can even use a couple of washers. Whatever you use, make sure that the pieces are clean and free of any insulating coating or dirt that might restrict conduction.

Next, you need to think about how you will mount the speaker. I chose to hold the speaker against the top inside surface of the project box with a brass strip. Brass strips are available at many large hobby shops. The brass strip is bent in four places to accommodate the dimensions of the speaker assembly. The speaker is kept about $\frac{1}{4}$ inch away from the plastic with three small metal supports. A small section of scrap rubber between the speaker and the strip helps hold the speaker in place.

The internal layout of your monitor will depend, in part, on the size and shape

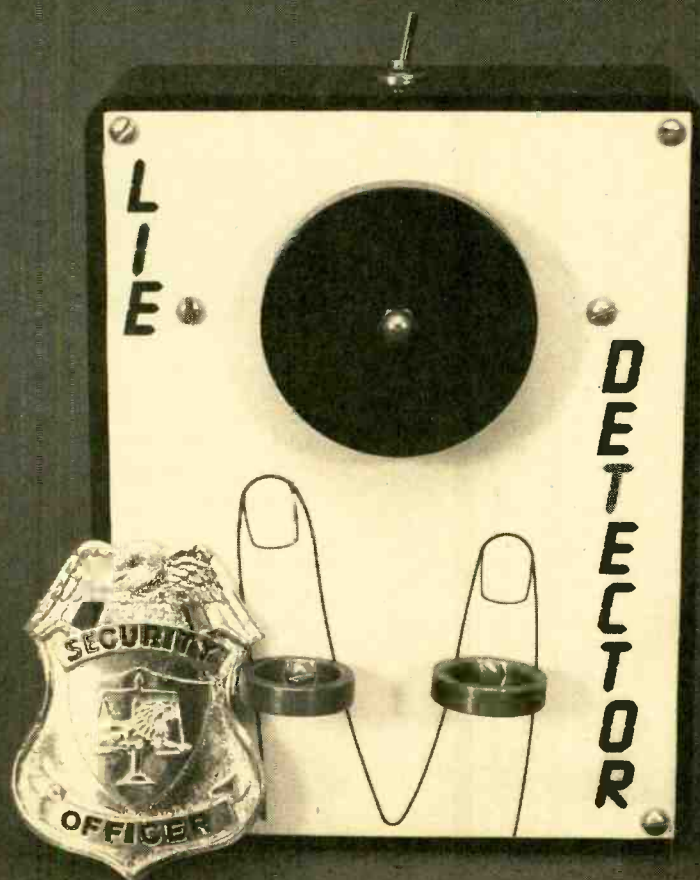
of the project box. The author housed his circuit in an enclosure measuring about $6\frac{3}{4}$ -inches long, $5\frac{1}{4}$ -inches wide, and $2\frac{1}{4}$ -inches high. A number of holes should be drilled in the cover of the box just above the speaker to prevent the tone from being muffled.

The number of screws showing on the surface of the box should be kept down to a minimum. One way, but not the only way, of doing that is to fasten the battery holder to one side of the speaker bracket and another bent brass strip, to which the circuit board has been attached, to the other side.

If you choose to use the mail-order kit, note that the copper contact pads on the circuit board must be bypassed with two pieces of hook-up wire. Note also that the kit does not include a switch. You must supply your own. A small SPST toggle switch works very well. The switch can be spliced between the

DETECTOR

BY
STANLEY A. CZARNIK

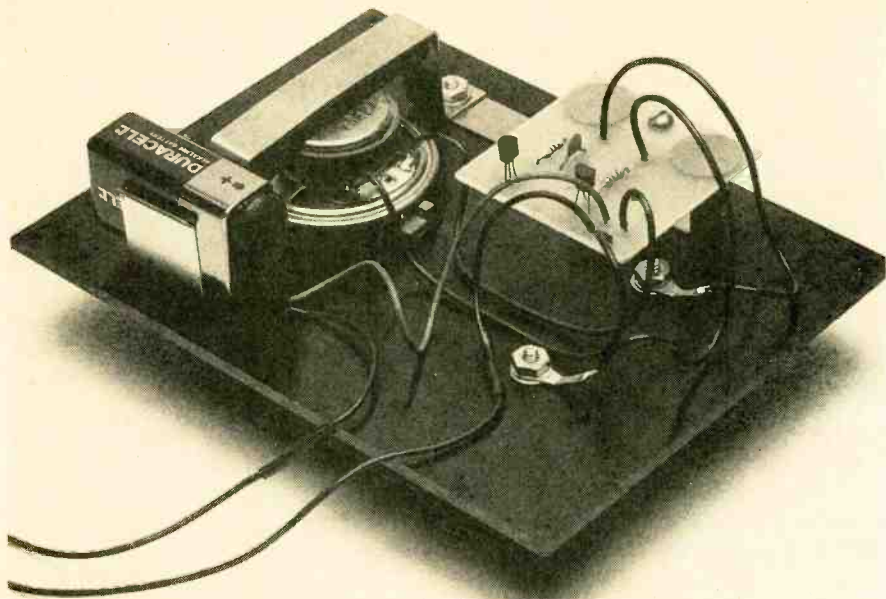


battery and the circuit board. The leads between the switch and the rest of the unit should be several inches long. That allows you to mount the switch out of sight on the rear vertical surface of the project box.

Finishing Touches. The finished appearance of the unit can be improved by suspending a large, black, plastic bottle cap just over the speaker holes. To do that, simply push a long machine screw through a hole drilled in the plastic cover directly over the center of the speaker. Drill the hole and insert the screw through it before you mount the speaker. Hold the screw in position with a small nut.

Place a short metal spacer of some sort over the screw. Then drill a small hole in the center of the bottle cap, put the cap on the screw, and secure the cap with a cap nut. The bottom of the bottle cap should be about $\frac{1}{4}$ inch off the top surface of the project box. The author used a cap measuring about $2\frac{1}{4}$ inches in diameter and about $\frac{1}{2}$ inch high.

Finally, connect a fresh 9-volt battery to the circuit, screw the cover to the box, and you're done.



Here the fully-assembled printed-circuit board is shown mounted on the front panel of the case. Note that the large copper contact pads on the printed-circuit board have been bypassed with two pieces of hook-up wire. The soldering lugs beneath the circuit board communicate with the contact rings by means of two short machine screws.

An Experiment. The Galvanic Skin Response Monitor is quite sensitive and can distinguish clearly between different skin resistances.

Obtain two small glasses of water. Dissolve some sodium chloride (ordinary table salt) in one of the glasses; use enough to make a strong solution. The salt solution is your "artificial sweat." The concentration of NaCl in human sweat is higher than that of any other substance.

Now wash your hands with soap and water and dry them thoroughly. Make sure that they are as free of moisture as

possible. When your fingers are ready, place them in the contact rings and turn on the monitor. You will hear a tone. Moisten your fingers with the plain

PARTS LIST FOR THE GALVANIC SKIN RESPONSE MONITOR

- Q1—2N3904 general-purpose NPN transistor
 - Q2—2N3906 general-purpose PNP transistor
 - R1—4700-ohm, 1/4-watt, 5% resistor
 - R2—82,000-ohm, 1/4-watt, 5% resistor
 - C1—.01- μ F, ceramic-disc capacitor
 - B1—9-volt transistor-radio battery
 - S1—SPST toggle switch
 - SP—8-ohm speaker
- Project box, brass strips, metal rings or plates, circuit board, bottle cap (See text), battery holder, battery snap, solder, soldering lugs, scrap rubber, hook-up wire, assorted hardware, etc.

Note: A kit of parts for the Skin Resistance Monitor, including a pre-etched printed-circuit board and the board-mounted parts, can be ordered from The Electronic Goldmine, PO Box 5408, Scottsdale, AZ 85261; Tel. 602-451-7454. The part number is C-4657 and the price is \$6.50. Please note that the company requires a \$10.00 minimum order and a flat \$3.00 fee for shipping and handling.

water and place them again in the rings. The frequency of the tone will be higher. Finally, moisten your fingers with the NaCl solution and put them once again in the contact rings. When your fingers are in place, you hear a very high frequency tone.

What your monitor is telling you is that wet skin is a better electrical conductor than dry skin and that sweaty (salty) skin is better still.

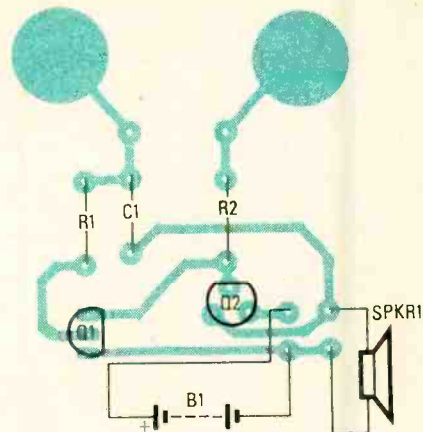
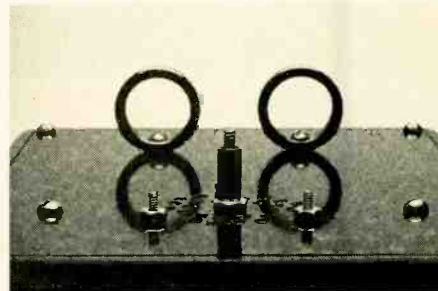


Fig. 3. Assembling the circuit board is so easy that it's almost impossible to make a mistake. In fact the greatest possibility of circuit malfunction may stem from circumstances beyond your control—a difference in pinout configurations that may be found in like transistors from different manufacturers.



This is how the area over the speaker holes will look before installing the bottle cap. A short metal spacer over the center screw suspends the cap about 1/4 inch off the surface of the box. The center screw may have to be cut to just the right length with a hacksaw.

Problems. The monitor is a simple device, and there is not too much that can go wrong. If the circuit has been built properly, the unit should work perfectly the first time you try it out. If not, look again at the position of all components, one by one. Then check the circuit for poor solder connections and solder bridges. Then check the battery; if the battery is weak, the performance of the monitor may suffer.

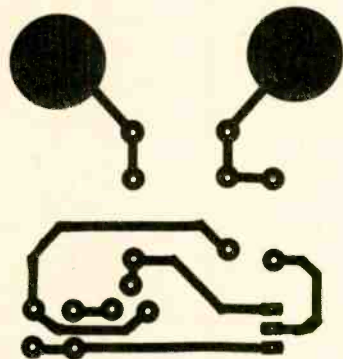
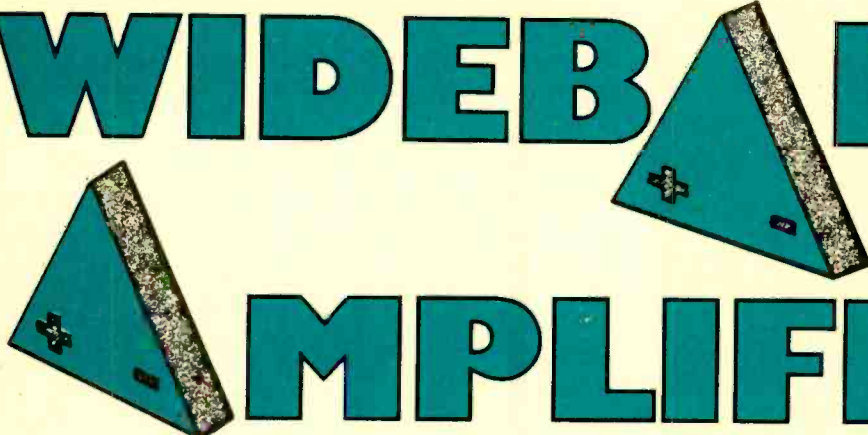


Fig. 2. Here is the full-size artwork for the Galvanic Skin Response Monitor. The pattern can easily be duplicated on a printed-circuit blank (unetched board) using dry-transfer electronic patterns, or simply drawn on a blank with a permanent-ink marker.

USING

BY JOSEPH J. CARR

WIDEBAND AMPLIFIERS



Learn about amplifiers capable of handling almost any signal and you'll be able to build circuits that can be used in a wide variety of applications.

Traditionally wideband amplifiers (or WBA's) have been used in color-TV receivers, high-grade oscilloscopes, and radar sets, but few ordinary electronic hobbyists have built them. But with more and more of us working on video projects, especially cable- or satellite-TV oriented ones, that has changed.

Very wideband amplifiers or VWAs (i.e. those operating from DC to the UHF or microwave ranges) used to be difficult to design and build. Furthermore, in the past only a few applications required such devices. Consequently, such amplifiers were either very expensive, or didn't work as well as claimed. But the advent of the cable-TV industry has created a large market for low-cost, compact gain blocks that would operate well into the VHF, UHF, and lower microwave regions.

Applications of Wideband Amplifiers. Although designed for the needs of the cable-TV and VCR industries, there are many applications for WBA's. In fact, any application that requires a 10- to 60-dB gain can make use of a WBA with the right frequency range.

For instance a passband amplifier needs to have a wide bandwidth, and typically must respond to a single band or group of bands. Only input and/or output tuning (or filtering) is needed to limit the frequency range of such a device. In fact, a narrow-band amplifier is usually a passband amplifier tuned to a single frequency. An example might be a 10.7-MHz IF amplifier, which will respond only to signals around that frequency.

In VHF receivers it is possible to use WBA's as either an easy-to-build (read that as "low manufacturing cost") mast-mounted antenna pre-amplifier, or an RF-input amplifier that is capable of amplifying frequencies over the entire tuning range of the receiver. Note however, that although the devices cover a wide swath of the spectrum up to the low microwave (GHz) region, they are not Low Noise Amplifiers (or LNA's) and are not intended for use in critical weak-signal applications.

Another application for a WBA is to provide gain after filters, double-balanced mixers, and other devices that are terribly useful, but have high insertion loss. For example, a popular low-

cost 10.7-MHz crystal bandpass filter used in two-way communication FM IF circuits has an 8.5-dB insertion loss at its center frequency. A MAR-1 or NE-5205-based WBA (which we'll discuss later) can easily make up for that amount of loss. You can even get "active" crystal filters that have 0-dB insertion loss, or even a small gain, because they have a WBA chip built-in. The gain of those amplifiers is normally specified in decibels, which can be calculated from the following:

$$\begin{aligned}\text{Power gain (dB)} &= 10\text{Log}(P_{\text{out}}/P_{\text{in}}) \\ \text{Voltage gain (dB)} &= 20\text{LOG}(V_{\text{out}}/V_{\text{in}})\end{aligned}$$

Sometimes you will see signal levels in those circuits given in dBm and dBmV. Units of "dBmV" are used in some MATV systems to refer to the relative signal level at some point. The reference voltage was set at 1000 microvolts (1000 μ V), or 1 millivolt (1 mV), across a 75-ohm resistive load. At the time the standard was set 1 mV was the amount of signal required by a receiver to produce a snow-free picture.

The dBm system is perhaps more commonly used. Some signal generators are calibrated in dBm rather than

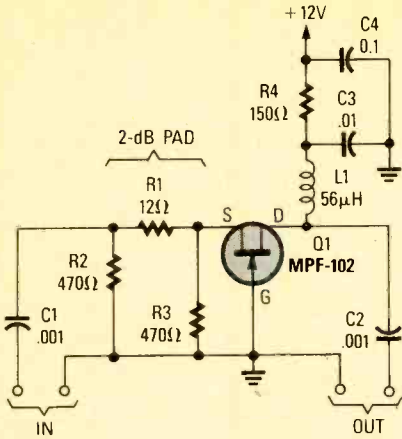


Fig. 1. Both power-supply decoupling and signal attenuation are important when using JFETs as wide-band amplifiers. All are present in this circuit.

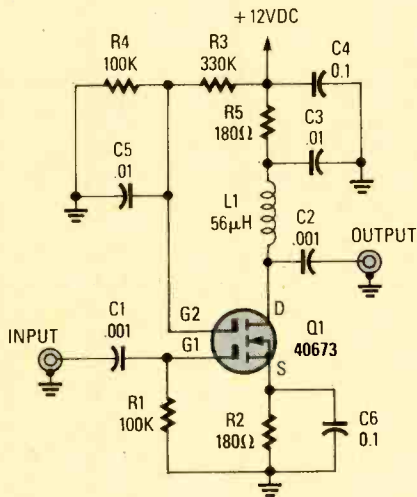


Fig. 2. Automatic or manual gain control is easy to obtain with dual-gate FET's. Here the gain is set to a constant value by tying G2 to a specific voltage.

microvolts or output. The system designates 0 dBm as 1 mW dissipated into a 50-ohm load (or 224 millivolts across 50-ohms).

If you want to convert power levels to their equivalent voltage levels, then simply take the square root of the product of power and resistance. To convert dBm to the equivalent power level in milliwatts use the following:

$$P = 10^{\text{dBm}/10}$$

Field-Effect Transistor Circuits.

There are two general forms of Field-Effect Transistors (designated FET's) used in WBA design: the Junction Field-Effect Transistor (or JFET) and the Metal-Oxide Semiconductor Field-Effect Transistor (MOSFET). The latter sometimes have special gates and are called Insulated-Gate Field Effect Transistors (IGFET's).

Figure 1 shows the circuit for a WBA

based on a VHF JFET (MPF-102 or equivalent). The circuit is a grounded-gate configuration, and so is almost immune to the self-oscillation problems that plague grounded-source amplifiers. The drain circuit is RLC-coupled to the next stage. Capacitor C2 operates to block the DC drain voltage to keep it from affecting the following stage. DC is carried to the drain through an RF choke (L1) and a load resistor (R4). The inductive reactance of L1 causes the load to increase as frequency increases, thereby compensating for the effects of output capacitance on frequency response. For that reason L1 is called a "peaking coil."

Decoupling is very important for keeping the WBA from oscillating. In Fig. 1, the DC power supply is decoupled by capacitors C3 and C4. In some circuits, feedthrough capacitors are used to bring the DC power through a unit's shielded enclosure. It is critical that all leads be kept as short as possible to keep the circuit stable.

The input circuitry is also capacitively coupled, but that is to prevent DC from previous stages from affecting the circuit. Like all JFET amplifiers, there is a resistor from the source to ground. But in this case, the resistor is actually a 2-dB attenuator pad. The purpose of the pad is to keep the impedance seen by both the input and the JFET reasonably constant. That is another important consideration for keeping the circuit stable.

Another FET WBA is shown in Fig. 2. That circuit is based on the dual-gate MOSFET (RCA 40673, or equivalent). The 40673 has two gate circuits. In most cases, gate G1 is used for the signal

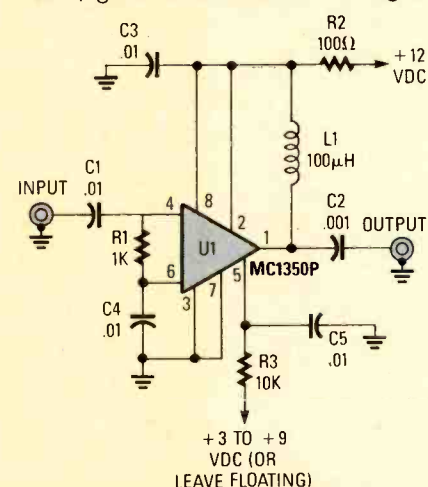


Fig. 3. The output of an MC1350P actually pulls the power supply low to yield a signal. That is why two power supplies are required.

