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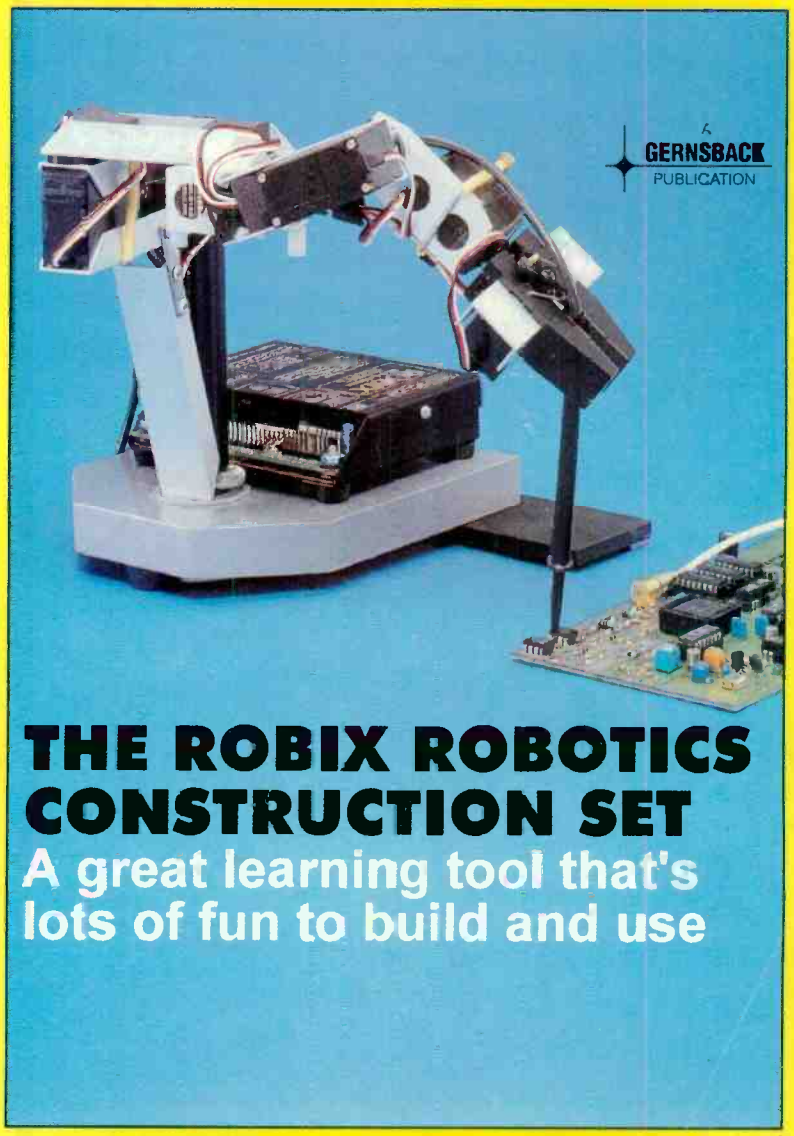

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Popular Electronics®

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EDITORIAL

GETTING A BACKBONE

Some of you may have noticed something different about this month's issue of **Popular Electronics**. We've done a little reorganizing; moving around Gizmo, some other monthly columns and features, and our Market Center advertising section. But even more important, we've grown a backbone!

The change is one that readers have been requesting for a long time. For one thing, adding a book-like spine to **Popular Electronics** makes storing and finding issues a lot easier. Just a glance at the spine will tell you the month and year of the magazine; no more pulling scads of magazines off the shelf to look for the particular issue you need.

Unfortunately, adding a spine wasn't practical until recently. Now, because of the increased size of **Popular Electornics**, we've been able to change to a binding technique known as "perfect binding," which gives the magazine its new look.

In publishing, like electronics, the only constant is change. The changes we've made in **Popular Electronics** are subtle, and we think for the better. Of course, you, our readers, are the final judge of that. Let us know what you think!

Carl Laron
Editor

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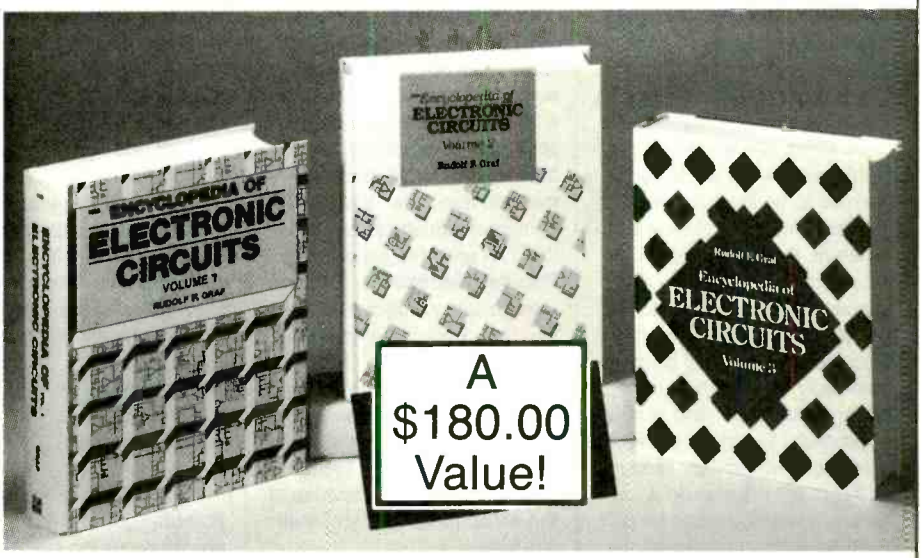

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LETTERS

METRIC MADNESS

In answer to Roger Gilbertson's request for what hobbyists think about his beloved metric system (*Letters*, **Popular Electronics**, October 1993), I would suggest that he devote his considerable energy toward some worthwhile cause. Spotted owls, perhaps, or we have some endangered crickets here in Oklahoma that he could champion.

Three main arguments are used to promote the change to the metric system. (1) The rest of the world uses it, so we should, too. (2) We can sell our products to the rest of the world more successfully if they were made with metric measurements. (3) The metric system uses different terms for force and mass, whereas the English system uses the same term, the pound.

Much of the world is starving, and a good deal of the rest is busy killing one another, so I don't see why we should work so hard to be like them. In fact, it's darn nice to be unique and different. Reason two is an obvious fiction mouthed by a surprising number of educated people who are either mendacious or stupid. Did building metrically dimensioned cameras, motorcycles, and cars hamper the Germans or Japanese from selling their products in the U.S.? If you build a quality product, it could be dimensioned in cubits for all the user cares. Further, there has never been anything to keep anyone in the U.S. from using the metric system, or any other system, whenever it benefits them. I hope we can keep it that way.

As far as reason three is concerned: yes. So what?

And, yes, I like the English system. It's got history, character, and class. It works, and it wasn't invented by the French.

This is not to suggest that the metric system won't take over, what with Big Brother and the schools behind it. I consider it a decided issue, but, as you might surmise, am in no hurry for it. I can handle the metric system when I run across it, but I think the shift to metric is a stupid waste of effort and money. But what else is new with our government?

H.C.D.
Tulsa, OK

A MEMORABLE MOTOROLA

The October issue of **Popular Electronics** is exceptionally well done, seamlessly interfacing with the quality of information and entertainment in the **Popular Electronics** of many years ago.

I am a computer-literate person, so I enjoy those sections also. I was commercially assembly-language programming a 16-bit mini computer when your first "computer" issue hit the stands. Sometimes your material duplicates that in the computer-industry publications that I receive, but just as often, **Popular Electronics** authors include some unique information or a different perspective.

In response to the October *Antique Radio* column, I have had the pleasure of operating several fine Motorola products over the years. In my eyes, their business succeeds because of the exceptional quality of their products.

My prize Motorola today is an R-174 Korean War-era military shortwave receiver. A friend of mine built a "battery eliminator" for it. I am amazed at the performance.

The circuit uses ultra-miniature vacuum tubes. Compared to any other tube (and many solid-state) receiver that I have used, the Motorola is incredibly sensitive and selective. Even in today's crowded bands, the Motorola does well through its entire 1.5–18.0-MHz frequency range. It even has a BFO for sidebanders.

The other big surprise for me is the rapidity with which this circuit warms up—almost as quickly as a transistor set. And there is no perceptible heat buildup! I picked the set up for little money from an ad in the **Popular Electronics** classified section.

K.F.
Santa Barbara, CA

HAVES & NEEDS

Help! I need the schematic for a Sharp stereo tape deck, Model RT-1165. I will be happy to pay all costs. Thanks.

DON GAGNON, KB7WGM
HCR-579-B
Payson, AZ 85541

I have a Tektronix model 7623 storage scope and I need the user's manual to operate the storage functions. I do have the repair and maintenance manual and would gladly exchange photocopies with anyone who has the operator's manual.

I've been a **Popular Electronics** reader since the early 1960's and would like to compliment your fine magazine—especially since you have dropped the emphasis on computers.

JEROME KNAPP
13180 McKanna
Minooka, IL 60447

I am looking for the electronic Scrabble game made some years ago by the Coleco-Serchow Co. I recently purchased the circuit board from All-Electronics Co. (a friendly, efficient company with a lot of goodies at very competitive prices), but they do not have any information on it. I tried writing to the current owner of the "Scrabble" name (Milton Bradley), but they have no information either.

The board I have is working but it is difficult to figure out exactly how this version was meant to be played. There are also a couple of wires with clips on the ends attached to the circuit board that have no readily apparent function. If any of your readers are familiar with this game and how the board was connected, I would appreciate a copy of the information. I will reimburse them for the cost of copying and postage.

RICHARD FLAWS
209 Douglass Way
Bolingbrook, IL 60440

I have a pair of prototype assembly boards made by E.L. Instruments of Derby, CT: an OA-2 op-amp designer, and a Digi Designer. Both include, in addition to the breadboard assemblies, power supplies, various waveform generators, and input/output terminals. They've been very useful to me over the years, but have seen better days and need some repairs and updates. E.L. Instruments no longer seems to be in business, and I'm hoping that someone else who has these boards might have the schematics/manuals for either or both. I would gladly pay for copying costs and other expenses.

GENE WARNER
522 Weiman Street
Ridgecrest, CA 93555

I need a schematic diagram and PC-board layout for a Westminster model No. 1428 AM/FM/CB 1–40 channel/SW1/SW2 412-MHz/Aircraft/PB 108–174-MHz five-band portable radio. If any of your readers have those items, or the manufacturer's address, and perhaps a copy of the owner's manual, I would gladly reimburse them for any printing and postage costs. Thank you.

KEITH TONN
P.O. Box 103
222 Elm Drive
Coleman, WI 54112

I recently bought a TEC-1802 board at a surplus store. Now I'm trying to find the operator's manual and schematic for it. The TEC-1802 was made by Tektron Equipment Corp.

I would appreciate hearing from anyone who can help. Thanks in advance.