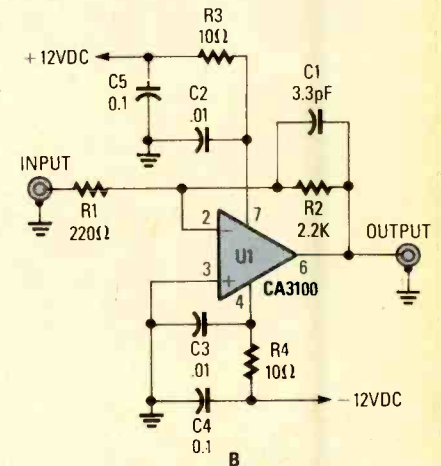
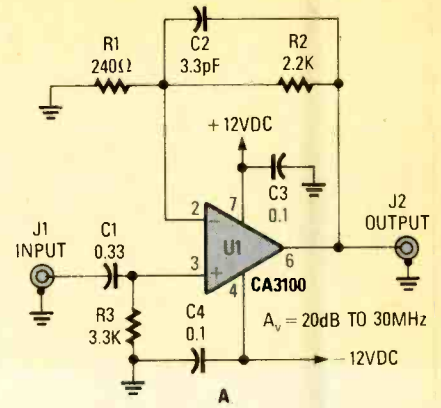


Fig. 4. The RCA CA3100 can operate as well over 30-MHz. The amplifier in A is a noninverting follower. The one in B is an inverting version of it.

input, while gate G2 is used for automatic gain control (AGC). The circuit of Fig. 2 is a grounded-source amplifier. The drain circuit is similar to that of Fig. 1. The input circuit applied to gate G1 is merely an RC-coupled network consisting of a 100k resistor and a 0.001-μF capacitor. The gain-control gate (G2) is biased to full on by a voltage derived from a resistor voltage divider (R3/R4). If gain control (manual or automatic) is required, then a variable voltage can be applied to G2 instead of a fixed voltage.

IC Wideband Amplifiers. Wideband amplifiers were among the first applications for integrated circuits. Although at first some integrated amplifiers made circuit-design more involved, most of the recent IC devices make the design and construction of wideband amplifiers a lot easier.

Figure 3 shows the circuit for a WBA based on the Motorola MC1350P. Originally developed for use as an IF amplifier in broadcast and FM two-way radio

(Continued on page 98)

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THE DIGITAL ELECTRONICS COURSE

UNIVERSAL LOGIC

Learn how basic gates are used to perform exotic functions, and how to apply DeMorgan's theorem to select the right gates for the job.

BY ROBERT A. YOUNG

So far we've looked at the basic logic gates, learned how they operate, how to prepare the gate's logic truth table, learned a little about Boolean algebra, and seen how the simple gates can be used to form more-complex circuits. Aside from serving as the building blocks of more-complex circuits, the basic logic gates can be combined with inverters to implement other basic logic gates. Figure 1 shows several examples of how various gates can be combined with inverters to implement the functions of other basic gates.

Back To Basics. Figures 1A-1D are easily recognizable as NAND, AND, NOR, and OR gates, respectively. Although it is very straightforward to build involved logic systems from the basic gates described thus far, AND gates and OR gates are more difficult to fabricate using conventional integrated-circuit techniques.

Therefore, NAND, NOR, and inverter gates are predominantly offered by the integrated circuit manufacturers. As one thumbs through a CMOS or TTL data book, it becomes quite obvious that the number of NAND and NOR gate IC's far exceeds the AND and OR gates.

The beauty of NAND and NOR gates (and the reason for their popularity) is that they can be combined in various circuit configurations to perform the functions of the AND, OR, and inverter

gates. Hence, they are often referred to as *universal* logic gates. In fact, it's possible to implement any logic function with NAND-gates only or NOR-gates only circuits.

It is most important, then, that you thoroughly understand how the various basic gates can be converted into gates of a different type. That conversion is done quite simply by using inverters. The symbol for an inverter function is simply the symbol for an amplifier with a small circle added at either end. (In general, what you have is an inverting amplifier.)

The circle can be at either end of the amplifier symbol as an aid in logic circuit analysis. The important point is that the circle is the determining factor in

changing the amplifier symbol to that of an inverter. When the circle is added to the AND function symbol, the symbol is transformed into that of the NAND gate. The addition of the circle changes the OR function symbol to the NOR symbol. Therefore, in logic diagrams, the minute you see a circle used with a logic symbol, you can consider that circle as an inverter.

Previously we saw how AND gates and OR gates can be converted to perform the NAND and NOR functions, and how NAND and NOR gates can be converted to AND and OR gates, respectively. In each case, a basic gate was converted by simply adding an inverter to its output.

But what is the effect of placing inver-

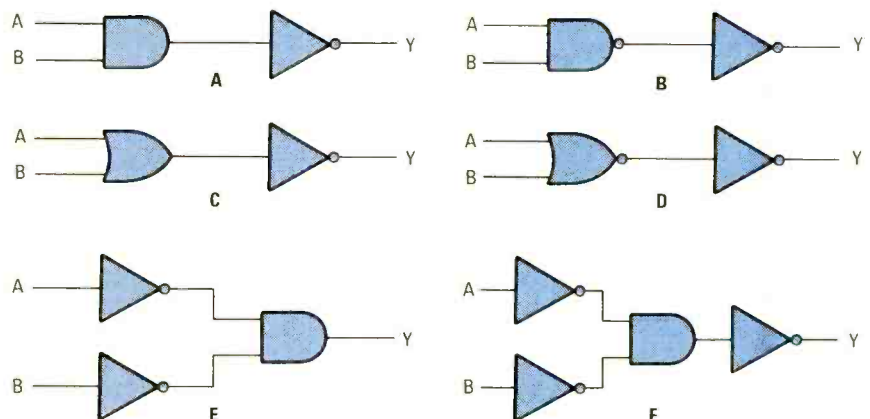


Fig. 1. Here are several examples of how various gates can be combined with inverters to provide the functions of other basic gates.

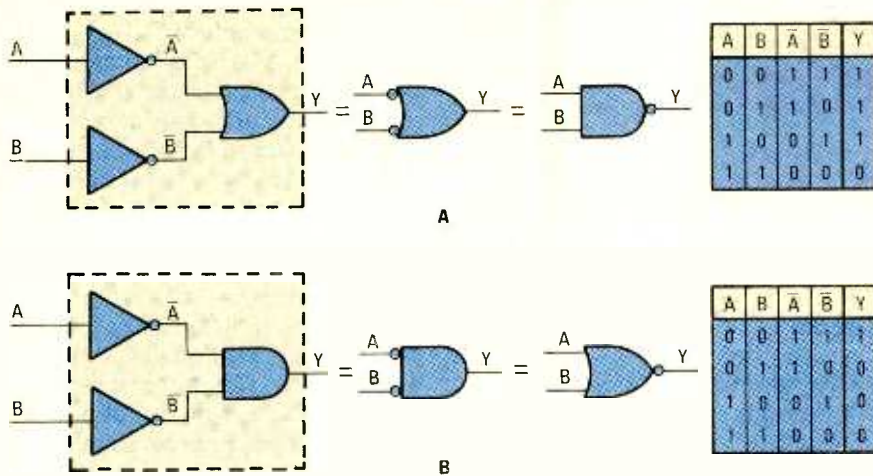


Fig. 2. If all of the inputs to an OR gate are first inverted (A), the output of the gate is identical to the output of a NAND gate. An AND gate can be converted to perform the NOR function by adding inverters in series with all inputs to the gate (B).

ters at the input of the gates? Figure 1E shows an AND/inverter implementation of the NOR function; while Fig. 1F shows a AND/inverter implementation of the OR gate function.

Figure 2A illustrates the fact that if all of the inputs to an OR gate are first inverted, the output of the gate is identical to the output of a NAND gate. That observation is borne out by the truth table. The first two columns (A and B) represent the four possible input combinations.

The third and fourth columns (\bar{A} and \bar{B}) represent the Boolean terms (logic levels) at the outputs of the inverters (or at the inputs to the OR gate). The Y column of the truth table shows the final result of applying various input combinations to the circuit. If you compare the truth table of Fig. 2A, excepting the A and B rows, to the truth table of the NAND gate, you would find them to be identical.

Figure 2B illustrates how an AND gate can be converted to perform the NOR function by adding inverters in series with the inputs of the gate. Note that if the \bar{A} , \bar{B} , and Y columns of the truth table in Fig. 2B are compared to the truth table of a OR gate, you'd find them to be identical.

By using inverters, any of the three remaining basic gates can be converted to any other gate. Looking at Fig. 3, simply add an inverter to the output of the gate when moving horizontally; add inverters to all of the inputs when moving vertically; and when moving diagonally, add inverters to all inputs and the output. In actual digital systems, inverters are often made from NAND and NOR gates. That is done by connecting all of the gate's input leads together, as shown in Fig. 4.

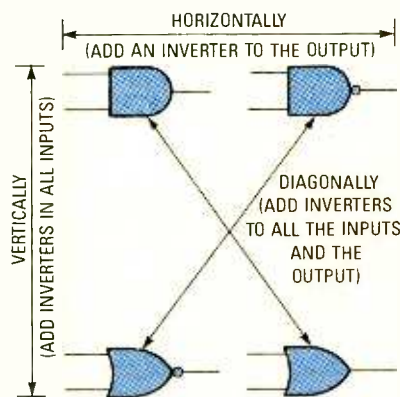


Fig. 3. By using inverters, any of the basic gates can be converted to any other gate: simply add an inverter to the output of the gate when moving horizontally; add inverters to all of the inputs when moving vertically; and when moving diagonally, add inverters to all inputs and the output.

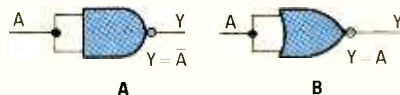


Fig. 4. In digital systems, inverters are often made from NAND and NOR gates, by connecting all of the gate's inputs together.

Sometimes NAND and NOR gates are converted into inverters to make use of all the gates in a single chip. Another reason is that it may be more convenient to convert a few gates to inverters in order to keep the printed-circuit layout as simple as possible. Gates having multiple input leads may also be converted to gates with fewer inputs by connecting two or more inputs together.

Fabricating Special Gates. In com-

Our gratitude is extended to the EIA/CEG for the creation of this course, especially to the consultants who brought it to fruition: Dr. William Mast, Appalachian State University; Mr. Joseph Sloop, Surry Community College; Dr. Elmer Poe, Eastern Kentucky University.

plex systems with a large number of input combinations, we often need gates with a non-standard number of inputs, (i.e., 7-input NAND gates, etc). The easiest solution is to use an 8-input NAND and tie the extra input high.

However, if there are unused gates available in the circuit, it is economically prudent to fabricate a 7-input NAND gate from say, a 4-input NAND and a 3-input NAND. The only requirement is to combine the outputs of the two gates in such a manner so as to yield the correct logic output. To illustrate, let's fabricate a 6-input NAND gate from two 3-input NAND gates.

There are two solutions to the problem and the one you use depends on what extra gates are available in your circuit. The first solution, which is the simplest, involves a 2-input NOR gate, an inverter, and two 3-input NAND gates.

Looking at Fig. 5A, we see three inputs going into each 3-input NAND gate. The 2-input NOR gate is drawn as a negated 2-input AND gate. Because the inverter circles cancel the effect of each other, we have effectively AND'ed inputs A, B, and C with inputs D, E, and F. To form the 6-input NAND gate, we merely invert the output of the 2-input NOR gate.

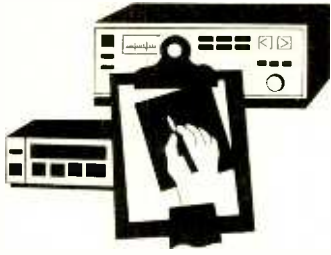
The second solution to the problem is shown in Fig. 5B. The inverters cancel the inverter circles of the 3-input NAND gates, and the resulting terms are NAND'ed together to produce the term:

$$Y = \overline{ABCDEF}$$

Either solution can be used to reduce the number of IC packages required to implement your circuit. (The extra gates available will dictate the appropriate solution.)

Of course, if no spare gates are available in your circuit, it will be necessary to use an additional IC(s) to provide the desired function. But if there are any unused gates, you must be able to figure out which combination of the spare gates on the board will produce the desired output. To do so we resort to using something called DeMorgan's theorem.

(Continued on page 104)



Product Test Reports

By Len Feldman

NAD MODEL 6300 STEREO CASSETTE DECK

NAD is a company that has always prided itself in offering excellent value and performance features in all their products. Their top-of-the-line cassette deck, the 6300, certainly conforms to that tradition. The 6300 is a 3-head machine, which means that you can monitor recordings as they are made. But that's really just the beginning. In addition to incorporating the two most popular forms of noise reduction, Dolby B and Dolby C, the 6300 includes such advanced features as Dolby HX-Pro, Dyneq and a couple of innovative and exclusive enhancements known as "Play Trim" and "CAR," a recording circuit that processes tapes for optimum playback in an automotive environment.

Dolby HX-Pro and Dyneq (the latter invented by the Tandberg Company of Norway) work synergistically. HX-Pro automatically adjusts recording bias to the needs of the program material; Dyneq dynamically adjusts high-frequency recording equalization to prevent tape saturation. Both circuits operate only during recording and neither requires any playback decoding. A fine-bias adjustment is also provided to allow you to compensate for slight variations between various brands of tapes, even those that are of the same general category or type.

Accurate reproduction is further enhanced by the Play Trim circuit, developed jointly by Dolby Labs and NAD. Play Trim is set by the user during play-

back to minimize high-frequency losses that may arise from incorrect biasing, equalization, or azimuth errors.

Less obvious, but nevertheless important design refinements are found inside the deck itself. One of those goes by the rather long, descriptive name of a "non symmetric dispersed resonance dual-capstan tape transport." Dual capstans are not new in high-quality tape decks. They tend to isolate the moving tape from any friction that might be caused by the cassette shell itself.

In the case of the 6300 however, the concept has been carried even further. Its two capstans differ in diameter by 10% and rotate on different sized bearings. Rotation is further smoothed by different sized flywheels whose motion is coupled via a wide, vibration-absorbing, soft rubber belt. As a result, any flutter and resonance components are dispersed to different frequencies instead of adding to each other. Azimuth skewing (tape running at an improper angle relative to the tape-head gaps), and any variations in holdback tension are also minimized by that dual capstan construction.

A wireless remote control is included with the Model 6300, enabling the user to initiate recording and playback functions from the listening position.

The Controls. Small power and cassette-eject pushbuttons are located at the left end of the front panel, adjacent

to the cassette holder. To the right of the cassette compartment is a MODE button that determines whether the tape counter displays arbitrary numbers or real-time, and a COUNTER RESET button.

The display area shows tape counter indications as well as a pair of record/play level meters consisting of banks of LED's calibrated from -20 dB to +8 dB. Indicator lights below the display area illuminate when the unit is in the record mode and when selecting the CAR compression mode, which is used when recording tapes that are intended for playback in an automotive environment. Small indicator lights above the display area light up when Dolby B or Dolby C noise reduction has been selected. Dual concentric master RECORD LEVEL and BALANCE controls are at the extreme right of the panel.

Buttons used to select the RECORD and CAR (COMPRESS) modes are just below their respective indicator lights. Major operating pushbuttons and rotary controls are arranged along the lower section of the front panel. A well defined PLAY button (in a lighter color than the other pushbuttons) must be depressed along with the RECORD button to initiate recording. Next come the PAUSE, STOP, FAST REWIND, and FAST FORWARD buttons, followed by a lever switch labeled B, C, and OFF that selects Dolby B, Dolby C, or no noise reduction, respectively. The PLAY TRIM and FINE BIAS controls come next, flanking a SOURCE/MONITOR pushbutton. Finally, a second three-position lever switch selects NORMAL (Type I), CRO, (Type II), or METAL tape equalization (bias) settings.

The rear panel of the NAD 6300 is equipped with the usual phono-tip stereo input and output jacks, a multiplex filter on/off switch, and an unswitched convenience AC receptacle. The wireless remote control supplied with the Model 6300 duplicates all of the tape-transport control functions (including the record function) found on the front panel. When the remote control is held in the right hand, all of the buttons are located so that they fall under the natural arc of the thumb. The transmitting end of the remote control unit is slanted upward so that you can place it on a tabletop or on the arm of a chair and use a forefinger to operate it. Obviously, a good deal of industrial engineering as well as electronic engineering went into the development of this beautifully styled deck and its remote control.

The Test Results. Basically, we tested



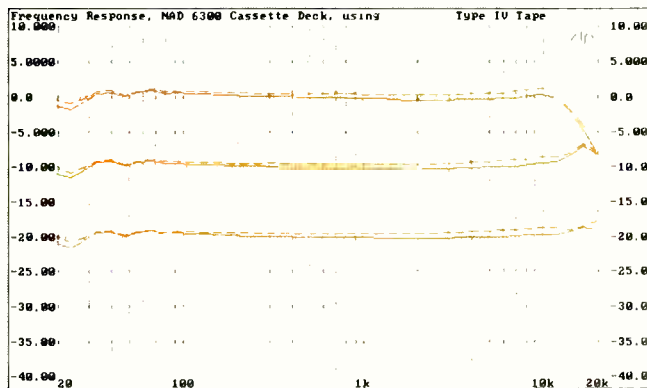
The NAD 6300 features Dolby HX-Pro, Dyneq, and an exclusive compression circuit that processes tapes for optimum playback on your car's cassette deck.

the performance of this cassette deck with three different high-quality types of tape. For normal-bias tape, we used Maxell XL-IS samples. For CrO₂ (high-bias) tape we used Maxell XL-IS tape, and for metal tape we used TDK MA-X cassette samples. For our frequency-response measurements, we made no attempt to use the PLAY TRIM OR FINE BIAS controls, since we wanted to see how good the frequency response would

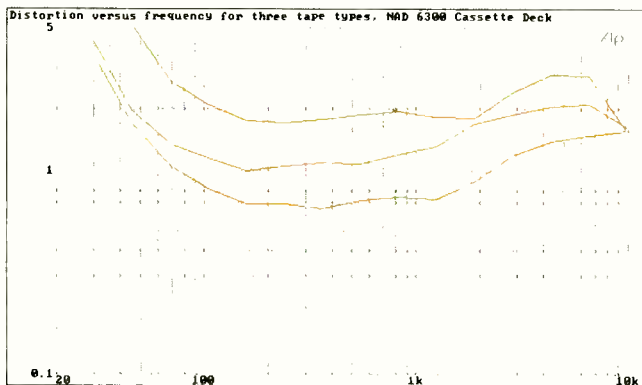
be if those controls were set to their mid-points, with only the tape selector set to the correct type of tape.