A. BOISVERT
1748 Meadowview Ave.
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You can cash in on this big demand quickly when you learn personal computer repair by the Foley-Belsaw method. This quick learning method teaches you the basics of computer repair so you start earning quickly as you continue to learn more complicated procedures. In a short time you'll be earning $80, $100 or more an hour.

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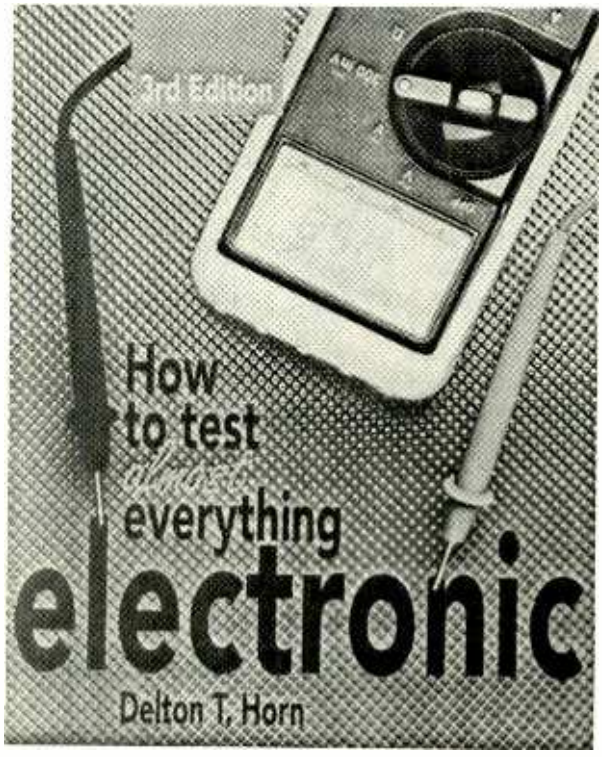
ELECTRONICS LIBRARY

How to Test Almost Everything Electronic Third Edition

by Delton T. Horn



Electronic testing requires specialized equipment, and this book explores the entire spectrum of test gear: multimeters, oscilloscopes, signal generators, logic probes, voltmeters, and ohmmeters, to name but a few. It explains what each instrument can and cannot do, and how to use it properly. Just as important, the book explains how to analyze and interpret the measurements you've made. That requires an understanding not only of the test gear, but also of the circuits being tested.

To that end, the book details a wide variety of actual tests, including voltage and current checks, digital-circuit testing, and television-circuit troubleshooting. In addition, the book covers signal tracing and alignment tests, locating specific components that have gone bad, and the principles of flowcharting and troubleshooting complex systems made up of multiple circuits. Time-saving shortcuts are revealed, as are a number of simple tests that can be made using only a pilot lamp, a neon lamp, or a DC voltmeter. The third edition eliminates some older material on tube circuits, replacing it with expanded information on testing transistor- and IC-based circuitry.

How to Test Almost Everything Electronic, Third Edition, cost $14.95 and is published by Tab Books Inc., Blue Ridge Summit, PA 17294-0850; Tel. 1-800-233-1128.

CIRCLE 98 ON FREE INFORMATION CARD

THE ARRL ANTENNA COMPENDIUM Volume 3

Edited by Gerald L. Hall, K1TD

Forty previously unpublished articles on antennas, transmission lines, computer modeling, and other related subjects appear in this book. Topics range from the practical and straightforward, such as an HF mobile antenna that you can build, to those that emphasize the theory behind some more complex types of antennas, such as off-center-fed multiband wire antennas. Also included are verticals, ground planes, and sloper antennas; miniature, trap, and multiband dipoles; yagis; and loop and quad antennas. The book includes articles on direction finders, ground effects, transmission lines and feed methods, impedance-matching technologies, installations, receiver overload, propagation, and measurements and test equipment. An article on computerized antenna modeling and feed-line calculations is accompanied by BASIC program listings; software is available separately on diskette.

The ARRL Antenna Compendium: Volume 3 costs $14.00 and is published by The American Radio Relay League, 225 Main Street, Newington, CT 06111; Tel: 203-666-1541; Fax: 203-665-7531.

CIRCLE 90 ON FREE INFORMATION CARD

A CONCISE USER'S GUIDE TO LOTUS 1-2-3 RELEASE 3.4

by N. Kantaris & P.R.M. Oliver

This small book is intended to help PC users learn to use a three-dimensional Lotus spreadsheet in the shortest and most effective way. Written with existing Lotus users in mind, yet suitable for newcomers to spreadsheets, the book is made up of self-contained tutorials. More experienced readers can simply skip over those sections with which they are already familiar, while beginners might want to read every tutorial in order.

The book explains how to manipulate three-dimensional worksheets and how to link different files together. It shows how to generate and add graphs to a worksheet, edit

them, and then preview and print the worksheet. The books explains how to use the program's Smarticons to make more effective use of time, and how to use the WYSIWYG add-in to produce top-quality screen and printed displays. In addition, it describes how to set up a database-management system; sort and search a database; use the find, extract, and modify commands to query and edit the information held in a database; create, use, and debug macros; and how to create and use customized menus. The self-contained reference book conveniently lists all of the Lotus 1-2-3 Release 3.4 indicators, Smarticons, functions, and macro commands.

A Concise User's Guide to Lotus 1-2-3 Release 3.4 (order number BP336) is available for $7.25 plus $2.50 shipping and handling from Electronics Technology Today Inc., P.O. Box 240, Massapequa Park, NY 11762-0240.

CIRCLE 97 ON FREE INFORMATION CARD

1994 CATALOG

from Radio Shack

Radio Shack calls its largest catalog ever an "encyclopedia of electronics." Within its close-to-200 pages, are featured more than 75 electronic "Buzz Words," brief definitions of terms. In several product categories, helpful hints for smart shopping also are included, and charts make it easy to make feature-by-feature comparisons of each product offered. A page of money-saving coupons is also included.

The full-color, perfect-bound catalog features more than 3000 performance-tested products that fall into such categories as audio, video, computers, telephones, do-it-yourself, automotive, communications, and home and family. New products include such innovative items as America's first Digital Compact Cassette (DCC) recorder and the Tandy Z-PDA Personal Digital Assistant, as well as the Optimus Professional Series of audio gear, Optimus home-theater

equipment, two stereo satellite systems, a mobile CB radio with digital signal processing, and two multimedia personal computers (MPC).

The 1994 Catalog is available for $2.95 at more than 6600 participating Radio Shack stores nationwide. For more information, contact Radio Shack, 700 One Tandy Center, Fort Worth, TX 76102.

CIRCLE 91 ON FREE INFORMATION CARD

VOODOO WINDOWS: Tips & Tricks With an Attitude

by Kay Yarborough Nelson

Although the appeal of Microsoft Windows, with its intuitive interface and friendly flexibility, is obvious, many Windows manuals obscure the programs attributes with excess information and technical language. This book helps remove the confusion by reducing each Windows function to its simplest ingredients, and limiting those functions to the most accessible, quickest, and easiest. The book demonstrates techniques for teaching your mouse new tricks, customizing Windows for fun and productivity, and avoiding common pitfalls. It provides tips on starting, switching, and exiting Windows; and on copying and pasting. It reveals Program Manager secrets for installation, creating new groups, and multitasking, along with File Manager hints for selecting, moving, copying, and renaming files; deleting files and directories; and using the View menu. The book also covers printing pointers; accessories including Calendar, Calculator, Notepad, Paintbrush, Cardfile,

and Clock; and various ways to customize and optimize Windows.

Voodoo Windows: Tips & Tricks With an Attitude costs $19.95 and is published by Ventana Press, P. O. Box 2468, Chapel Hill, NC 27515; Tel: 919-942-0220; Fax: 919-942-1140.

CIRCLE 92 ON FREE INFORMATION CARD

ISA & EISA THEORY AND OPERATION

by Edward Solari

This successor to, and replacement for, Ed Solari's best-selling *AT Bus Design* covers ISA and EISA buses in a uniform and logical fashion. The just-released Addendum covers EISA EMB (Enhanced Master Burst), also known as Fast EISA, which allows transfers up to 133 Mbytes/second. The first part of each chapter covers the ISA bus. That material is substantially the same as that in the previous book, although in some cases it has been rewritten to achieve consistency with the EISA and EISA EMB buses.

The book creates order out of the numerous combinations of bus cycles, and covers memory-access cycles, DMA transfer cycles, memory refresh, and bus master arbitration cycles for both ISA and EISA buses. The book explains how data sources and destinations of different data widths work with each other, and how byte-swapping affects the bus timing. Common questions about bus timing are also answered.

The author was involved in the design of Intel's EISA interface chip set and was one of the chief authors of the ISA specification developed by the IEEE P996 working group. This book actually clarifies some portions of the EISA specification that are ambiguous or in error. The book replaces both the ISA specification and the EISA specification (which costs $125), and the Addendum replaces the EMB specification (which costs $300).

ISA & EISA Theory and Operation is available for $89.95, and the Addendum for $29.50 from Annabooks, 11848 Bernardo Plaza Court, Suite 110, San Diego, CA 92128; Tel: 800-462-1042 or 619-763-0870; Fax: 619-673-1432.

CIRCLE 93 ON FREE INFORMATION CARD

INSIDE YOUR SHORTWAVE RADIO

by Ted Benson, WA6BEJ

Written in a clearly understandable style, this book explains how your shortwave radio works, beginning with radio reception and taking readers through the inner workings of a typical superhet shortwave receiver. It goes beyond the information that is typically in your receiver's manual, expanding upon what the manual leaves unclear, or leaves out altogether. Throughout the book, the emphasis is placed on helping you get the most from your shortwave radio.

The book discusses receiver tuning, passband tuning, and receiver displays. It explains CW, SSB, Fax, and RRTY signals, and shows you how to tune them in. Shortwave accessories are also covered. The book explains phase-locked loops, IF filters, IF notches, exalted-carrier single sideband, panoramic adaptors, preselectors, antenna tuners, antenna connections, feedlines, and grounds. A wealth of illustrations accompany the text. There is also a handy glossary of receiver terms, and a section that answers many of the most commonly asked questions about shortwave receivers and their use.

Inside Your Shortwave Radio is available for $14.95 plus $2.00 shipping and handling ($3.00 outside the U.S.) from Tiare Publications, P. O. Box 493, Lake Geneva, WI 53147.

CIRCLE 100 ON FREE INFORMATION CARD

RIDING THE AIRWAVES WITH ALPHA & ZULU

by John Abbot

If you'd like your children to get their Amateur Radio Novice or No-Code license but couldn't get them to finish reading a license manual, this book could be the answer. Taking a fresh approach to teaching the amateur-radio question pool, it uses a family of "Phonetico" cartoon characters that review every question contained in the pool. Graphics and drawings are used in place of endless pages of text.

Each cartoon episode is one or two pages long and is followed by a mini exam designed to test reader comprehension. Additional teaching tools provided in the book include word searches, crosswords, and other fun puzzles. Each Phonetico character is named after a letter in the Phonetic alphabet, and their bodies are made up of the appropriate Morse code dits and dahs for that letter. Youngsters and adults alike will enjoy following the Phoneticos' adventures as they explore and discuss the exciting world of amateur radio.