Normally, frequency-response measurements are made at -20-dB record levels to prevent tape saturation at high frequencies. To explore the merits of Dolby HX-Pro and Dyneq, we decided to run three sets of response tests for each type of tape at 0 dB, -10 dB and -20 dB. Results were outstanding! At

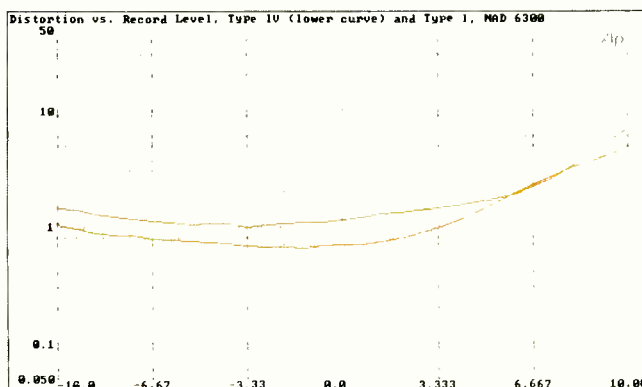
-20 dB, all three types of tape exhibited record/play response to beyond 20 kHz. At the -10-dB record level, the normal-bias tape exhibited a slight roll-off (around 3 dB) at 20 kHz, while the other two tape types actually showed a slight peak at 20 kHz. That peak could, of course, have been trimmed with the PLAY TRIM control to provide flat response out to and beyond 20 kHz. As we would have expected, at the 0-



Here are the frequency-response graphs for the NAD 6300 using Type IV (metal) tape. To explore the merits of Dolby HX-Pro and Dyneq, tests were run at 0, -10, and -20 dB.



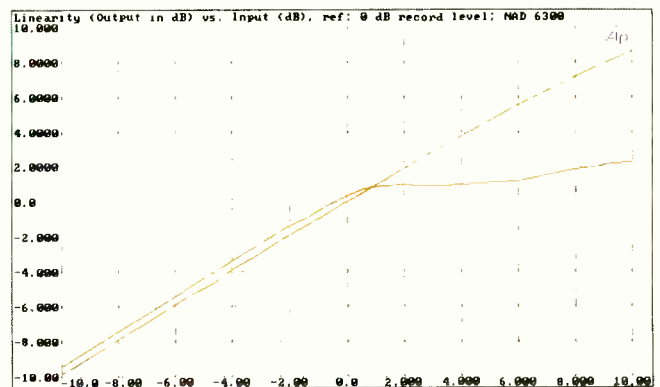
The plot of harmonic distortion versus frequency is shown here. The lowest curve is for the metal-tape sample, the middle curve is for the normal-bias (Type I) tape, and the upper curve is for the high-bias (Type II) tape.



To study distortion further, the recording level of a 1-kHz signal was varied between -10 and +10 dB. The lower curve is for metal tape; the upper one for Type-I tape.

NAD 6300 Published Specifications and Actual Performance

SPECIFICATION	MFR'S CLAIM	PE MEASURED
Speed Accuracy	± 1%	+ 0.3%
Wow and Flutter (WRMS)	< 0.3%	< 0.2%
Frequency Response	± 3 dB to 19 kHz	± 1 dB to 20 kHz
Response with MPX Filter	± 1 dB to 15 kHz	Confirmed
THD at 0 dB, Type I	< 1%	1.2%
THD at 0 dB, Type II	< 1.5%	0.7%
THD at 0 dB, Type IV	< 1.5%	1.8%
S/N Ratio, re: 3% THD		
Type I, Dolby Off/B/C (dB)	59/68/78	61/70/78
Type II, Dolby Off/B/C (dB)	59/68/78	65/74/81
Type IV, Dolby Off/B/C (dB)	59/68/78	64/73/80
Channel Separation (@ 1kHz)(dB)	45	47
Erasure	> 70 dB at 1 kHz	Confirmed
Input Sensitivity	40 mV	Confirmed
Output Level at 0 dB	500 mV	480 mV
Dimensions (WxHxD, in.)	17.1x4.7x11	
Net Weight	13 lbs. (5.9 Kg.)	
Power Requirement	50/60 Hz at 110,120,220 or 240 VAC	
Power Consumption	42 Watts	40 Watts
Suggested Price	\$899.00	



Using a metal-tape sample, a 1-kHz test signal remained linear to +10 dB; for a 10-kHz test signal, a 10-dB input produced a playback level of just a bit over +2.0 dB.

dB record level, the normal tape rolled off in response above 10 kHz, the high-bias sample did slightly better, while the metal tape began to roll off in response above 13 kHz.

Next, we measured total harmonic distortion (THD) versus frequency for all three tapes at the 0-dB recording level. Lowest distortion (around 0.7% at mid-frequencies) was achieved by the metal-tape sample. The Type I tape distortion hovered around the 1% mark for mid-frequencies while the Type II (high-bias tape) exhibited the highest distortion at this recording level: around 2.0% for mid-frequencies. As expected, distortion increased proportionately for all three types of tapes at the low- and high-frequency extremes.

A further study of distortion was made by varying the record level from -10 dB to +10 dB for a 1-kHz input signal using the Type I and the metal-tape samples. The 3% distortion point was reached at a record level of approximately 8 dB for both types of tape. Ideally, if you increase signal levels to the input of a tape recorder in a linear fashion during playback, the signal level should also increase linearly.

To check that out, we ran tests using 1-kHz and 10-kHz signals of increasing intensity. Normally, in tests of that sort, the 1-kHz signal is fairly linear during playback, while the high-frequency signal usually reaches a maximum value and then actually decreases with further increases in input levels. Thanks to the action of Dolby HX-Pro and Dyneq, that's not quite what happened in the case of the NAD 6300. For normal-bias tape, the 10-kHz output increased almost linearly all the way up to a -2-dB record level. That's much better than we would have expected from that tape at that frequency. Furthermore, instead of the 10-kHz level decreasing with further increases of input (normally, that would occur because of tape saturation), the playback level remained the same all the way out to the end of our test, when input levels had increased to +10 dB!

The linearity of the metal tape was even more remarkable. Normally, metal-particle tape does have better recording capability at higher frequencies. With the assistance of Dolby HX-Pro and Dyneq, the tape remained linear at 10 kHz to well above the 0-dB recording level and, at a +10-dB input level, the playback level of the 10-kHz signal was a bit above +2.0 dB.

Next, we measured the signal-to-

noise performance of the various tape samples, with and without Dolby B and Dolby C. The signal-to-noise ratio quoted by most manufacturers is referred to the signal level at which 3% distortion occurs. However, our readings were taken relative to 0-dB recording level; for comparison purposes add about 8 dB to obtain the S/N ratio the way it's usually quoted by cassette-deck manufacturers. For the normal-bias tape, the S/N with respect to a 0-dB reference level measured 53.8 dB. Turning on Dolby B noise reduction improved the S/N reading to 62.9 dB, while with Dolby C, the reading increased further to 69.8 dB.

The Type II (high-bias) tape produced somewhat higher signal-to-noise ratios with this deck. Without Dolby, the S/N ratio was 56.9 dB. With Dolby B turned on, it was 65.7 dB, while with Dolby C, it was 72.5 dB.

Finally, using the metal tape (Type IV), S/N with no Dolby measured 56.2 dB. With Dolby B it was 65.2 dB and with Dolby C it was 72.3 dB. Using Dolby C with either Type II or Type IV tape and adding the 8 dB of headroom available above 0 dB before the 3% distortion point is reached, results in a practical dynamic range (the range between the highest recorded level and the residual noise floor) of more than 80 dB! In most instances, that's enough dynamic range to handle even the most dynamically recorded CD's that you may want to copy onto tape for listening while jogging, traveling, or driving in a car.

Wow-and-flutter, that annoying fluctuation of pitch that occurs when listening to tapes on inferior playback equipment was so low with this model that it was virtually inaudible even when listening to sustained piano tones where wow-and-flutter is most noticeable. In terms of measured values, the wow-and-flutter, measured during the course of a 30-second interval, remained just below 0.02%. That's lower than the wow-and-flutter on most reel-to-reel tape recorders and is a glowing testament to the effectiveness of NAD's unusual dual capstan arrangement.

Having completed the major performance measurements for the cassette deck, we wanted to check out the extra features such as the CAR compression mode, the PLAY TRIM control and the FINE BIAS adjustment control. We easily determined that the CAR compression feature has no effect upon high levels of recorded program material. For mate-

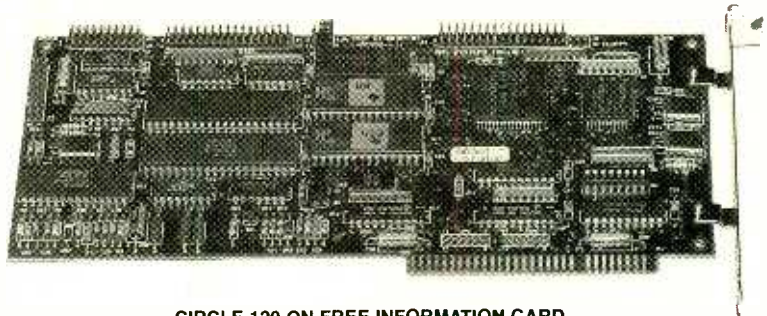
rial at around the -20-dB level, the circuit compresses such material by around 5 dB, so that sounds that are applied at levels of -20 dB are reproduced at -15-dB levels. The compression increases for sounds recorded at still lower levels. Material recorded at the -40-dB level is compressed so that it is reproduced at around -27 dB at mid frequencies. For low and high frequencies, the compression is even greater to take care of the unequal loudness characteristics of the human hearing system in much the same way as a tapered loudness control on an amplifier.

The range of the PLAY TRIM control was such that during playback of a tape, response at 20 kHz could be boosted by around 10 dB, and attenuated by about 5 dB. At 10 kHz, maximum boost amounted to about 5 dB, while the maximum possible attenuation was around 3 dB. The feature has little or no effect upon response for frequencies below about 2 or 3 kHz.

Checking out the FINE BIAS control through the entire record/play cycle you might conclude that its effect is the same as that of the PLAY TRIM control. The difference lies in the fact that PLAY TRIM is used only during playback to compensate for differences in equalization or azimuth alignment for tapes made, for example, on other machines, especially those not equipped with Dolby HX-Pro headroom extension. The FINE BIAS adjustment, on the other hand, is intended to compensate for slight variations between various brands of tapes, even those that are of the same general category or type. The FINE BIAS control would therefore be used while making a recording.

The one thing that puzzled us when using this feature was the way the FINE BIAS control was labeled. To us, the + direction of the control would have meant more bias applied. In fact, what it turned out to mean was "more high frequency level," which, in fact, is produced by slightly lowering the bias level. The instruction booklet, of course, clarifies the matter, but like most of you, we tend to read instruction books as a last resort.

The Hands On Tests. The NAD 6300 Cassette Deck is one of the easiest tape decks to use properly. Thanks to the 3-head monitoring system, you can easily verify that your recording is up to the quality you expect as the recording
(Continued on page 102)



CIRCLE 120 ON FREE INFORMATION CARD

RMT SYSTEMS FLOPPY/HARD-DISK CONTROLLER

Untangle the rats-nest in your computer and open up another card slot by using a floppy/hard-disk controller board that lets you up-grade your system any way you like.

Have you let the world pass you by? I did! I let my PC/XT clone get old before its time. I purchased the computer with two 5.25-inch, 360K diskette drives and thought it would do for a long time. Not long afterwards, I received some diskettes that I couldn't read. They were 1.2MB disks and I was really stuck. Things got a little stickier with the advent of DOS 3.2 and 720K floppies.

Worse still, that version of DOS also supported 3.5-inch 720K disks and subsequent versions could handle 1.44MB disks. I had to get a 3.5-inch drive or I could not swap programs with my friends.

In the middle of this growth/obsolescence period I added a Seagate ST-225 20MB hard disk. That meant having two controller boards instead of one, not to mention a bunch of ribbon cables choking the innards of my computer.

And then "it" happened: One 5.25-inch drive went bad and the other was not far behind. The time was ripe to get a 3.5-inch drive and a new controller card. In the course of my hunt for a new controller I happened upon the *RMT Systems Inc. RMT2001-F2H2 Floppy/Hard-Disk Controller* for IBM PC's, PC-XT's, and true compatibles.

What Can It Do? The RMT Disk Controller supports two diskette drives and two

TABLE 1—DOS & Drive Compatibility

DOS Version	5.25-in. Drive			3.5-in. Drive	
	360 KB	720 KB	1.2 MB	720 KB	1.44 MB
2.1	Y	N	N	N	N
3.1	Y	N	Y	N	N
3.2	Y	Y	Y	Y	N
3.3 & Up	Y	Y	Y	Y	Y

hard-disk drives. Because of the built-in BIOS, the controller can handle almost any combination of drives. The controller supports 5.25-inch disk drives that handle 360K, 720K, or 1.2MB floppies; 720K and 1.44K 3.5-inch disk drives; and most 20-, 30-, and 40MB hard-disk drives. Whatever drives are currently in your system, the RMT Disk Controller should handle them. My old JVC 5.25-inch diskette drive and my Seagate model ST-225 20MB hard-disk were no trouble for the controller.

The DOS version you use will determine what drives the RMT Controller will support. Table 1 lists the drives compatible with the more common versions of DOS. The Y (for yes) indicates that a particular drive can be used with the version of DOS shown. If you are using version 3.3 or higher, you can use any combination of disk drives listed.

Also, if the BIOS in your computer is dated earlier than 10-27-82, you must install a newer BIOS, which is easy enough to do. To obtain the BIOS date

from your computer, you might be able to use the DEBUG.COM utility (check your DOS manual for particulars).

Installation. When you're ready to install the controller turn off your computer and remove its cover. It will be necessary to remove the old controller board. In my case I had two; one for the diskette drives and one for the hard disk. Before you do so, place masking-tape labels near the connectors on the board and on the cables you will disconnect so that you can restore them to their original positions.

Unpack the RMT2001-F2H2 Controller and compare it to the diagram in the board's manual. Be sure you can locate the correct connectors after the board is installed in the computer. But first, check the jumper settings to ensure that they are as listed in the installation manual. Mine were, so I proceeded. Also check the switch bank of 8 switches. Four are used to set the board for the

(Continued on page 102)



Antique Radio

AC POWER FOR A RELIC

By Marc Ellis

other unused connection in the K-111 schematic: a tap wired to the junction of the two choke coils. The tap was there to provide plate voltage for a Type 71-A power amplifier tube (not present in the A.C. Super-Wasp). It supplied the high voltage required by the tube (higher than that available at any point on the voltage-dividing resistor). And its location "upstream" of the divider helped isolate the power amplifier from the other stages of the receiver, minimizing feedback and "howling."

Two months ago (see the July–November 1989 issues of **Popular Electronics**), we completed the restoration of a *Pilot A.C. Super-Wasp* receiver. Those of you who've been following the work know that this fascinating relic of the late 1920's is now ready to try out, except that it still lacks a power supply. Last month, we took a short break from the project to go through some of the accumulated reader mail and—at the same time—give me a little more time to work out power supply details and accumulate parts. Now I'm back on track again and ready to continue the story.

The Original Power Pack. Back in 1929, the purchaser of a new A.C. Super-Wasp could fire it up in one of two ways: He could purchase a factory-built power pack, such as Pilot's model K-111, or build a supply from scratch. But in 1990, K-111's aren't so easy to come by—and I found myself left without much of a choice except to proceed with option two.

Thanks to reader Frank Krantz (Somerdale, NJ), who was kind enough to send some photocopies from his file of Pilot material, we have a pretty good idea of what the K-111 was like. Specially designed for compactness, the power pack was housed in a can that was 9½-inches long, 6⅞-inches wide, and only 3½-inches deep. Besides serving as a power source for the A.C. Super-Wasp, the K-111 was also marketed as a general-purpose unit that could be used to "electrify" older battery-powered receivers. Because of its modest dimensions, the pack could sometimes be placed alongside the old receiver right in the original cabinet.

The K-111's Many Voltages. The circuit of the K-111 shows a Type 80 tube hooked up as a conventional full-wave rectifier. A two-section capacitor-input

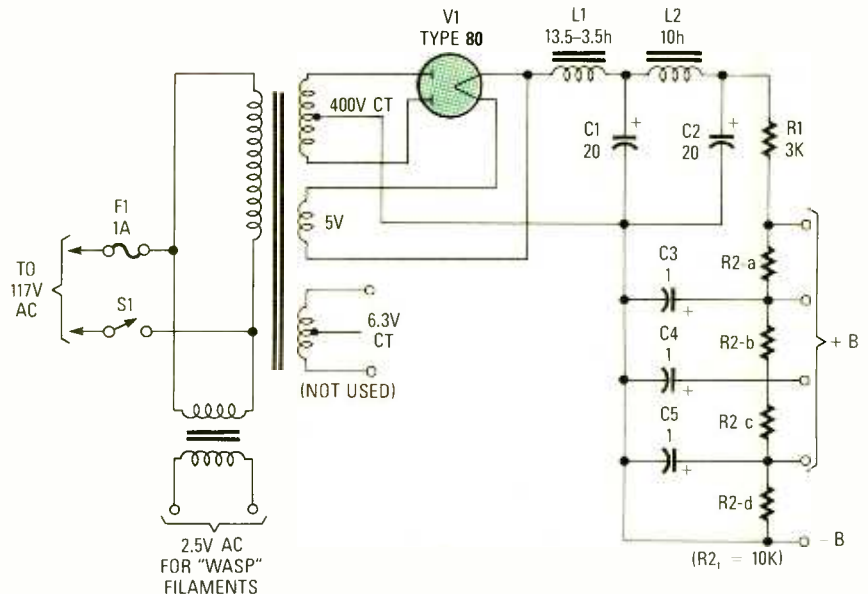


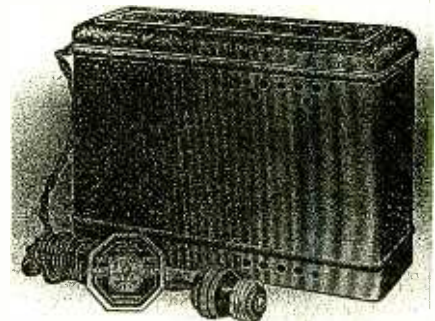
Fig. 1 Schematic for my version of the K-111. Choke-input filter and 3000-ohm resistor in bleeder circuit were used to reduce the voltage delivered by the transformer.

filter is used, and a tapped-voltage divider resistor breaks down the output of the power supply into the four different DC voltages required by the receiver.