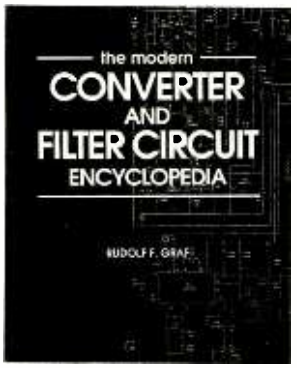
Riding the Airwaves with Alpha & Zulu costs $14.95 and is published by Artsci Inc., P. O. Box 1428, Burbank, CA 91507; Tel: 818-843-4080; Fax: 818-846-2298.

CIRCLE 101 ON FREE INFORMATION CARD

THE MODERN CONVERTER AND FILTER CIRCUIT ENCYCLOPEDIA

by Rudolf F. Graf

This book contains a large assortment of ready-to-use circuits sure to meet the converter and filter needs of engineers, technicians, students, and hobbyists. Representing state-of-the-art technology, the circuits include analog-to-digital and digital-to-analog converters; current-to-voltage and frequency-to-voltage converters; temperature-to-frequency converters; frequency



converters; and band-pass, high-pass, low-pass, notch, noise, and state-variable filters. For easy reference, the circuits are arranged alphabetically by application. Each entry includes a schematic and a brief explanation of how the circuit works. Also included is the original source for each circuit, making it easy for readers to obtain additional information.

The Modern Converter and Filter Circuit Encyclopedia costs $12.95 and is published by Tab Books Inc., Blue Ridge Summit, PA 17294-0850; Tel: 800-233-1128.

CIRCLE 98 ON FREE INFORMATION CARD

THE OFFICIAL AMERICA ONLINE FOR WINDOWS: Membership Kit & Tour Guide

by Tom Lichty

This book-and-diskette package represents an opportunity for Windows users to purchase a complete, Windows-based online package that includes software and support. The book introduces new members to the full range of America Online's services, which include electronic mail, shopping, travel, stock quotes, conferencing, computer support, news, and hobbies. In addition, it introduces new and current members alike to America Online's new Windows capabilities, including multitasking, support of tiling and cascade features, pull-down menus, tool bars, and more. The tour guide provides step-by-step instructions to help users quickly get online and start exploring. It offers pointers on quickly accessing online files and information, getting free online support for your PC and software, and "meeting" and sharing ideas with people who share your interests. The purchase price of the book includes the diskette and a bonus of ten free hours of online time on the American Online system.

The Official America Online For Windows Membership Kit & Tour Guide costs $34.95 and is published by Ventana Press, P. O. Box 2468, Chapel Hill, NC 27515; Tel: 919-942-0220; Fax: 919-942-1140.

CIRCLE 89 ON FREE INFORMATION CARD

ECG SEMICONDUCTORS INSTANT CROSS MASTER GUIDE FLOPPY DISK PROGRAM

from Philips ECG

The newly expanded version of Philips ECG Semiconductor INSTANT CROSS software now cross references more than 8100 additional industry part numbers. The entire data base from the recently published "Supplement 1 to the ECG212Q Semiconductors Master Replacement Guide" has been merged with that in the original (version 1.0) release of the INSTANT CROSS software for IBM PC's and compatibles. The expanded version contains more than 4000 ECG semiconductors that replace more than 270,000 industry devices. Among the devices added are some 60 modules and IC's used in VCR's TV's, audio, PC's, and industrial-equipment applications. Functions include voltage regulators, motor drivers, signal processors, decoders, small-signal subsystems, deflection circuits, and electronic attenuators. A number of transistors, rectifiers, and diodes have also been added.

The enlarged program also features a complete ECG Product Index file that can be selected from the main menu. Entering and ECG part number will display that number and the following numbers plus device description and case style. It is also possible to scroll through the Index file.

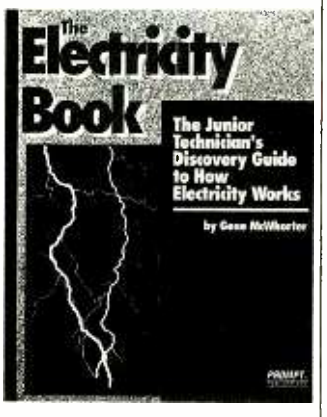
The ECG INSTANT CROSS Semiconductor Master Guide software is available through authorized Philips ECG distributors; Philips ECG, 1025 Westminster Drive, Williamsport, PA 17701; Tel: 800-526-9354.

CIRCLE 88 ON FREE INFORMATION CARD

THE ELECTRICITY BOOK: The Junior Technician's Discovery Guide to How Electricity Works

by Gene McWhorter

This book aims to "spark" the young reader's imagination and interest in electricity—for a hobby, a science-fair project, or even a future career in electrical engineering. With easy-to-read text and clearly illustrated ex-



amples, the book guides junior-high and older students through the principles of electricity. Topics covered include atoms, protons, electrons, and neutrons and how their charges attract or repel one another; motor action and how it is produced; voltage, current, and resistance; and magnetic fields. Each chapter includes applications for various projects and experiments, and ends with a self-test for what the student has learned about electricity. Bold two-color graphics are used in the book and are designed to hold a the young reader's interest.

The Electricity Book costs $14.95 and is published by Prompt Publications, Howard W. Sams & Company, 2645 Waterfront Parkway, East Dr., Indianapolis, IN 46214; Tel: 317-298-5710; Fax: 317-298-5604.

CIRCLE 87 ON FREE INFORMATION CARD

OPERATING AN AMATEUR RADIO STATION

from the American Radio Relay League

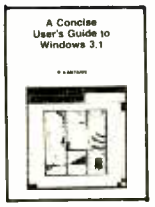
This booklet shows new hams—those who have just passed their Novice (or higher class) Amateur Radio exam—how to jump right in and get started. The booklet answers common questions asked by beginners, including how to decide what equipment to buy, how to choose an antenna, what are the proper operating procedures, and what to say to your first contact. It explains the four cornerstones of successful operating—knowledge, skill, dedication, and courtesy—and then goes on to impart knowledge, help readers hone their skills, inspire dedication, and teach the principles of courtesy and helpfulness that are so important to the amateur-radio hobby. The booklet also provides advice and information about joining clubs, getting technical advice, and sending messages or checking into a packet-radio bulletin board. Finally, it tells about the various awards and operating events.

Operating an Amateur Radio Station costs $2.00 and is published by The American Radio Relay League, 225 Main Street, Newington, CT 06111; Tel: 203-666-1541; Fax: 203-665-7531. ■

CIRCLE 86 ON FREE INFORMATION CARD

Electronic Paperbacks at Special Prices

☐ **BP325—A CONCISE USER'S GUIDE TO WINDOWS 3.1 . . . . $7.95.** Come to grips with Windows 3.1 in the shortest and most effective way. Learn how to manipulate Windows screens and DOS by Windows graphics interface. Master its word processor, Paintbrush and data base along with Notepad, Macro Recorder, PIF Editor, and Calculator.



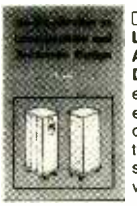
☐ **BP311—AN INTRODUCTION TO SCANNERS AND SCANNING . . . . $7.95.** Radio scanners have opened a realm of exciting radio listening. Understand radio wave propagation, types of transmissions, antennas, band assignments—the straight dope on what to hear and where to hear it! Comes complete with index, glossary of important terminology.

☐ **BP287—A REFERENCE GUIDE TO PRACTICAL ELECTRONICS TERMS . . . . $8.95.** More than just a dictionary of practical electronics terms, the book goes a step further in getting down to fundamentals. A reference volume that can be read casually by a reader seeking knowledge.

☐ **BP248—TEST EQUIPMENT CONSTRUCTION ..... $5.95.** Details construction of simple, inexpensive, but extremely useful test equipment. AF Gen, Test Bench Ampl, Audio Millivoltmeter, Transistor Tester and six more.

☐ **BP267—HOW TO USE OSCILLOSCOPES AND OTHER TEST EQUIPMENT ..... $6.95.** Mastering the oscilloscope is not really too difficult. This book explains all the standard controls and functions. Other equipment is also described.

☐ **BP265—MORE ADVANCED USES OF THE MULTIMETER . . . . $5.95.** Use these techniques to test and analyze the performance of a variety of components. Also see how to build add-ons to extend multi-meter capabilities.



☐ **BP256—INTRO TO LOUDSPEAKERS AND ENCLOSURE DESIGN ..... $5.95.** We explore the variety of enclosure and speaker designs in use today so the reader can understand the principles involved.

☐ **BP298—A CONCISE INTRODUCTION TO THE MACINTOSH SYSTEM AND FINDER. . . .$6.25.** If you have one of the popular Macintosh range of computers, this book is designed to help you get the most from it. Although the Mac's WIMP user interface is designed to be easy to use, much of it only becomes clear when it is explained in simple terms. All Macintosh computers are covered including the new "Classic" range.

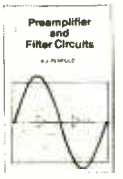
☐ **BP299—PRACTICAL ELECTRONIC FILTERS ..... $6.95.** Presents a dozen filter-based practical projects with applications in and around the home or in the constructor's workshop. Complete construction details are included.

☐ **BP249—MORE ADVANCED TEST EQUIPMENT CONSTRUCTION . . . . $6.95.** Eleven more test equipment construction projects. They include a digital voltmeter, capacitance meter, current tracer, etc.

☐ **BP245—DIGITAL AUDIO PROJECTS ..... $5.95.** Practical circuits to build and experiment with. Includes A/D converter, input amplifier, digital delay line, compander, echo effect and more.

☐ **BP247—MORE ADVANCED MIDI PROJECTS ..... $5.95.** Circuits included are a MIDI indicator, THRU box, merge unit, code generator, pedal, programmer, channelizer, and analyzer.

☐ **BP257—INTRO TO AMATEUR RADIO . . . . $6.95.** Amateur Radio is a unique and fascinating hobby. This book gives the newcomer a comprehensive and easy to understand guide to the subject.



☐ **BP309—PREAMPLIFIER AND FILTER CIRCUITS ..... $6.95.** Provides circuits and background info for a range of preamplifiers, plus tone controls, filters, mixers and more. All are high-performance circuits that can be built at a reasonable cost.

☐ **BP303—UNDERSTANDING PC SOFTWARE ..... $6.95.** This book will help you understand the basics of various types of business software in common use. Types of software covered include word processors, spelling checkers, graphics programs, desktop publishing, databases, spreadsheets and utilities.

☐ **BP251—COMPUTER HOBBYISTS HANDBOOK . . . . $8.95.** A wrapup of everything the computer hobbyist needs to know in one easy to use volume. Provides a range of useful reference material in a single source.

☐ **PCP115—ELECTRONIC PROJECTS FOR HOME SECURITY . . . . $10.00.** 25 projects ranging from a single-door protection circuit that can be completed in an hour or two, to a sophisticated multi-channel security system. Each project is described in detail with circuit diagrams, explanations of how it works, instructions for building and testing, and how to adapt circuits to meet special requirements.