In addition to the center-tapped high-voltage winding, the K-111's power transformer boasted no less than four separate low-voltage windings. One of those provided the five volts of alternating current needed to operate the filaments of the Type 80 rectifier tube. The other three were there to supply AC power to the tube filaments in the associated receiver.

Filament voltages weren't well standardized in those days, and each of the three windings supplied a different commonly-used value. One provided 2½ volts for tubes such as the Types 27 and 24-A used in the A.C. Super-Wasp. The others gave 1½ volts and 5 volts to heat Type 26 and Type 71-A tubes, respectively. (The latter two windings are left unconnected when the K-111 is used with a Wasp.)

Readers with sharp eyes will note an-



Pilot K-111 power pack as pictured on reader Frank Krantz's data sheet. The compact housing was designed to fit inside existing radio cabinets. Note light-socket attachment on power cord.

Those Quaint Bypasses. Before leaving the K-111's circuit, I should mention the three 1-microfarad (μF) capacitors that are wired from the taps of the voltage divider to ground. These are *bypass* capacitors, installed to provide the necessary pathways for RF currents to flow in the various stages of the receiver. Not generally used in the earlier

battery sets, the bypasses were made necessary by the circuit characteristics of AC-operated power supplies.

You won't find these bypasses in more recent power-supply schematics because, as time went on, it became obvious that they needed to be incorporated into the radio itself—as close as possible to the component requiring the bypassing. However, it was convenient to include them in power supplies—such as the K-111—that were being marketed for the "electrification" of battery sets not having such capacitors. The capacitors (in conjunction with their associated voltage-divider segments) also served as additional filter elements, supplementing the action of the main filter capacitors and chokes.

A "Modern" K-111. I'm sure the purists in the crowd won't object to my developing a home-made power pack for the Wasp. After all, not every 1929 Wasp owner bought the K-111; many built their own. And if you compare the schematic of my supply (see Fig. 1) with that of the K-111, you'll see that they match fairly closely. However, I'm going to have to apologize for making some departures from the original 1929 circuit.

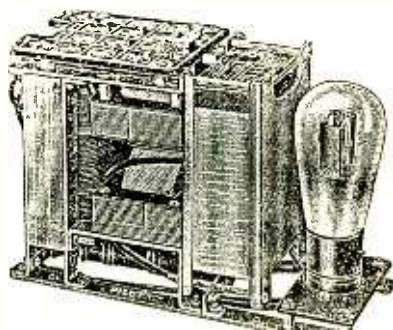
The greatest difference lies not so much with the wiring as with the values chosen for the filter components. Back in 1929, the high-value electrolytic capacitors so familiar to us today were not yet commonly available. The biggest capacitors available for use in high-voltage filter circuits were oil-filled jobs rated at not more than 2 or 3 μ F. In order for those capacitors to function effectively in filters, they had to be matched with chokes having very high

inductances (on the order of 30 henries).

But the 30-henry chokes and 2- or 3- μ F high-voltage capacitors are seldom seen today—even in surplus catalogs. By the 1940's or so, the parts manufacturers were providing inexpensive high-voltage electrolytics rated at 20 μ F and higher. Later, 40- and 50-microfarad units became common. Using one of those larger capacitors in a filter circuit made it possible to downsize the accompanying choke, saving weight and money. Once the electrolytics became available, it was rare for chokes of greater than about 15 henries to be required.

In today's semiconductor age, of course, one has to scrounge to obtain any of the high-voltage components necessary for vacuum-tube circuits. Forget the bubble packs at Radio Shack. We antique-radio nuts have to do our shopping at flea markets, and at those few mail-order outlets catering to our rather exotic needs.

The filter circuit most suited to the parts I already had on hand—or could easily get hold of—is a two-section

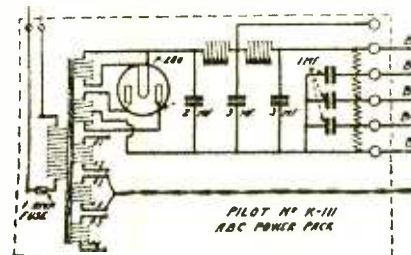


The K-111 with cover removed. Connections to the unit were made via terminal board at top.

choke-input filter with component values typical of those used in the 1940's and 1950's. However, as my schematic shows, I'm retaining the 1-microfarad capacitors associated with the voltage divider taps. Because their capacitance is quite small compared with that of the filter capacitors used, the additional filtering they afford is probably not significant. But the bypass action is likely to be necessary for proper operation of the Wasp—which does not have internal bypass capacitors.

Current and Voltage Ratings. The power transformer and chokes for an A.C. Super-Wasp power supply need to carry only about 60 milliamps (mA) of current. (It takes approximately 40 mA to operate the radio, and another 20 are used in the bleeder resistor). I did have a 60-mA power transformer in my junkbox, but the only usable chokes I could locate had ratings in excess of 100 milliamps.

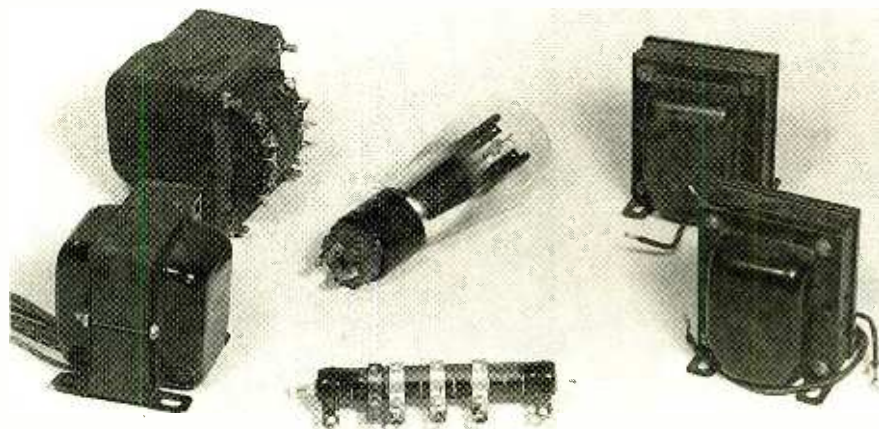
So I kept searching until I located a transformer that looked as if it could easily supply 100 or more milliamps. That way all current ratings would be consistent with that of the Type 80 rectifier tube (which can carry a maximum of 125 milliamps). And if I ever should want to use the supply for a project requiring a little more power, the extra capacity will be there.



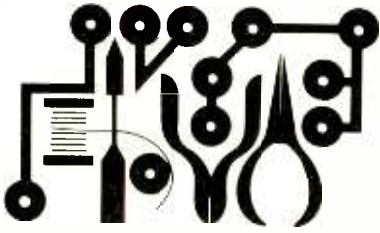
Schematic diagram of the K-111. When powering the A.C. Super-Wasp, the 1.5-volt and 5-volt filament windings were unused—as was the high-voltage tap between the choke coils.

Of course, being a fairly modern unit (maybe 1950's vintage), the transformer doesn't have the variety of tube-filament voltages offered by the one in the K-111. Besides the five volts for the Type 80 filament, it has only a center-tapped six-volt winding (which is all but useless for 1920's-era AC radios). Luckily, a little research in the Fair Radio Sales (P.O. Box 1105, Lima, OH 45802) catalog produced a 2.5-volt filament transformer with ample power (10 amps) to operate the four tubes in the Wasp.

(Continued on page 103)



Results of my parts scrounging for a modern-day adaptation of the K-111. Power transformer and extra (2.5-volt) filament transformer are at left; chokes are at right; bleeder resistor at lower center.



Circuit Circus

ASTABLE MULTIVIBRATORS

By Charles D. Rakes

This month we are going to spend our time together exploring a number of astable-multivibrators, more commonly known as oscillators. When it comes to picking the most often used circuit in electronics, the oscillator has got to be right up there near the top of the heap. And since the oscillator can do its own thing (in most cases) without support circuitry, it is a very popular "fun" circuit for the experimenter and project builder.

The most common type of oscillator starts off as an amplifier with a controlled amount of positive feedback from output to input to initiate and sustain oscillation. I'm sure most of you are familiar with the screeching sounds produced when a PA (public address) amplifier's gain is set too high.

The screeching sound is the result of positive feedback from the amp's speaker to the microphone. That type of oscillation is usually undesirable and in some instances difficult to overcome. Not all oscillators are welcome guests in the world of electronic circuitry.

Three-Transistor Oscillator. Our first entry, see Fig. 1, is a versatile oscillator circuit that will function at audio and low radio frequencies using just about any LC combination for the frequency-

determining components. In our schematic diagram, the three transistors are connected in a Darlington/emitter-follower configuration, which presents a very high input impedance to the LC combination. That circuit arrangement reduces the loading effect on the frequency-determining components.

A simple way to determine the frequency of the LC tuned circuit is to follow this easy-to-use formula:

$$f = 5028/\sqrt{LC} \quad (1)$$

where f is frequency in hertz, L is inductance in millihenrys, and C is capacitance in microfarads. Since C_1 and C_2 are connected in series the total capacitance (C_t) value must be calculated for the above formula using:

$$C_t = C_1C_2/(C_1 + C_2) \quad (2)$$

Here's an example of how to determine the resonant frequency of an LC combination, if L_1 equals 10 mH, and C_1 and C_2 each equal 1 μ F. Since C_1 and C_2 are in series, the total value is determined by:

$$C_t = 10^{-6} \times 10^{-6} / (10^{-6} + 10^{-6}) = 0.5 \mu\text{F}$$

The next step is to multiply the total capacitance (C_t) of 0.5 μ F by the inductance value (10-mH) which gives us a value of 5. Now pull out your cal-

culator and take the square root of 5 which is 2.236. Divide the number 5028 by 2.236, which works out to be 2248 Hz.

If you know the target frequency and have a specific coil on hand, the required capacitance value in microfarads can be determined by:

$$C = 5028^2/f^2L \quad (3)$$

where C represents the combined value of the two series-connected capacitors. Just remember that the series value of C_1 and C_2 must equal the value determined by the formula. If C_1 and C_2 are of equal value, the actual value of the individual capacitors must be 2 times that calculated from the formula; e.g., if the required capacitance is 2 μ F and the capacitors are of equal value, then the individual capacitors must have a value of 4 μ F. (Notice that capacitors in series divide like resistors in parallel.)

PARTS LIST FOR FIGURE 1

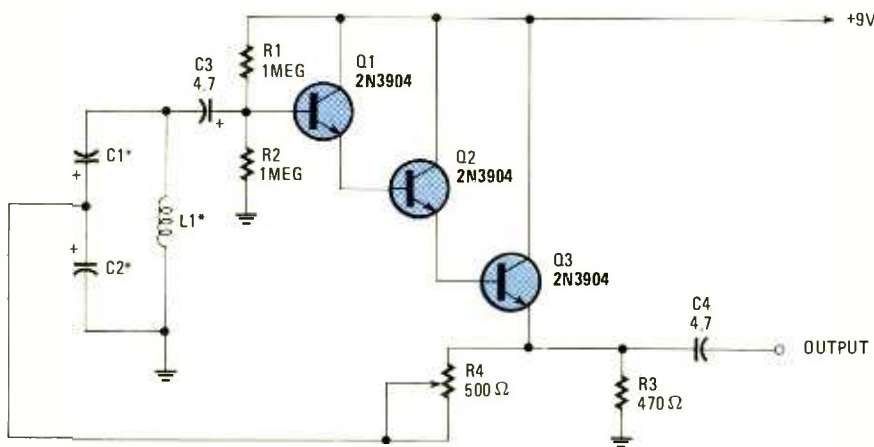
- Q1, Q2—2N3904 general-purpose NPN transistor
- R1, R2—1-megohm, 1/4-watt, 5% resistor
- R3—470-ohm, 1/4-watt, 5% resistor
- R4—500-ohm potentiometer
- C1, C2—See text
- C3, C4—4.7- μ F, 35-WVDC, tantalum capacitor
- L1—See text
- Printed-circuit or perfboard materials, enclosure, IC sockets, battery and battery holder, wire, solder, hardware, etc.

The LC tuned circuit best matches the transistor circuitry when C_2 is larger than C_1 by as much as 2 to 3 times. If you know the required frequency and have a capacitor on hand, the required inductance (L) can be determined by:

$$L = 5028^2/f^2C \quad (4)$$

The receiver element from a telephone handset can be used for L_1 and two 4.7- μ F, 35-volt tantalum capacitors can be used for C_1 and C_2 (note polarization of C_1 and C_2 in Fig. 1) to produce a 700-Hz tone that can be heard coming from the inductor. The oscillator thrives on small inductors and very large capacitors. That feature is helpful in producing very low-frequency tones without the expense of a large inductor.

Potentiometer R_4 sets the positive feedback and should be adjusted for the cleanest waveform. If an os-



*SEE TEXT

Fig. 1. In this circuit, three transistors are configured as a Darlington/emitter-follower, and will function at audio and low RF frequencies.

cilloscope is handy, monitor the output at C4 and decrease the value of R4, starting from its maximum resistance, until the circuit just starts to oscillate. Continue turning R4 in the same direction until the waveform just begins to show some distortion, and then back R4 off until the waveform appears symmetrical.

One-Transistor Oscillator. A similar oscillator circuit designed to operate at a much higher frequency is shown in Fig. 2. The upper frequency limit of that circuit is set primarily by the transistor. The L and C values are selected in the same way as for the oscillator in Fig. 1.

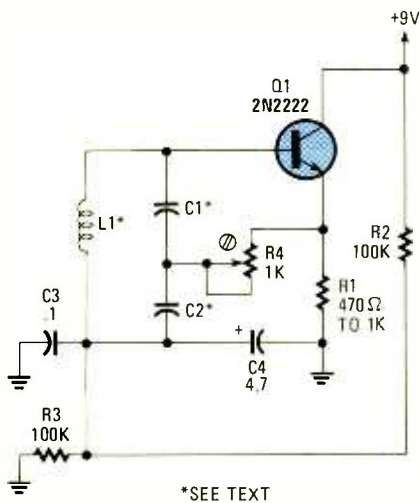


Fig. 2. This oscillator is designed to operate at a much higher frequency than the previous circuit, and its upper frequency limit is governed primarily by the transistor.

PARTS LIST FOR FIGURE 2

- Q1—2N2222 or similar general-purpose NPN transistor
- R1—470- to 1000-ohm, 1/4-watt, 5%, resistor
- R2, R3—100,000-ohm, 1/4-watt, 5%, resistor
- R4—1000-ohm trimmer potentiometer
- C1, C2—See text
- C3—0.1- μ F, ceramic-disc capacitor
- C4—4.7- μ F, 16-WVDC, electrolytic capacitor
- L1—See text
- Printed-circuit or perfboard materials, enclosure, IC sockets, battery and battery holder, wire, solder, hardware, etc.

The oscillator circuit in Fig. 3 is a good choice for a very low frequency, audio-tone generator. Tone frequencies below 10 Hz, and even less than 1 Hz, are obtainable with that oscillator circuit.

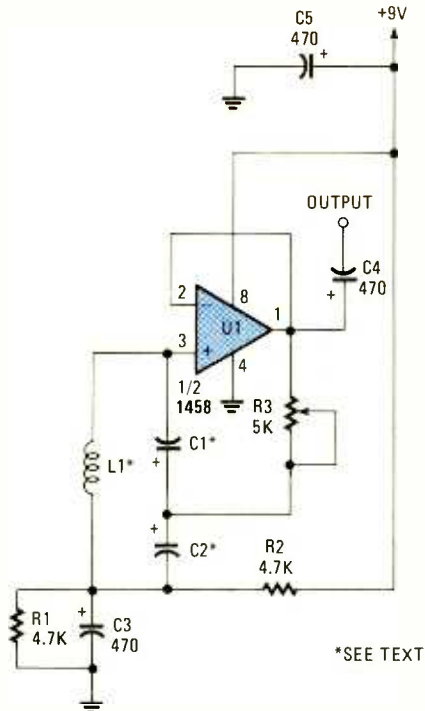


Fig. 3. The low-frequency audio-tone generator (built around a 1458 dual op-amp) can produce frequencies below 10 Hz, and contains an LC tuned circuit similar to those used in the previous two circuits.

PARTS LIST FOR FIGURE 3

- U1—1458 dual-op-amp, integrated circuit
- R1, R2—4700-ohm, 1/4-watt, 5% resistor
- R3—5000-ohm potentiometer (see text)
- C1, C2—See text
- C3—C5—470- μ F, 16-WVDC, electrolytic capacitor
- Printed-circuit or perfboard materials, enclosure, IC sockets, battery and battery holder, wire, solder, hardware, etc.

One half of a 1458 dual op-amp serves as the active element and the LC tuned circuit is similar to those used in the previous two circuits.

When you start working with an LC tuned circuit that resonates at or below 10 Hz, you are dealing with very large inductors with values on the order of 10 henries (H) and up. Not only are large chokes hard to find, they are very expensive. But that's no problem for our circuit because it's happy to oscillate with just about any inductor that you choose to use.

With a little digging in the junkbox, you should be able to come up with a number of choices for the inductor portion of the tuned circuit. In fact, just about any power transformer's primary winding can be used for the inductor;

the several tested ranged from a low of 3 to a high of over 10 henries. One of the best choices, if available, is a variable autotransformer that's made for 117-volts AC operation. Ham swap meets and surplus stores are good places to find that item.

Another very useful inductor that can be used for tuning the oscillator to a very low frequency range is the auto's high-voltage ignition transformer. Connect the high voltage output terminal and either of the primary terminals to the circuit and you can approach a frequency of 1 Hz.

In tuning the 10-henry coil to a frequency of 5 Hz, we find that by using formula 3 (above), a 100- μ F capacitor is needed, and since C1 and C2 are in series, each capacitor value must be twice that size, or 200- μ F each. Thanks to the circuit's versatility, electrolytic capacitors can be used for C1 and C2.

When using the formulas with large inductor values remember that 1 H = 1000 mH. Some LC combinations, especially those used to tune extremely low frequencies, require that R3 be set near the low-resistance end of its rotation. If you get erratic outputs under those conditions, substitute a 500-ohm potentiometer for R3. That arrangement makes controlling the circuit's feedback much smoother.

The "Q" of the large, inexpensive inductors is usually very low, requiring a greater circuit gain to sustain oscillation. Coils used for 100 Hz and up usually are higher in "Q" and require less feedback to maintain oscillation.

Wien-bridge Oscillator. Our next oscillator circuit—a Wien-bridge oscillator (see Fig. 4)—also generates nice low-frequency sine waves and does not require large inductors. The frequency-determining components for that oscillator circuit are two resistors and two capacitors.

The gain of the oscillator's active component, the popular 741 op-amp, is set by the values of R5, R6, R7, and the non-linear characteristic of diodes D1 and D2. The fine gain control, R7, sets the op-amp's gain to produce a clean sinusoidal output waveform. The oscillator's frequency is determined by the values of R1, R2, C1, and C2, when R1 = R2 and C1 = C2.

Setting the frequency of the Wien-bridge oscillator is slightly more difficult than tying your shoes. If a frequency of 1 kHz is desired and two 5% .005- μ F ca-

(Continued on page 101)



Ham Radio

A VISIT TO A.R.R.L. HEADQUARTERS

By Joseph J. Carr, K4IPV

QST QST QST DE W1AW W1AW W1AW. Every evening for many decades, W1AW, the *American Radio Relay League* (ARRL) station at Newington, CT, has pounded out Morse-code lessons on 80-meters, 40-meters, and 20-meters. Generations of aspiring and successful amateur-radio operators (including me 30-years ago) got their "leg up" on the Morse-code skills required for the FCC "ham" ticket by tuning their shortwave receivers to the code-practice frequency used by the ARRL.

When I was having trouble with the code in 1959, my "Elmer" (the late Mac Parker, W4II) loaned me a 1930's vintage Hallicrafters S-20R receiver to tune in W1AW. It worked! The lessons alternate fast and slow on opposite nights. Write to the ARRL (225 Main Street, Newington, CT, 06111) for the current schedule of code-practice sessions.

For many years W1AW was housed in a small brick building (Fig. 1), but that site is now being renovated. When the

building is completed (about the time this column is published), it will house a completely new station that includes seven Harris commercial-shortwave transmitters and an impressive array of antennas. At the time of my visit last summer, the ARRL employee's club station (see Fig. 2) was being used for W1AW activities.

Code-practice text for W1AW practice transmissions are taken from the text of league publications, and is entered into a Heath H-89 computer (see Fig. 3) that, in turn, controls the W1AW transmitters. That explains the perfect "fist" of the W1AW code-practice and official-bulletin transmissions!

What is the ARRL? The ARRL is the principal national organization of amateur-radio operators in the United States, and is a leader amid similar organizations in foreign lands that comprise the *International Amateur Radio Union*. The ARRL has approximately

156,000 members, of which all but about 5,900 are in the United States. Full Membership requires an amateur-radio license, although any person with an interest in amateur radio can become an Associate Member.

The ARRL traces its heritage to 1914 when it was founded by Hiram Percy Maxim (who first held the W1AW call-sign) and Clarence Tuska. Maxim is near-legendary in amateur radio, as well as in other fields because of his technical and organizational skills. He made contributions not only to the radio art, but also to automobile design and cinematography.

After World War I, during which amateurs were silenced by the government, it was the league—under the guidance of Maxim—that fought successfully for the restoration of amateur radio as a hobby. At the time, powerful commercial interests were trying to force hams off the air in order to obtain our frequencies.

They did, in fact, force hams to wavelengths of 200-meters and shorter (supposedly useless frequencies). Instead of hurting us, however, it was a boon...those wavelengths are what we call shortwave today, and form the basis of long-distance (DX) communications. Throughout the 1920's and 1930's, amateurs and the ARRL led the way to developing shortwave-radio equipment.

Amateurs have long been interested in DX, and it is perhaps the biggest drawing card for many aspirants to the amateur-radio hobby. When I walked into the QSL bureau distribution center in ARRL headquarters, my mouth just drooled over the stacks upon stacks upon stacks of DX QSL cards being sorted for distribution to the regional QSL bureaus (who distribute them to you and me).

The ARRL sponsors the coveted "DX Century Club" (DXCC) award, which requires the applicant to work a minimum of 100 different foreign countries. Additional awards, in the form of endorsement stickers to attach to the original DXCC certificate, are granted for every additional ten countries worked. Currently, more than 300 present and previously existing countries are recognized for DXCC purposes.

I visited ARRL headquarters last summer. Staying with my friend Doug Turnbull (E2CN), who was over from Ireland to spend the summer in Connecticut with his family, I took the opportunity to make the 45-minute drive up to New-



Fig. 1. For many years, ARRL headquarters was housed in this small brick building; that site is now being renovated. When the building is completed, it will house a completely new station.



Fig. 2. Temporary operations of WIAW. At the time of this writing, the ARRL employee's club station (pictured here) was being used for WIAW activities.



Fig. 3. Practice text for WIAW code-practice transmissions are taken from the text of league publications, and is entered into a Heath H-89 computer that, in turn, controls the WIAW transmitters.

ington, CT in order to visit ARRL headquarters (see Fig. 4). The ARRL location is a little off the main drag, but is easily found with a little common sense even if you don't have a map (Main Street intersects with the highway right after the Newington sign).

However, if you're a little smarter than me, before you visit, write to ARRL and request a map. Visits are encouraged, and they will give you a guided tour of the facilities. On entering the league

building you will find yourself in a lobby that includes a very nice museum of antique-radio gear (see Fig. 5). Antique-radio buffs take note: the museum is interesting to anyone who likes pre-WWII and pre-WWI vintage radio gear, not just licensed hams.

If you visit ARRL headquarters, and are a licensed amateur-radio operator, be sure to bring the original copy of your ham license with you—perhaps they will allow you to operate W1AW.

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Fig. 4. ARRL headquarters building at 225 Main Street, Newington, CT, 06111. When approaching the site on Main Street, look for the WIAW building (Fig. 1) and the towers. The headquarters-building parking lot is behind the radio-station building, and its parking lot is accessed from the adjoining side street.



Fig. 5. In the lobby of the ARRL facilities is a very nice museum of antique-radio gear. The facility would be interesting to anyone who likes pre-WWII and pre-WWI vintage radio gear, not just licensed hams.

Code practice and the DXCC award are not the only services of the ARRL. They also operate a substantial publishing department that is the principal source of amateur-radio technical literature. The *ARRL Radio Amateur's Handbook* has been the main technical reference book for hams since the late 1920's. They also sell the publications of the "Radio Society of Great Britain."

While waiting in the lobby for my tour guide I couldn't resist the display of books...so I bought a few. To support the technical publications, and to maintain a very high technical standard, the ARRL maintains a technical laboratory (Fig. 6) that is equipped with some of the best test equipment on the market.

The lab includes a walk-in Faraday cage (shield room) that keeps test emanations at home, and prevents outside interference from spoiling measurements.

The ARRL also has a technical department that can provide high-quality technical advice to members who mail in written questions. A network of affiliated amateur-radio clubs is maintained and supported by the ARRL. Although each club is locally controlled and is supported financially by its own membership, the ARRL affiliation offers significant advantages and a cohesiveness with other clubs around the country.

The ARRL also sponsors a number of



Fig. 7. ARRL Executive Vice President David Sumner, K1ZZ. David manages the activities of the League on a day-to-day basis, although he reports to a slate of officers and a Board of Directors.

operating activities throughout the year, including a DX contest, the November ARRL Sweepstakes contest, and the annual outing called Field Day (the last full weekend in June). Throughout the year there are a number of regional conventions, a national convention, and innumerable ARRL-sanctioned hamfests around the country. There are also a number of other on-the-air operating activities that are ARRL sanctioned, even though not run directly by ARRL.

Following my guided tour, I was treated to more than an hour of conversation with David Sumner (see Fig. 7), K1ZZ, Executive Vice President of the ARRL. David manages the activities of the League on a day-to-day basis, although he reports to a slate of officers and a Board of Directors. We talked about a number of issues that affect amateur-radio, league activities in general, and certain technical topics that interested me personally.

The ARRL has its critics in ham radio and some of the criticisms are valid. Nonetheless, the league is *the* amateur-radio organization and, for the most part, they do a bang-up job. If you want to inquire about ARRL membership, its activities, publications, or about amateur radio in general, then feel free to write to their headquarters at the address above. ■

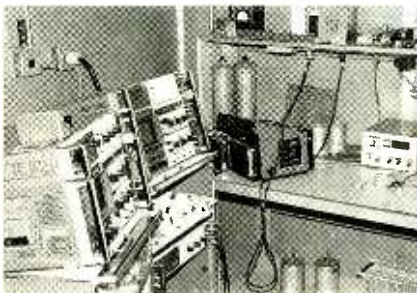
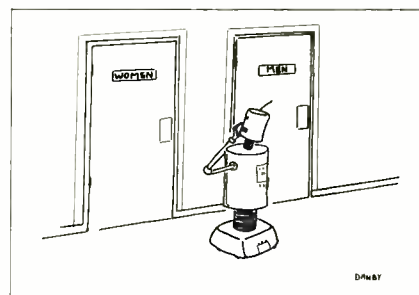


Fig. 6. To support the League's many technical publications, and to maintain a very high technical standard, the ARRL maintains a top-notch technical laboratory that is equipped with some of the best test equipment on the market. The ARRL's technical-laboratory Faraday Cage facility is shown here.





Computer Bits

By Jeff Holtzman

sorting, an extremely comprehensive index and table of contents generator, mail merge, the ability to search for disk files by name or by contents, and more.

In short, XyWrite is extremely powerful and customizable, and runs in 256K of memory. If you're looking for a text tool that you can mold and shape in your own image, XyWrite most likely can fill the bill.

OmniView. If you're reading this column, you already know that computers are addictive. The more you learn to do, the more you want to do. Eventually, however, you get to the point where you work faster than the machine. So you end up waiting for long printouts to finish, for files to transfer from your favorite BBS, for disks to format, etc. At that point it's either buy another computer—or learn to make the one you have do double duty. And doing that is a whole lot cheaper than buying another machine.

Actually, there are several products on the market that allow you to multitask (do several things at once) on your PC. My favorite is called OmniView. OmniView lets you load several programs at once, and depending on the type and amount of memory you have, run those programs simultaneously. For example, in a 640K machine with no additional memory you could easily run ProComm (which requires about 200K) and a text editor (Qedit, for example, which requires only about 50K plus space for text) simultaneously. That way you could write a letter to Aunt Sally while downloading the latest version of Asteroid Adventures.

If you have an EMS 4.0 memory board or a 386, you can multitask several programs that together could not fit in 640K. For example, you might run ProComm (200K), a 300K spreadsheet program, and a 500K word processor simultaneously. In a system with an EMS 3.2 memory board, you couldn't run those programs simultaneously, but you could still load them all into memory and switch among them manually as necessary.

For example, for several years I found it useful to operate a manual task-switching system. I set up five partitions: (1) A 300K partition that ran a program (GrandView) I used for organizing my daily tasks. (2) A 250K partition that ran a database program (PC-File) I used for keeping a phone log. (3) A 450K partition for my word processor. (4) A 400K
(Continued on page 93)

POTPOURRI

This month I've got several products to look at, so let's jump right in.

XyWrite III Plus. Writers, like most craftsmen, tend to have an endless fascination with their tools. Not so long ago it might have been a favorite pen or typewriter. Nowadays the fascination concerns word processors. So I decided to check out XyWrite, which has a reputation of being fast and powerful; it's also considered to be somewhat unfriendly.

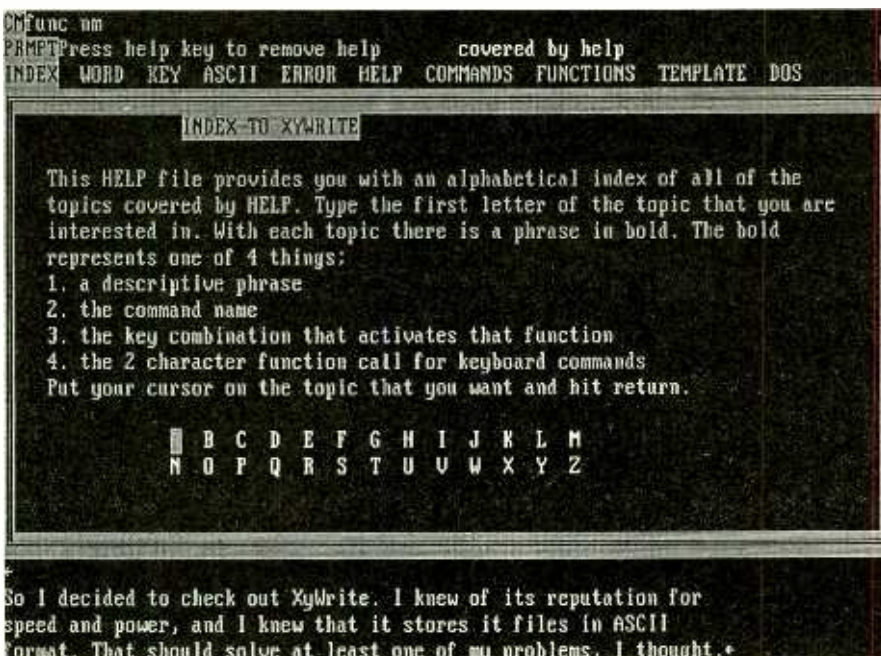
XyWrite is big and full of features, including large-file editing, spell checker and thesaurus, on-line help, macros, and support for many types of printers, including lasers.

Unusually, in this day of drop-down menus and the like, to accomplish most tasks you move the cursor to a command line where you type things like SPELL (to start a spelling check), WC (to count the number of words in a file), TYPE (to print a file), etc.

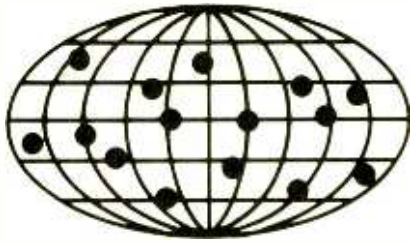
Part of XyWrite's power comes from its built-in programming language, and from its customizable printer and keyboard files. The keyboard file lets you customize and modify each of six shift-states for every key (<A>, <SHIFT-A>, <CTRL-A>, <ALT-A>, etc.). And if you have an off-brand printer (or if you simply want to customize the default setup), just edit the ASCII printer file.

Xywrite's programming language is quite powerful; you can build entire menu-driven systems for controlling the editor's operation. For example, XyWrite's installation program is simply a XyWrite program that helps you copy necessary files from the installation disk. The latest version of XyWrite includes another XyWrite program called A La Carte Menus that provides a somewhat more friendly user interface than the standard product.

Advanced features include the ability to open nine windows simultaneously, multi-column editing, file



XyWrite III Plus is a fast, powerful word processor with all the necessary features and enough customizability to keep tinkers busy for years.



DX Listening

TRAGEDY IN CHINA

Last summer's events in China, culminating in the tragic shattering of freedom's bright hopes, resulted in some of the best and worst of shortwave listening.

The worst was a throwback to the propaganda situation that prevailed during the darkest years of the Iron and Bamboo Curtains. In the bad old days, the airwaves were filled with blatant propaganda, disinformation programming, and jamming that blocked listeners from hearing foreign shortwave broadcasts.

We heard that all again from China, both before and after June 4, 1989, the day the government and its troops violently stamped out the student protest in and around Beijing's Tiananmen Square.

As shortwave listeners, we look to international broadcasts to keep us informed on world developments as they occur around the globe.

But in the weeks before that date, SWL's found little in the English programs of *Radio Beijing* about the growing protests and huge public demonstrations in the Chinese capital.

When the Chinese people, looking for news of what was happening in their own country, turned to shortwave programming of the *British Broadcasting Corp.* and the *Voice of America*, they found those channels jammed.

And in the months following the terrible events in China, listeners again have looked in vain for candid and factual reports from *Radio Beijing's* English programming.

But on June 4th, there was one brief, bright moment of truth and bravery on *Radio Beijing*. And for SWL's who happened to be tuned in, it was a rare and thrilling moment, the best that SWL'ing can offer.

*CREDITS: Brian Alexander, PA; Edward Cichorek, NJ; Norman Bobb, MN; Harold Frodge, MI; Jerry Clinck, NY; John Carson, OK; Jim Renfrew, NY; Bob Rydzewski, CA; John Tuchscherer, WI; North American SW Association, 45 Wildflower Road, Levittown, PA 19057.

By Don Jensen

If you didn't hear it, you probably read about it in your newspaper, or saw it reported on network-TV newscasts, as the minute when *Radio Beijing* lost control. An English-language announcer threw away the propaganda script and began telling all the world what was really happening in the streets outside the studio.

In an emotional voice, the announcer told of thousands of innocent civilians killed, shot, and crushed under army tanks, as troops forced their way into the heart of Beijing.

"Radio Beijing's English department," he said, "deeply mourns those who died...and appeals to all its listeners to join our protest of the gross violation of human rights and the most barbarous suppression of the people!"

For some 60 seconds, listeners heard what to China's aging leaders was heresy. The *Radio Beijing* announcer was summarily replaced, not to be heard on the air since. The lid again was clamped on tight; government orthodoxy was enforced.

Some reports say that the heroic broadcaster was Liu Dan, then head of Beijing's English-language service, who, at the very least, seems to have lost his job in the crack down on dissent. Other accounts out of China suggest it was another, unnamed announcer. One, unconfirmed report claimed the heretical broadcaster paid with his life for his daring and commitment to truth.

At the time this column was written, we don't know for certain his identity and fate, or that of other *Radio Beijing* staff members who supported the freedom movement. We can salute them, however, for contributing to the best that shortwave broadcasting can offer.

WDX Monitoring Service. Since our return to the newsstands, I've been getting a number of letters from faithful souls who first began reading **Popular Electronics** several decades ago. And many of those readers ask about the WPE call letters once issued by **Popular Electronics**.

For those of you who don't date back that far, a bit of explanation is in order. In the 1950's and 1960's, shortwave listeners, perhaps a bit envious of the call letters assigned by the government to licensed radio amateurs, applied for "call letters" issued by the magazine. Of course, these were unofficial as far as the Federal Communications Commission was concerned. After all, SWL's don't need licenses. But they were distinctive identifiers and, simply, were fun to have. For instance, in 1959, I was as-



Gene Pearson of Perrysburg, OH began his shortwave listening as a 12-year-old boy more than 30 years ago. Today he's an Episcopal minister and still an avid DX'ing enthusiast. What interests him most on shortwave? Unusual and rare stations "that tickle my DX'ing curiosity and instincts!" His receiver is a Japan Radio Co. NRD-525.

signed, the "call," WPE9EZ. The number indicates the area of the U.S. where you live. There were special "country" designators incorporated in the calls for those living in Canada or abroad.

Later, the system was administered by longtime shortwave listener and author, Hank Bennett, who for some years was editor of the **Popular Electronics** SWL column. When the magazine ended its sponsorship of the program, Bennett continued it, with the "call" designator changing from WPE to WDX/KDX. Many who had "old" style call letters converted, as I did, to WDX9EZ.

But several years ago, the WDX program was suspended for personal reasons, Bennett explained to me recently. Now, though, it's back in business gain, continuing this old SWL'ing tradition.

As Hank notes, "The primary purpose of the registration system is to give everyone interested a handsome certificate of registration for their listening post, complete with an individualized identification. No two people have the same (call letters) and a permanent record of all registrants is maintained at our headquarters."