☐ **BP190—ADVANCED ELECTRONIC SECURITY PROJECTS.....$5.95.** Includes a passive infra-red detector, a fiber-optic loop alarm, computer-based alarms and an unusual form of ultrasonic intruder detector.

☐ **BP235—POWER SELECTOR GUIDE . . . . $10.00** Complete guide to semiconductor power devices. More than 1000 power handling devices are included. They are tabulated in alpha-numeric sequence, by technical specs Includes power diodes, Thyristors, Triacs, Power Transistors and FET's.

☐ **BP234—TRANSISTOR SELECTOR GUIDE.....$10.00.** Companion volume to BP235. Book covers more than 1400 JEDEC, JIS, and brand-specific devices. Also contains listing by case type, and electronic parameters. Includes Darlington transistors, high-voltage devices, high-current devices, high power devices.

☐ **BP117—PRACTICAL ELECTRONIC BUILDING BLOCKS—Book 1.....$5.75.** Oscillators, Timers, Noise Generators, Rectifiers, Comparators, Triggers and more.

☐ **BP195—INTRODUCTION TO SATELLITE TV..... $9.95.** A definitive introduction to the subject written for the professional engineer, electronics enthusiast, or others who want to know more before they buy. 8 × 10 in.

☐ **BP179—ELECTRONIC CIRCUITS FOR THE COMPUTER CONTROL OF ROBOTS ..... $7.50.** Data and circuits for interfacing the computer to the robot's motors and sensors.

☐ **BP239—GETTING THE MOST FROM YOUR MULTIMETER..... $5.95.** Covers basics of analog and digital meters. Methods of component testing includes transistors, thyristors, resistors, capacitors and other active and passive devices.

☐ **BP97—IC PROJECTS FOR BEGINNERS.....$5.50.** Power supplies, radio and audio circuits, oscillators, timers, switches, and more. If you can use a soldering iron you can build these devices.

☐ **RADIO—100 RADIO HOOKUPS.....$3.00.** Reprint of 1924 booklet presents radio circuits of the era including regenerative, neutrodyne, reflex & more.

☐ **BP42—SIMPLE LED CIRCUITS..... $5.50.** A large selection of simple applications for this simple electronic component.

☐ **BP122—AUDIO AMPLIFIER CONSTRUCTION . . . . $5.75.** Construction details for preamps and power amplifiers up through a 100-watt DC-coupled FET amplifier.

☐ **BP92—CRYSTAL SET CONSTRUCTION..... $5.50.** Everything you need to know about building crystal radio receivers.

☐ **BP255—INTERNATIONAL RADIO STATIONS GUIDE . . . . $7.95.** Provides the casual listened, amateur radio DXer and the professional radio monitor with an essential reference work designed to guide him or her around the more than ever complex radio bands.

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NEW PRODUCTS

Digital Special-Effects Generator

Although it is targeted primarily at the semi-professional "prosumer" market, small production facilities and home-video enthusiasts can use *Sony's XV-D1000* digital special-effects generator to obtain professional-like results. The easy-to-use component lets you combine multiple video and audio sources, create dramatic scene transitions, add spectacular video effects, and quickly program effects sequences. Designed to

work with professional editing decks, the effects generator features VISCS and GPI interfaces for use with computerized editing systems, three A/V inputs and two A/V outputs for multiple-source editing and post-production effects sessions, and an S-Video input/output.

The XV-D1000 features a digital frame synchronizer for precise combination of two distinct video sources, a double-frame memory for high-resolution images, and 77 different wipe patterns. It allows you to size and insert one image into another, fade to white or black, zoom in on a particular area, divide the screen into nine picture areas, stop the action at successive points and display each point in a nine-image matrix, and freeze the full-screen image without ghosting or tracking lines. A ten-program memory lets you store effects that later can be automatically inserted while editing or watching tapes. Picture quality is retained thanks to the unit's double-frame memory, digital Y/C separation, and video noise reduction.

The XV-D1000 digital special-effects generator has a suggested retail price of $2600. For more information, contact Sony Electronics Inc., One Sony Drive, Park Ridge, NJ 07656.

CIRCLE 103 ON FREE INFORMATION CARD

NINE-RANGE BATTERY TESTER

A compact battery tester from *L-com*, the *DX20BT*, accepts any standard carbon-zinc, alkaline, mercury, silver-oxide, lithium, or nickel-cadmium battery. When the selector switch is set to the desired battery type, the meter will provide a true test of its condition with an actual load imposed. Test results are shown on three colored meter scales for regular, lithium, and nickel-cadmium cells.

The DX20BT features permanent, built-in test leads to prevent signal loss. A special

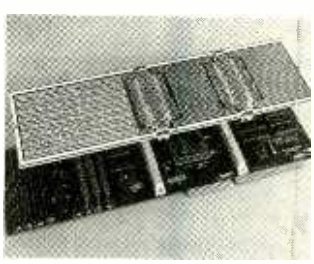
adjustable clamp holds all types of button cells, making the test fast and simple. Dual contact buttons on the top panel accept 9-volt batteries, eliminating the need for test leads in 9-volt tests. The tester also features a "neg" contact button to test any size single cell, so that only the red test lead is required for those tests. The case is elevated for easy reading.

The DX20BT nine-range battery tester costs $18.50 in single units; quantity discounts are available. For further information, contact L-com, Inc., 1755 Osgood Street, North Andover, MA 01845; Tel: 800-343-1455 or 508-682-6936; Fax: 508-689-9484.