Hank points out that the call is not valid for any type of transmitting purposes, but can be used in correspondence, particularly when writing to radio stations. An awards program, instituted in the past, is to be resumed later.

There is a nominal fee, ranging from \$2 to \$5, for issuing the call signs and certificates. For \$2, you will receive a three-letter call sign (e.g., KDX4PDQ), issued in alphabetical order. If you prefer to select your own three letters to follow the WDX/KDX "prefix," (for instance, your initials), the fee is \$3, subject to their availability. If you prefer a two-letter call (e.g., WDX8ZZ) or a one-letter choice (e.g., DKX6R), the fee is \$5. In the case of the latter option, give several choices since few one and two letter calls remain unassigned.

The address is WDX Monitoring Service, P.O. Box 3333, Cherry Hill, NJ 08034. If you have any questions about the WDX/KDX "call letters," drop Hank a line, enclosing a stamped, self-addressed envelope for a reply.

It's a bit of old time SWL'ing nostalgia that's still alive as we move into the 1990's.

Down The Dial. This is the corner of the column devoted to what's on the air, and when and where you can tune in on the shortwave bands to hear sta-

tions around the world. These tips come from listeners and DX-hobby publications.

What are you hearing on SW? Why not share your information with the rest of our readers? Or maybe you have comments or questions about the SWL'ing scene. Your letters are always welcome! Send them to me in care of *DX Listening*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735.

What are the others hearing on SW? Let's take a look:

Antigua—5,975 kHz. The British Broadcasting Corp. programming you hear on this frequency during the nighttime hours, say around 0530 UTC, is being relayed by a transmitter on this West-Indian island. Strong signals from this one, and the broadcasts are in English, naturally.

Australia—9,580 kHz. *Radio Australia* should be an easy log provided you get up early in the morning, say around 1030 UTC.

Austria—13,730 kHz. *Radio Austria International* from Vienna is being reported on this frequency around 0145 UTC with good signals. Strauss waltzes? Sure, but much less *schmaltzy* programming too.

Bulgaria—9,835 kHz. *Radio Budapest* has been a regular in this part of the 31-meter band for a long while. Listen for English programming around 2330 UTC.

Cameroon—4,950 kHz. *Cameroon Radio Television* operates on this frequency from the city of Yaounde. Listeners report some great regional African music. Look for it before 2400 UTC sign off, when you can hear bilingual identifications in French and in English.

Central African Republic—5,035 kHz. *Radio Contrafrique* is another West-African station that can be logged during the late afternoon in North America. It signs off at 2300 UTC.

Denmark—25,850 kHz. *Radio Denmark* is now operating on this high frequency now that the sunspot count is increasing rapidly and the band is "open." Look for its sign on to Greenland at 2000 UTC. Programming is in Danish, but there's a quick English ID at the beginning of the transmission.

Philippines—15,220 kHz. *Radio Veritas* is the Roman-Catholic broadcasting outlet in Manila. Though the frequency is bothered by interference, you may find this one with religious programming around 1500 UTC. ■

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Scanner Scene

By Marc Saxon

ANTENNA QUESTIONS ANSWERED

The Realistic PRO-2010 is Radio Shack's top popular-priced scanner. That means that, at \$219.95, it's priced far below their super scanners (PRO-2005 and PRO-2021, more than \$400 and \$300, respectively), yet it's fancier than their other "base station" units, priced as low as \$140. So, for those who aren't quite ready to go hog wild, yet want something dressed up with some frills, the PRO-2010 offers a compromise worthy of consideration.

For your \$219.95 you get full low/high-band VHF coverage, the VHF aero band, and the UHF/UHF-T bands. Fully keyboard programmable, the 2010 lets you punch more than 23,000 different action frequencies into the set, and retain 20 of them in its memory banks. It's got a floating priority channel, plus search/scan capability. An easy-to-read LED display lets you know the status of what the set is doing.

The PRO-2010 comes with its own telescoping antenna and a connector that you can use to attach an outside antenna for improved reception. All in all, it's a rather good scanner at a price that is reasonable for what you're getting. See it at your local (or nearest) Radio Shack store.

Antenna Matters. This column frequently receives letters asking for some answers to questions relating to antennas for scanners. In view of the fact that very often the antenna system sets the level for the monitoring efficiency of the entire station, we thought we'd tackle some of the most-often-asked questions posed to the column.

For instance, you won't believe the number of people who have written in asking about whether we suggest running a scanner into the cable-TV company's incoming line that supplies signals to the family TV set. After all, it's bringing in distant TV signals.

The presumption is that a cable-TV company is no more than a gigantic multi-outlet signal booster or preamp.

That's really a lot less than what a cable system is. Suffice it to say that those systems receive distant TV signals and then actually retransmit them via cable. Therefore, the only signals that are being fed into their cables are those that they put there, which are TV and sometimes FM-broadcast signals. Since they aren't feeding any police, fire, federal, aero, and other two-way signals through, there's not much point in trying to use their facilities to feed your scanner.

Next, we've heard complaints from readers who say that while they have never had any problems receiving far-away stations in the scanner bands below 174 MHz, they do have problems hearing anything but relatively close stations in the 406- to 512-MHz band, and those above 800 MHz. I agree; the UHF signals don't seem to have quite as much moxie over the long haul as two-way stations on the VHF bands.

One approach that some have used successfully is to get a directional beam

for the band you want, and use it with a rotor so that you can point it into the direction you're trying to monitor. A beam for the 442- to 450-MHz ham band will receive well over the entire 406- to 512-MHz range, while a beam for the 902- to 928-MHz ham band will receive well on communications frequencies above 800 MHz. Those should be used with low-loss coaxial cable intended for UHF communications work.

A considerably cheaper, and frequently adequate, means of improving distant-station reception above 406 MHz is to use a UHF TV antenna intended for reception in a fringe area. If you mount it with the antenna elements in a vertical plane (as opposed to horizontally, as intended for TV reception), you'll have a decent beam offering lots of gain and, if cut for 470 to 812 MHz, one that will receive communications in the 406- to 900-MHz band from rather far away. Use a transformer to change the antenna's 300-ohm impedance to 75 ohms; you can use the 75-ohm TV-type cable to feed the signals into your scanner. While scanners are intended to be fed with 52-ohm coaxial cable, you'll find that (at least, in this case) the mismatch doesn't seem to cause much grief.

Signals can be improved further by the use of a TV-type signal booster inserted in the cable.

People also complain that sometimes the reception on handheld scanners is less than desired. My own experience has been that handhelds



A moderately priced scanner that goes the distance, the PRO-2010 provides plenty of coverage, search/scan capability, and is fully keyboard programmable.

delivered with 6- or 7-inch antennas just don't seem to live up to the receiving potential of the scanner itself. My guess-timate is that they might be delivering less than three-quarters of the signal possible with a more formidable high-efficiency whip that will allow the hand-held to operate at its maximum as a portable unit.

When I felt that my own handheld wasn't doing as well as it should, I ditched the stock antenna and replaced it with a 10½-inch, helical, top-loaded, rubberized, high-efficiency *Scantenna* with a 30- to 512-MHz range. It gave substantial improvement on all bands. If your handheld (like most modern handhelds) has a BNC-type antenna connector, you might want to try a *Scantenna*; it did a good job for me. The *Scantenna* comes from *CRB Research*, P.O. Box 56-PE, Commack, NY 11725. Ask for their free catalog and check it out.

Mail Call. Bob Williamson of Streator, IL, wants to know if we'll oblige him by running the frequencies used by the Federal Bureau of Prisons. Nationally, the agency is believed to use 170.65, 170.875, and 170.925 MHz at the various institutions it operates.

For P.L. W., and all of the others who asked that we publish the VHF frequencies used by airline pilots to chat with one another, we offer: 123.45 MHz over North America; 131.80 over the North Atlantic; 130.55 MHz over the Caribbean; and 128.95 MHz over the Pacific.

We hope to hear from you with your questions, frequencies, monitoring tips, and anything else relating to scanners and scanning. Write to us at: *Scanner Scene*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735 ■



"Please put the parrot in another room when you're working on your electronics projects!"

COMPUTER BITS

(Continued from page 89)

partition for getting into DOS quickly. (5) A 500K partition for running test software, compilers, etc.

Of course, I needed about 2MB of EMS 3.2 memory to run that setup. But it sure was convenient to be able to switch from my word processor to the telephone log when the phone rang, or from my compiler to *GrandView* to jot notes or adjust my schedule.

OmniView provides a menu that you use to start your programs and switch among them. Or you can press hot keys to switch directly among programs. *OmniView* also provides an advanced manual mode that, if you can figure it out, allows you to load a complete "environment" (like mine) automatically with batch files.

There are fancier multi-tasking programs on the market, but none as simple, reliable, not to mention inexpensive, as *OmniView*.

Vendor Information

XyQuest, Inc.

XyWrite III Plus (\$445)
44 Manning Road
Billerica, MA 01821
(508) 671-0888

SunnyHill Software

OmniView (\$89.95)
P.O. Box 33711
Seattle, WA 98133-3711
(800) 367-0651
(206) 367-0650

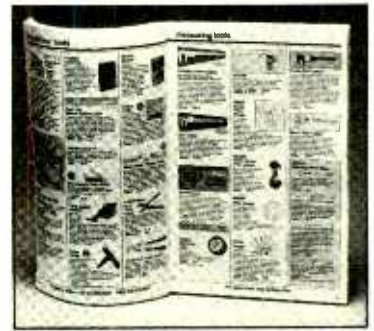
Wilson Windoware

Command Post (\$20 for license, \$5 for disk, \$10 for documentation)
3377 59th Street SW
Seattle, WA 98116
(206) 937-9335

Shareware Update. Last month I discussed a number of shareware products, and sources thereof. One product I neglected to mention, but which deserves a place high on the honor roll for providing excellent utility at very low cost (\$20), is called *Command Post*. This little gem tames Microsoft Windows, allowing you to create menus of your own programs so you don't have to go through Windows' clunky method of changing directories to run programs. The latest version (6.2b as of this writing) adds file-management tools and other features. *Command Post* is available on BBS's everywhere, or order direct from the developer ■

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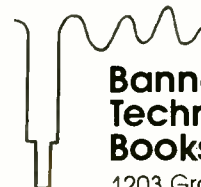
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CORDLESS DC TEST LIGHT

(Continued from page 62)

of the casing. You must now determine the best location for a screw to be inserted through the casing material to make contact with the negative terminal of the lamp (see Fig. 2). Drill a hole just large enough to start a small self-tapping screw. Work the screw all the way into the casing so that the head rests on the casing and then remove it, and file off the tip.

If the lamp fits too loosely into the casing, a plastic bushing can be placed around the lamp to make it more stable. The bushing should be drilled or slit to allow the screw to touch the side of the bulb to complete the circuit.

A clear plastic visor of some sort can be placed over the lamp to prevent damage, however it must be secured in a way that permits easy removal so that the batteries and/or lamp may be replaced. Insert the lamp (with a bushing, if needed), and screw the screw into the casing until it rests lightly against the metal portion of the lamp. Warning: do not overtighten the screw or it may cause damage to the lamp. Nail polish may be applied to base of screw if necessary to keep the bulb firmly in place.

The Cordless DC Test Light is now ready to be pressed into service. But before doing so, take a moment to perform this simple test: Touch the probe tip to the positive terminal of your vehicle's battery with one hand, while placing your other hand on the chassis ground, and then remove your hand from the grounding point. Repeat that little test procedure several times. The lamp should light and go dark as you do, assuming that your battery isn't dead. If the lamp fails to light, check the polarity of the batteries and make sure that the spring is touching the negative terminal of the lower battery.

To use the unit, simply press the probe tip through the wire insulation and place your hand on some grounding point. If the wire being tested is a "hot" wire, the lamp will light; if not, the lamp will remain dark.

Well there you have it. The next time something in your auto fails to operate, do an electrical check on the wiring system to determine if a loose or broken wire is at fault. It might just help you to avoid an unnecessary and expensive repair bill. (Remember, mechanics don't come cheap.) ■

FLOOD DAMAGE

(Continued from page 46)

power transformer. Here we are placing a 117-volt AC lamp in series with the primary of the HV transformer. The current flow is enough to cause internal heat build up, but not enough to zap the transformer. If the HV power supply uses a 220-VAC primary circuit, then place one lamp in series with each AC hot line.

Drying Capacitors. Some remaining areas of concern (and probable damage) are those components where moisture can get in and remain hidden. Candidates include: IF and RF transformers; switches; potentiometers; trimmer, air variable, paper capacitors, and electrolytic capacitors.

On trimmer capacitors, we can open the capacitor up to the minimum capacity position (screw all the way out) and apply a hair dryer or incandescent lamp for 10 or 15 minutes. Whether or not this step is needed can be determined after the initial power-on test shows a specific problem. Otherwise, you will mess up the alignment of the set for nothing. This step should not, therefore, be used merely as a matter of course—only in response to a specific symptom.

Similarly, air variable capacitors may have corroded contact wipers between the rotor and stator, and this will be apparent when the rig is turned on.

Paper and electrolytic capacitors can absorb water, especially if they have a fiber or cardboard end cap. If the capacitor shows signs of being soggy, then replace it; capacitors are, after all, relatively cheap items.

Further Advice. If there remains a lot of "scum" on the printed-circuit board, then spray clean it with Freon TF or some similar material. I prefer to use a small paint brush or "cheese cloth" to help remove the material when through.

After publishing earlier articles on this same topic I heard from a reader who endorsed my advice and added some of his own. He was a former Naval officer who used to have electronics technicians working for him on shipboard. He said they used to repair salt-water soaked equipment in an unusual manner. A sailor would take the equipment into the shower, and slosh it down with warm water. They then took the desalinated equipment to the galley

(that's the kitchen for you landlubbers) and dried it out in the ovens with low heat and good air circulation. The retired Lt. Commander also advised that distilled water is best, and that tap water in some locations is too hard (i.e. contains minerals); you must either buy distilled water or use a water softener.

For a chassis covered with oily dirt, the equipment can be cleaned with a mixture of 8–10 ounces of household ammonia; 4–6 ounces of a cleaner such as *Mr. Clean* or *Lysol*, or acetone; and enough distilled (or soft) water to make one gallon of solution. The equipment is then dunked into it. For larger devices, proportionally larger amounts can be used. He also recommended using an old dental "Water Pik" to hose off equipment that is too large to dunk. The equipment is then dried in an oven set to 140 to 150 degrees Fahrenheit (note: some plastics will melt at temperatures over 130 degrees, so beware) for 4–5 hours. All lubricants in switches, potentiometers, and air variable capacitors (where used) must be replaced after this treatment.

Another Bit of Restorative Advice.

The black asphalt-like goop that oozes out of overheated transformers can be easily removed from chassis by using either a freezing spray, or a blast from a CO₂ fire extinguisher (use an under-pressure one that already needs refilling so that you don't waste your protection on cleaning jobs). The frozen goop becomes brittle and can be flaked off using a dental tool or a soldering tool.

You will find that flood-damaged equipment is often salvageable. The methods described above have been used by professional service technicians for a lot of years—and are proven successful. ■



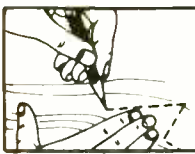
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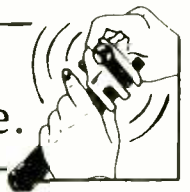
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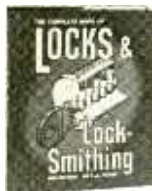
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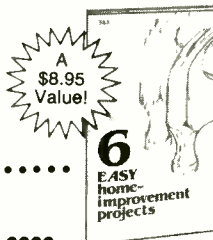
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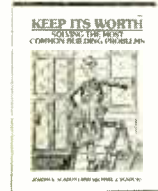
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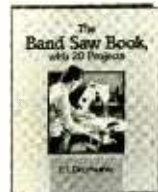
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CIRCLE 7 ON FREE INFORMATION CARD

BUILD THE IC DESIGNER

(Continued from page 42)

KEY(S) PRESSED	SHOWN IN DISPLAY
	COMMAND?
LD PRG	ENTER OUTPUT PIN# (OP)
19	OP19

(The '1' need not be entered as all outputs start with 1, i.e., 12, 13, etc.)

ENTER	ENTER MACRO CONFIG (MC)
ENTER	MC13
13	ENTER OE LOGIC EQUATION OR (ENTER) TO ENABLE
!9	!9
ENTER	ENTER PRODUCT TERM EQUATION
2 & 19 & !18 & !17 & !16	2&19&!18&!17&!16 (only four digits at a time)
ENTER (#)	ENTER PRODUCT TERM EQUATION
2 & !19 & !18 & 17 & !16	2&!19&!18&17&!16
ENTER (#)	ENTER PRODUCT TERM EQUATION
2 & !19 & 18 & 17 & !16	2&!19&18&17&!16
ENTER (#)	ENTER PRODUCT TERM EQUATION
!2 & !19	!2&!19
ENTER (#)	ENTER PRODUCT TERM EQUATION
ENTER	ENTER OUTPUT PIN# (OP)
18	OP18
ENTER	ENTER MACRO CONFIG (MC)
Etc., until all data are entered, then	
ENTER	ENTER OUTPUT PIN# (OP)
!	ENTER AC LOGIC EQUATION OR (ENTER) TO DISABLE
8	8
ENTER	ENTER SP LOGIC EQUATION OR (ENTER) TO DISABLE
ENTER	COMMAND? (Done)

Insert a PEEL 18CV8 into the program socket—BE SURE TO ORIENT IT CORRECTLY. . . IT WILL BE DAMAGED IF INSERTED INCORRECTLY!!!

PROGRAM	PROGRAMMING (takes 5 seconds)
	COMMAND?
VERIFY	VERIFY OK or VERIFY ERROR
SECURE	SECURED (Set the Security bit to prevent copying if you wish)

Because the PEEL has no direct exclusive OR (XOR) capability, that logic function must be emulated with the

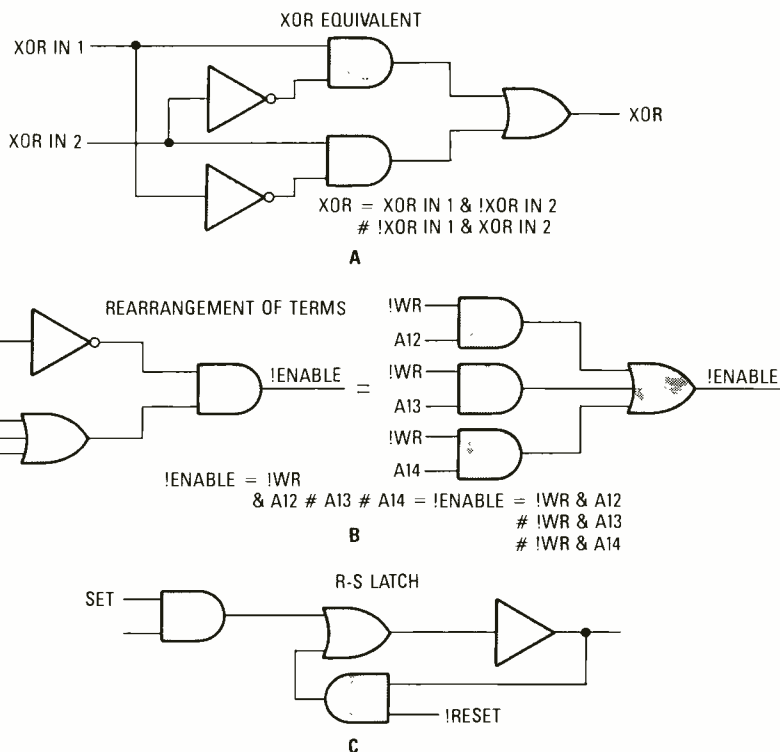


Fig. 12. The PEEL has no direct exclusive OR (XOR) capability, so that logic function is emulated with the equivalent circuit in A. Because AND gates precede the OR gate, the circuit is rearranged (see B). The circuit in C is equivalent to an R-S latch.

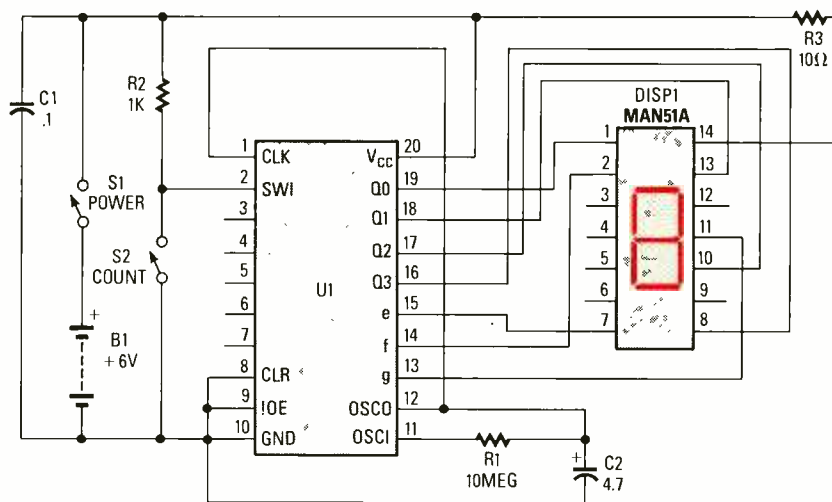


Fig. 13. The schematic diagram for the Lottery Number Selector is built around the custom-designed IC that we just programmed.

equivalent circuit shown in Fig. 12A. Also, since AND gates precede the OR gates, circuits such as that shown in Fig. 12B must be rearranged to overcome that limitation. The circuit in Fig. 12C is equivalent to an R-S latch.

Building a Lottery Number Selector.

The schematic diagram, printed-circuit foil pattern, and parts-placement diagram are shown in Figs. 13, 14, and 15 (respectively) for a novel Lottery Number Selector using the project IC

we designed earlier. And because of the space efficiency of the PEEL, the Lottery Number Selector can be assembled and fitted into a keychain-sized enclosure. The Lottery Number Selector can also be assembled on perfboard using point-to-point wiring instead of the printed-circuit board.

The Lottery Number Selector is simply a random number generator and is not intended as an accurate means of selecting winning lottery numbers.

To use it press and hold the POWER

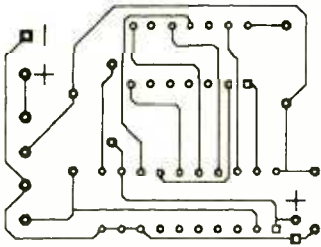


Fig. 14. The printed-circuit template for the Lottery Number Selector is shown here.

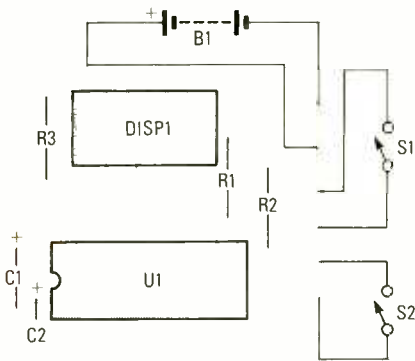
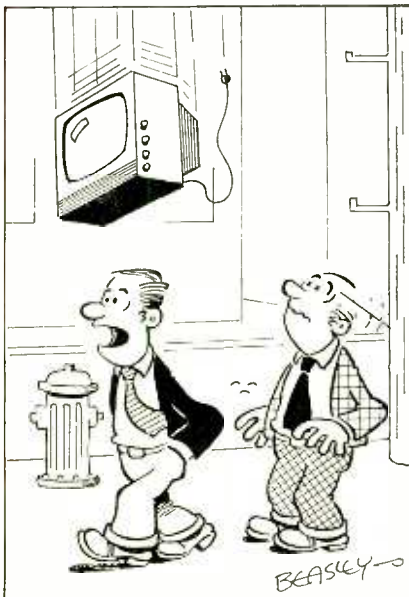


Fig. 15. There is so little to the circuit that you can almost assemble it with your eyes closed.

switch, and press and release the COUNT switch. The counter will continuously increment while the COUNT switch is held and the display will update when it is released. With some minor changes to the design, several of the counting stages can be ganged to make a multi-digit display for a frequency counter, a timer, or a digital voltmeter.



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(See instructions on reverse)

WIDEBAND AMPS

(Continued from page 74)

receivers (and widely used as such), it can also be used as a WBA. The key feature of the circuit that identifies it as a wideband amplifier is the lack of frequency-selective elements. The input and output are capacitively coupled, and a coil is used to "peak" the response at the high end of the frequency spectrum.

The AGC input is either left floating (for maximum gain), or connected to a DC source if the gain of the circuit must be selectable. The DC voltage must be from +3 to +9 VDC or the gain will drop rapidly. Between those limits, however, gain can usually be raised up to about 20 dB.

Two circuits based on the RCA CA3100 wideband operational amplifier are shown in Fig. 4. That device operates to well over 30 MHz, and is as easy to use as any other operational amplifier. The CA3100 is not easy to obtain in local outlets that are friendly to hobbyists, but it can be found in the Dick Smith Electronics (173 East Broadway, P.O. Box 468, Greenwood IN 46142) catalog. The circuit shown in Fig. 4A is a noninverting follower. The gain of this circuit is found from:

$$A_v = 1 + R2/R1$$

With the values shown, therefore, the voltage gain of the amplifier is 10.2, or about 20 dB, over a frequency range of audio to 30 MHz.

The stability of the circuit is determined by three capacitors: C2, C3, and C4. Capacitor C2 is used to keep the gain needed at higher frequencies from causing self-oscillation. Capacitors C3 and C4 are decoupling capacitors. Because of the frequency response of the circuit, it is absolutely essential to keep the capacitors as close as physically possible to the body of the CA3100 to prevent oscillation.

Figure 4B is an inverting version of the circuit shown in 4A. In this case the gain is merely the ratio of the two feedback network resistors: R2/R1. With the values shown, the gain is 20-dB, or -10 (the output is inverted with respect to the input). The circuit uses isolation resistors in series with each power-supply line to improve decoupling.

What Are MMIC'S? Monolithic Microwave Integrated Circuits (MMIC's) are tiny little "gain-block" IC's that operate from DC (or near DC) to a frequen-

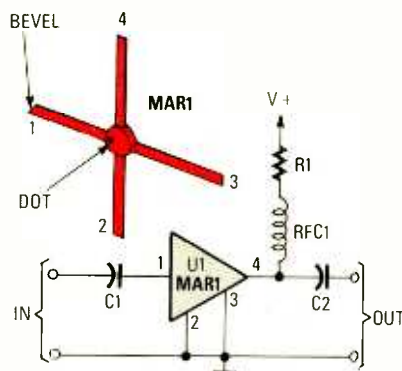


Fig. 5. This simple amplifier requires only decoupling and power. Talk about easy-to-use devices!

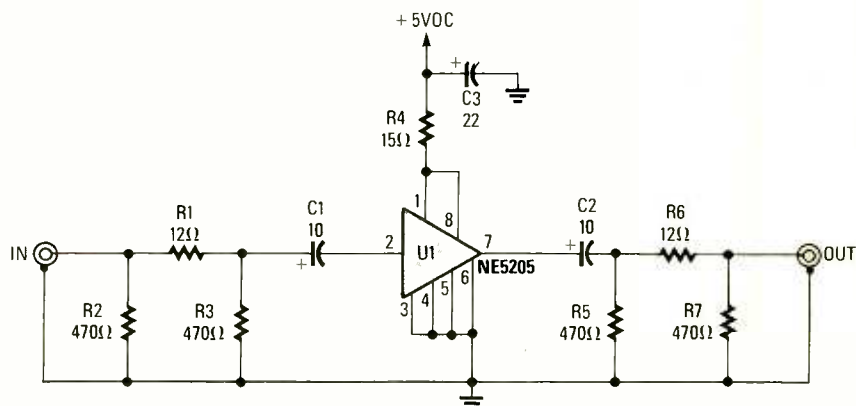


Fig. 6. The pi filters to the left and right of the op-amp are there to squelch any changes in the source and load impedances, respectively.

cy in the UHF or lower microwave region. For example, one product (Signetics NE5205) offers +20-dB gains from DC to 600 MHz, while another (Mini-Circuits MAR-1) offers a +13-dB gain from DC to 1000 MHz. Other MAR-series devices offer gain up to +20 dB, and top-end frequency responses up to 2000 MHz.

There have been other very wideband amplifier IC's on the market, but two things specifically characterize the new MMIC devices. First, is simplicity. As you will see from the circuits we discuss, the MMIC device usually has only input, output, and power-supply connections. Other wideband IC devices often have up to fourteen pins, all of which have to be either biased or bypassed. The second feature is the very wide frequency range of the devices. The frequency response of MMIC devices is often specified in gigahertz.

Figure 5 shows a circuit based on the MAR-1 device. Note that the package of this IC is very much like a UHF transistor package. It is about the size of a BB, so it might be a little difficult to handle if your eyesight is poor. I found it necessary to use a magnifying glass

while building an MAR1 amplifier circuit. The circuit shown works to 1 GHz.

The RF choke (L1) has a value of 1-5 μH, and is used as a peaking coil for the higher frequencies. The resistor (R1) supplies power, and is selected to drop the supply voltage from its regular value to +5 VDC while also limiting current to 17-mA, or less. For +12-VDC supplies, use a value of 470 ohms.

A circuit based on the Signetics NE5205D device is shown in Fig. 6. It is similar to the MAR-1 circuit except that the DC power lines are separate from the output line. The two power terminals are in parallel with each other, as are

the four ground leads. That configuration is used to reduce the effects of inductance of the leads on frequency response.

Attenuators in Amplifier Circuits?

When dealing with devices such as LC filters (low-pass, high-pass, bandpass), VHF/UHF amplifiers, matching networks, and MMIC devices, engineers find it useful to place a 1-, 2-, or 3-dB resistor pi-attenuator pad in the input and output lines. That is done to swamp out any changes in load/input impedances. The characteristics of many RF circuits depends on having a certain impedance at the inputs and outputs. With the attenuator pad in the line, changes don't affect the circuit nearly as much.

The trick is also useful to electronic servicers who are confronted with seemingly unstable very wideband amplifiers. They often insert 1-dB Mini-Circuits Laboratories fixed attenuators, or a homebrew equivalent, in series with both the input and output lines of a flakey amplifier. That tactic costs about 2-dB of voltage gain, but can cure certain instabilities that arise out of load- or source-impedance changes. ■

CIRCUIT CIRCUS

(Continued from page 85)

capacitors are handy, the required resistance can be determined by:

$$R = .159/fC$$

$$R = .159/1000 \times .005$$

$$R = .0318 \text{ megohms or } 31,000 \text{ ohms}$$

The closest standard resistor values to that calculated would be 30k or 33k.

If you can locate a pair of 1- μ F Mylar or polyester capacitors, or even make your own by paralleling two 0.5- μ F units for C1 and C2, you can generate some truly low-frequency sine waves. Two 100,000-ohm resistors for R1 and R2 and the two 1- μ F capacitors for C1 and C2 will cause the circuit to oscillate at about 1.6 Hz. Increase the resistor values to 1 megohm and the oscillator slows down to about 0.16 Hz.

Sinusoidal Oscillator. Our last oscillator circuit generates a sine wave by using three equal-value capacitors and resistors in a phase-shift configuration; see Fig. 5. A 741 op-amp supplies amplification to overcome the losses in

PARTS LIST FOR FIGURE 4

- U1—741 op-amp, integrated circuit
 - D1, D2—1N914 general-purpose small-signal silicon diode
 - R1, R2—See text
 - R3, R4—4700-ohm, 1/4-watt, 5% resistor
 - R5—10,000-ohm, 1/4-watt, 5% resistor
 - R6—33,000-ohm, 1/4-watt, 5% resistor
 - R7—10,000-ohm potentiometer
 - C1, C2—See text
 - C3, C4—47- μ F, 16-WVDC, electrolytic capacitor
- Printed-circuit or perfboard materials, enclosure, IC sockets, battery and battery holder, wire, solder, etc.

PARTS LIST FOR FIGURE 5

- U1—741 op-amp, integrated circuit
 - R1–R3—See text
 - R4, R5—4700-ohm, 1/4-watt, 5% resistor
 - R6—22,000, 1/4-watt, 5% resistor
 - R7—500,000 potentiometer
 - C1–C3—See text
 - C4, C5—47- μ F, 16-WVDC, electrolytic capacitor
- Printed circuit or perfboard materials, enclosure, IC sockets, battery and battery holder, wire, solder, etc.

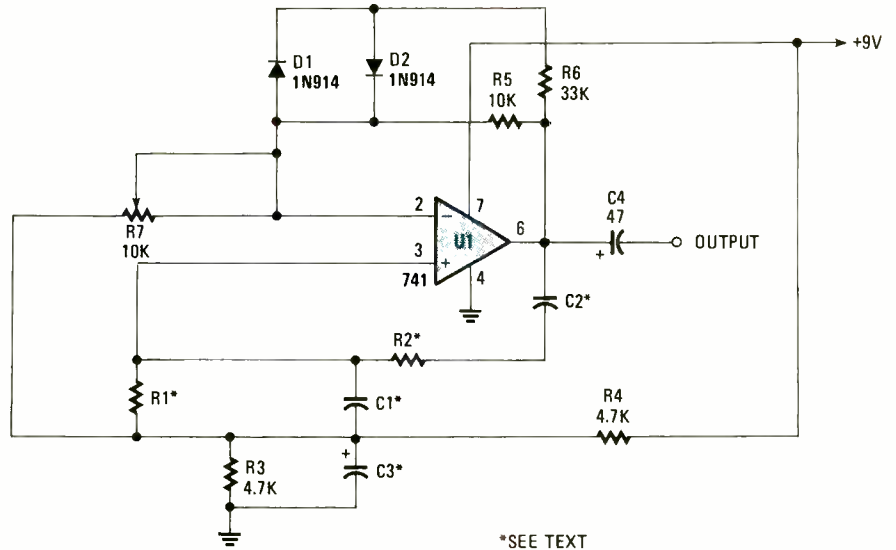


Fig. 4. The Wien-bridge oscillator generates low-frequency sine waves and does not require large inductors.

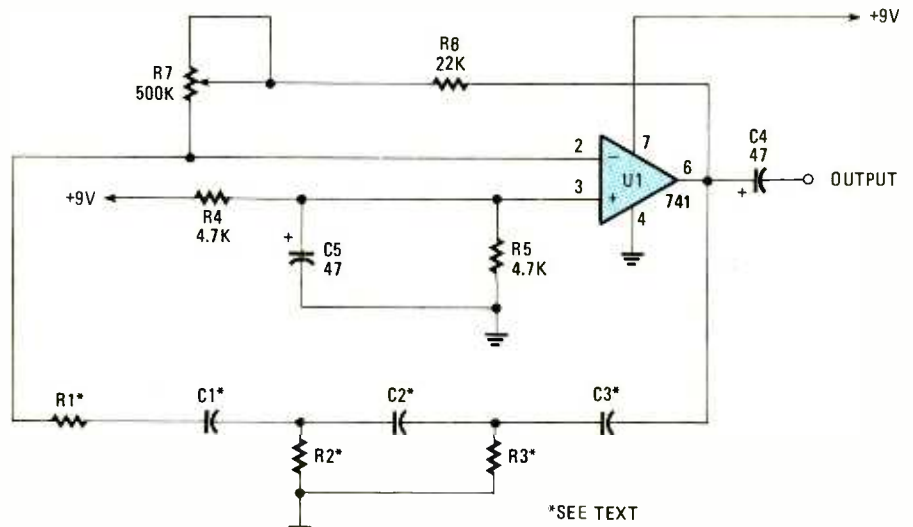


Fig. 5. The sinusoidal oscillator (built around a 741 op-amp) uses three equal value capacitors and resistors in a phase-shift configuration. Setting the frequency of this oscillator is no more difficult than the previous circuit.

the RC phase-shift network and one half of the phase shift needed to sustain oscillation.

The op-amp's gain is set by the values of R6, R7, and R1, or $R6 + (R7/R1)$. With a gain of about 30, the oscillator will produce a good sine-wave output. Each time the values of R1–R3 are changed, the op-amp's gain must be re-adjusted.

Setting the frequency of the phase-shift oscillator is no more difficult than the previous circuit, but different formulas (derived from: $F = 1,000,000/2\pi \times \sqrt{6RC}$) are used to calculate values. To calculate frequency, use formula 5; for resistance, use formula 6; and for capacitance, use formula 7.

$$f = 65k/RC \quad (5)$$

$$R = 65k/fC \quad (6)$$

$$C = 65k/fR \quad (7)$$

Here's an example of how the simple frequency formula works. With three 10k resistors and three .068- μ F capacitors, the oscillator frequency is:

$$f = 65k/RC$$

$$f = 65k/10k \times .068$$

$$f = 65k/680$$

$$f = 95.5 \text{ Hz}$$

It's a good idea to plug in your own component values, and experiment with those formulas to accustom yourself to them.

Well that's about all the space that has been allotted to us this month...but be sure to join us next time. ■

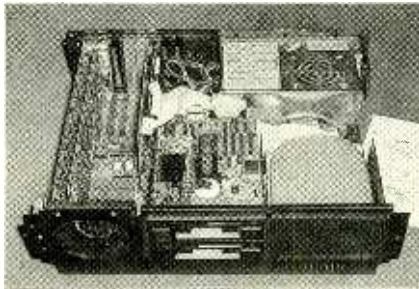
RMT DISK CONTROLLER

(Continued from page 81)

diskette drives you are using, and the other four set the type of hard disk you have.

Connect the floppy-disk drive cable(s) to the controller. If you labeled the cables, as suggested, you should have no problem. The diskette-drive connector is labelled FLOPPY. Be sure that the red or blue wire on the edge of the ribbon cable(s) connects to pin 1 on the board. Press the connectors together securely.

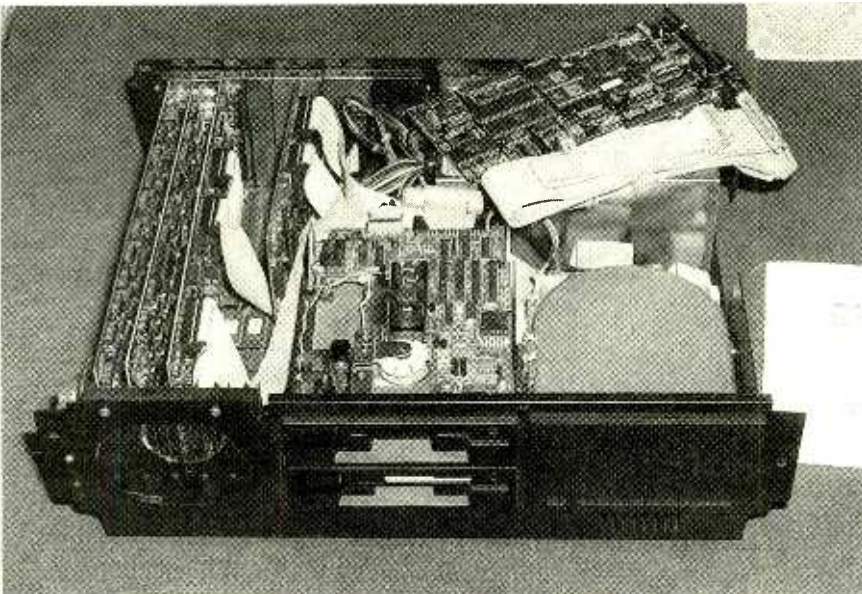
Connect the hard-disk drive(s) to the controller using the cables supplied with the controller. Start by attaching the cable's 34-pin connector to the board connector marked HARD DISK and then connect the two drives. The cable connectors are marked A and B. Be sure to attach the A connector to the



Notice the three extra expansion slots available now that the controller is in. Gee, all that and three drives, too!

3.3, I can store 1.44MB per diskette and swap diskettes with hacker contacts of mine.

The manual rates between good and excellent. All the data you'll need is in it, including information on formatting a new hard-disk drive. The writers of the manual were not bashful about suggesting that you call up their tech-



Shown here are the old controllers (the half-size card and the full card next to it) saying their last goodbyes to the motherboard, and the RMT controller ready and waiting on the right.

bootable hard-disk drive. If you have only one drive, ignore the B connector.

I had one small problem when I replaced the cover. I wasn't too careful and the four-pin power connector to the hard-disk drive came loose as I closed the unit so be careful: check all connectors, even those you did not disconnect.

The New Controller at Work. When I got back to work on the computer it was like old times. The following weekend I purchased a 3.5-inch diskette drive and removed one of the old 5.25-inch drives. Now, by using DOS Version

nical-support service. I did that for the problem I experienced and they suggested several corrective actions, including the loose connector. That's good backup!

You can pick up the RMT Systems RMT2001-F2H2 Floppy/Hard-Disk Controller for your IBM PC, PC-XT, or true compatible for \$199.00 (request information on shipping and handling charges when ordering) direct from RMT Systems, Inc., 18226 McDermott West, Suite E, Irvine, CA 92714. For technical information call 1-714-863-1092. For more information, circle No. 120 on the Free Information Card. ■

NAD 6300

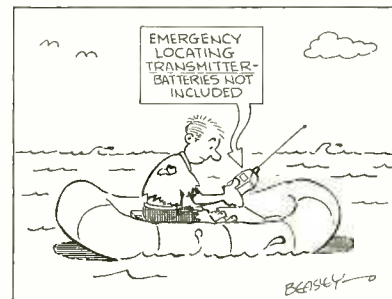
(Continued from page 80)

is made. You simply use the front-panel MONITOR switch to alternately listen to both the source and the resulting recording. If you do detect a slight difference in sound quality, simply adjust the FINE BIAS control until the two sound alike. Using the tapes that we chose for our tests, and with Dolby C turned on, we found that we only had to increase the bias ever so slightly to obtain nearly perfect reproduction. During listening tests of various kinds of musical material, from solo instruments, to voice, to full orchestral works, we were very pleased with the sound quality of recordings made on this deck.

To check out the desirability of the CAR compression feature, we transcribed a couple of CD's that had wide dynamic-range excursions, first without compression, and then with. We took the resulting recording to our own car and did some driving at highway speeds. With the uncompressed recording we found ourselves having to reach for the volume control repeatedly—either to raise the level of quiet passages so that we could hear them above the road and wind noise, or to lower the volume when loud passages were reproduced. When we played back the compressed version of the same recording, we were pleased to find that no volume-control adjustments were ever required during playback.

All in all, the NAD 6300 is an excellent example of how much quality can be built into an analog cassette-tape deck if a company really cares to put its mind to it. If you check out this deck and end up purchasing it, you may wonder, as we did, how NAD was able to cram so much performance into a deck that's priced so low.

For more information on the 6300, contact NAD (57 University Ave., Norwood, MA 02062) directly, or circle No. 119 on the Free Information Card. ■



ANTIQUE RADIO

(Continued from page 83)

I still have enough room on the chassis for a second filament transformer, and if I'm fortunate enough to find one having windings for 1.5 and 5 volts I'll incorporate it into the supply. Those voltages aren't required for the Wasp, but they'd make it possible for me to heat up almost any radio from the "early AC-set" era.

Pilot Testing The Supply. After I'd acquired all of the major parts for the supply, I thought it would be a good idea to pilot test the unit before final assembly on the chassis. So I laid out all of the components on the bench-top, tack-soldered them together, and connected the output of the supply to the voltage-divider/bleeder resistor given to me by the Super-Wasp's previous owner. (It's a hefty 10,000-ohm power unit equipped with an adjustable tap for each of the different voltages required by the radio.)

Connecting a voltmeter across the voltage divider/bleeder, I plugged in the power transformer and awaited the results. Everything worked well, except for the fact that my power transformer was delivering a little more voltage than the one previously used with the Wasp. The reading across the bleeder was about 60 volts too high. That was corrected by placing a 3,000-ohm resistor (see schematic) in series with the "hot" end of the bleeder.

I plan to assemble the power pack in a conventional aluminum chassis, without making any attempt to simulate the special "skinny" housing used in the K-111. To add a touch of nostalgia, however, I'm going to use an old-style, "pear-shaped" 80 tube, as well as a fabric-covered line cord and an archaic-looking molded plastic plug recently obtained from Antique Electronic Supply (688 W. First St., Tempe, AZ 85281).

Although no serious attempt was made to reproduce the "look" of any particular era, the finished supply shouldn't look too anachronistic when compared with the radio. And that's about all that I'm going for!

Brother Pat's Tube Museum. A few years ago, I devoted several issues of this column to a review of the physical and electrical characteristics of early tube types. One of the responses I received was a cordial letter from Brother

Patrick Dowd. Brother Pat teaches science at Paramus (N.J.) Boys High School, but he's better known in antique-radio circles for his writings in *The Old Timers Bulletin* (the official journal of the Antique Wireless Association). He's the contributing editor for vacuum tubes, and writes a regular column on the subject.

In his letter, Brother Pat mentioned the work he has done in putting together the permanent vacuum-tube exhibit housed in Manhattan College's Engineering Library Reading Room. The exhibit is a world-class collection of almost 4,000 items, representing every phase of vacuum-tube design and manufacture as it evolved in this country. The pictures Brother Pat enclosed with his letter made me want to know more—and I approached him for additional information, as well as permission to develop an article about the exhibit for readers of this column.

He was enthusiastic about the idea, and over the past several months, we've had a slow, but regular, exchange of correspondence on the subject. Final copy for the article has now been approved by Brother Pat, and he's in the process of shooting a couple of extra photos to supplement the few he originally sent. You can look forward to reading about that fascinating museum in one of the next few installments of this column.

More Info On The Wasp Tubes. In the October, 1989 issue, I devoted some space to a discussion of the interesting tube types and brands installed in the A.C. Super-Wasp. I included a draft of that discussion in one of my letters to Brother Pat, and asked for his comments. In his reply, he noted that the type JY227 tube I found in the detector socket was not—as I'd been told—a product of a Japanese manufacturer. The "JRC" logo it bears identifies the tube as a product of the Johnsonborg Radio Corp. of Johnsonborg, PA.

That's a Wrap ...for this month. And remember, I'm still looking for *your* contributions to the Super-Wasp story. So far, I've received some much-appreciated data sheets—but I haven't yet seen any stories about personal experiences with this radio. Come on, now! If you have something to tell, don't hold out on us. Write to *Antique Radio, Popular Electronics*, 500-B Bi-County Blvd., Farmingdale, NY 11735. All contributions will be acknowledged in the column. ■

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DIGITAL COURSE

(Continued from page 77)

DeMorgan's Theorem. DeMorgan, a great logician and mathematician, devised two theorems by which one logic circuit is equated with another logic circuit. Those theorems state: 1) The complement of the sum is equal to the product of the complements ($\overline{A+B} = \overline{A} \cdot \overline{B}$); and 2) The complement of the product is equal to the sum of the complements ($\overline{A \cdot B} = \overline{A} + \overline{B}$).

A logic diagram and truth table corresponding to the first theorem is shown in Fig 6A. We want to show that the left side of the equation equals the right side for all possible input combinations; the first case being $A=0$ and $B=0$:

$$\begin{aligned} \text{left: } \overline{A+B} &= \overline{0+0} = \overline{0} \\ \text{right: } \overline{A} \cdot \overline{B} &= \overline{0} \cdot \overline{0} \\ &= 1 \cdot 1 = 1 \end{aligned}$$

Case 2 is $A=0$ and $B=1$:

$$\begin{aligned} \text{left: } \overline{A+B} &= \overline{0+1} = \overline{1} \\ &= \overline{1} = 0 \\ \text{right: } \overline{A} \cdot \overline{B} &= \overline{0} \cdot \overline{1} \\ &= 1 \cdot 0 = 0 \end{aligned}$$

For case case 3: $A=1$ and $B=0$:

$$\begin{aligned} \text{left: } \overline{A+B} &= \overline{1+0} \\ &= \overline{1} = 0 \\ \text{right: } \overline{A} \cdot \overline{B} &= \overline{1} \cdot \overline{0} \\ &= 0 \cdot 1 = 0 \end{aligned}$$

For case 4: $A=1$ and $B=1$:

$$\begin{aligned} \text{left: } \overline{A+B} &= \overline{1+1} \\ &= \overline{1} = 0 \\ \text{right: } \overline{A} \cdot \overline{B} &= \overline{1} \cdot \overline{1} \\ &= 0 \cdot 0 = 0 \end{aligned}$$

Since no other combinations of A and B exist, we have proven DeMorgan's first theorem: For possible input combinations $\overline{A+B}$ is equal to $\overline{A} \cdot \overline{B}$. (Note that the

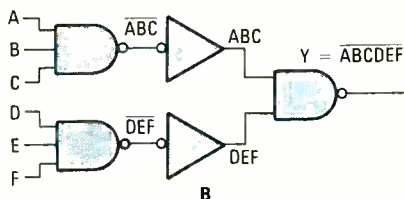
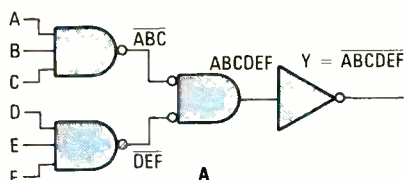


Fig. 5. The circuits in A and B are equivalent, although they may be fabricated from different gates.

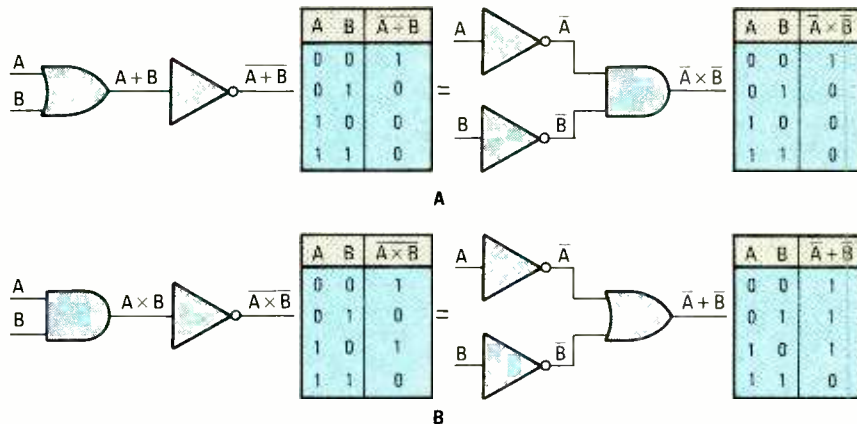


Fig. 6. The circuit in A illustrates DeMorgan's first theorem: The complement of the sum is equal to the product of the complements. The circuit in B illustrates DeMorgan's second theorem: The complement of the product is equal to the sum of the complements.

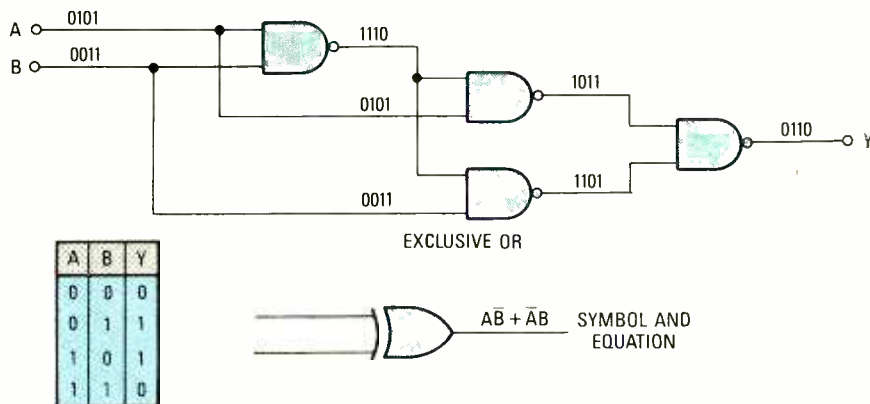


Fig. 7. This NAND-implemented XOR gate is but one example of how one type of gate can be used to perform the function of any of the others.

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logic truth tables for the two logic systems developed from the equation coincides with our findings.) What DeMorgan's first theorem tells us is that the two logic circuits are interchangeable.

The second of DeMorgan's theorems says that $\overline{A \cdot B}$ equals $\overline{A} + \overline{B}$ (i.e., the complement of the product is equal to the sum of the complements). The second

theorem can be easily proven in much the same manner as the first.

The logic systems and truth tables for the Boolean expression representing DeMorgan's second theorem is shown in Fig. 6B. Note that the truth tables are identical: Therefore the expressions are equivalent, and the logic systems developed from those expressions are interchangeable.

As already demonstrated, in order to apply DeMorgan's theorems, we must change any plus (+) signs to multiplication (·) signs (or vice versa) and take the complement of the individual terms. For instance, for $\overline{A+B}$, first change the + sign to a · sign to get $\overline{A \cdot B}$. Take the complement of each term to get $\overline{A} \cdot \overline{B}$.

Even if the A and B terms represent complicated expressions, we can still apply DeMorgan's theorem. For instance, suppose:

$$Y = \overline{(C+DE)(CE+DF)}$$

That's the complement of a product— $(C+DE)$ times $(CE+DF)$ —therefore we

could use DeMorgan's second theorem to re-write the expression as shown below:

$$Y = \overline{(C + DE)} + \overline{(CE + DF)}$$

Thus we have shown that, $\overline{(C + DE)}\overline{(CE + DF)}$ is equal to $\overline{(C + DE)} + \overline{(CE + DF)}$, and the logical expressions on the two sides of the equation are interchangeable.

Exercise. The best way to accustom yourself to using NAND and/or NOR gates to provide a specific function within a logic circuit is to actually do some experimenting with those gates. So pull out the old breadboard, first build the circuit shown in Fig. 6A, and assign pin numbers to the inputs and output of the circuit.

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Now study the AND/OR/inverter logic system, and label the output of each gate with the Boolean expression produced. Set up a logic truth table for the circuit containing all possible input combinations (remember that a logic circuit containing 4 variables has 24, or a total of 16 possible input combinations), but leave the output column blank for now.

Apply the input combinations listed in the truth table to the logic circuit, and record your observations in the truth table's output column.

Next wire up the circuit shown in Fig 6B, and make a Truth table for that circuit. Again label each gate with its output expression. Apply the input combinations to the gate using the +V and ground busses of the power supply (which we placed on the breadboard back in the first lesson) and record your findings in the truth table. Compare the data in the output column of the two truth tables.

As a final exercise build the NAND-implemented XOR gate shown in Fig. 7; make a truth table and record the resulting output states under all possible input conditions. And compare your observations to the findings listed in the XOR-gate truth table. ■

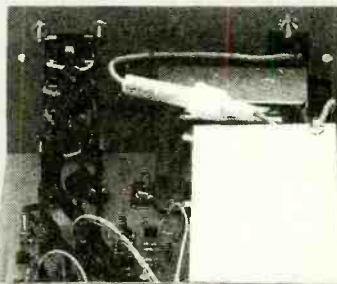
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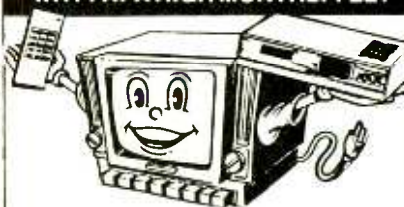
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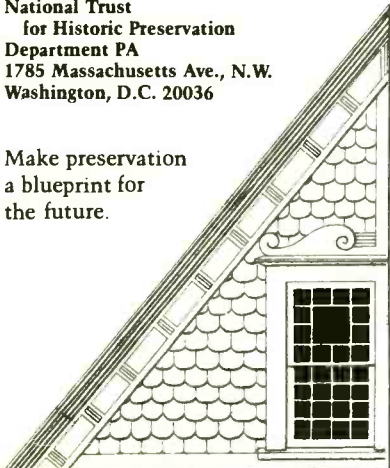
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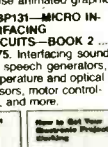
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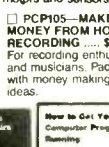
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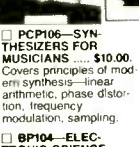
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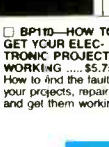
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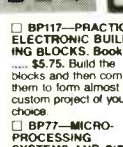
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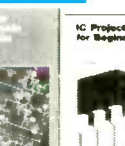
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