CIRCLE 104 ON FREE INFORMATION CARD

DSP-PROTOTYPING DAUGHTER BOARD

Answering the need for a wire-wrapping board that can be used in the development of DSP hardware, *Wintriss Engineering* offers a prototyping daughter board that mounts to their 8- and 16-bit PC-based Turbo 320 DSP development boards, which are based on the industry-standard TI TMS320C30 floating-point digital processor. The four-layer, 3.75 × 13-inch, 0.090-inch-thick daughter board has VCC and ground planes, as well as 1500 plated through holes and two additional power busses. The



board mounts via two 96-pin DIN connectors and has a wire-wrap area incorporating fully labeled TMS320C30 signals. The Turbo boards plug into an IBM-compatible PC/AT 8- or 16-bit bus.

The prototyping daughter board costs $142; Turbo 320 prices start at $995. For additional information, contact Wintriss Engineering Corporation, 6342 Ferris Square, San Diego, CA 92121-3244; Tel: 800-733-8089.

CIRCLE 105 ON FREE INFORMATION CARD

FOUR-HEAD HI-FI VCR

Aiwa is positioning its *HV-FX1000* VHS hi-fi videocassette recorder as an A/V-system source unit. The VCR features MTS stereo and VHS hi-fi circuitry for realistic sound reproduction. HQ circuitry delivers high-quality video, and an automatic head-cleaning system maintains that quality despite heavy use.

Convenience features include a bi-lingual (English/Spanish)

on-screen display, front-panel inputs for easy connection of a camcorder, a VHS Index Search System (VISS) tat makes it easy to mark and then locate specific portions of a recording, frame advance, picture search, and a full-function remote control. Other features include digital auto-tracking, 181-channel synthesized tuner, and an eight-program/one-year timer.

The *HV-FX1000* VCR has a suggested retail price of $450. For additional information, contact Aiwa America Inc., 200 Corporate Drive, Mahwah, NJ 07430; Tel: 201-512-3600.

CIRCLE 106 ON FREE INFORMATION CARD

PC-BASED CALLER ID

Most products designed to provide security against intrusion into telecommunications equipment automatically answer incoming calls and wait for the caller to enter an access code or password. Such systems are easily thwarted by hackers and inconvenient for authorized users. According to *Pewee Valley Innovations*, however, their *PC Receptionist*, a PC-based Caller ID accessory, eliminates any chance for a hacker to gain access to the system, while allowing the user to completely block calls from unauthorized, "privatized," or unknown numbers, or to pass only calls from

particular numbers. The device is transparent to outgoing calls.

The PC Receptionist uses Caller ID to determine whether to pass or block the ring signal. When a call comes in, foreground computer activity is temporarily suspended and a display pops up on the screen, showing the phone number of the caller and, if previously entered into the system, the caller's name. The user can enter a one-line memo regarding the call. Previous consumer activity is restored with a single keystroke, or after a user-specified time period. At the end of the call, the device saves the call record and memo along with a date and time stamp and the length of the call. The call record can be called up at any time, and can be imported into many popular databases. With the included software for managing a digital pager, you needn't give out your pager number. Incoming calls can be routed to an answering machine, with only calls from prespecified numbers forwarded to your pager.

The package includes an easily configured, 8-bit adapter card for IBM PC-compatible computers, a DOS-based software package on 3.5 and 5.25-inch diskettes, a modular extension cord, and a user's manual. The user must subscribe to Caller ID from the local telephone company.

The PC Receptionist package costs $149.95; for Windows software, add $30. For more information, contact Pewee Valley Innovations, Inc., 6601 Old Zaring Road, Crestwood, KY 40014; Tel: 502-241-4295.

CIRCLE 107 ON FREE INFORMATION CARD

DIGITAL AC-LINE MONITOR

Well suited for such applications as high-end consumer elec-

tronics, laboratory instrumentation, and other products requiring accurate AC-line monitoring, *Datel's DMS-20PC-1-LM* is a self-contained, 3-digit LED display that measures AC-line voltages from 85–265 VAC (47–63 Hz). No external components or auxiliary power are needed. When the device is plugged into any wall outlet or PC board, it instantly measures line voltages. Using half-wave sinusoidal averaging techniques, typical accuracies of ±1 VAC are achieved over the full input span of the meter. The AC-line monitor is packaged in a

0.88 × 1.38 × 1.00-inch red filter case with an integrated bezel. The 0.37-inch high LED is easy to read under virtually any lighting conditions.

The DMS-20PC-1-LM digital AC-line monitor costs $45. For additional information, contact Datel, Inc., 11 Cabot Boulevard, Mansfield, MA 02048; Tel: 508-339-3000; Fax: 508-339-6356.

CIRCLE 108 ON FREE INFORMATION CARD

RANGEMASTER MULTIMETER

Extech's 380280 Rangemaster multimeter has nine functions for monitoring and testing, and a large 3½-digit LCD readout for easy viewing. The rotary range-selector switch lets you monitor DC and AC amps in four (ranges from 2 mA to 20 A), DC volts in five ranges (from 200 mV to 1000 V), AC volts in five ranges (from 200 mV to 750 V), resistance in six ranges (from 200 ohms to 20 megohms), capacitance in five ranges (from 2 nF to 20 μF), and frequency

in four ranges (200 Hz to 200 kHz). Other functions include a transistor test, diode check, and continuity tester with buzzer. Ideal for field work, the rugged Rangemaster features full overload protection and low-battery and over-range indicators. It comes complete with built-in tilt stand, a rubber holster, test leads, and a 9-volt battery.

The 380280 Rangemaster multimeter costs $79. For additional information, contact Extech Instruments Corporation, 335 Bear Hill Road, Waltham, MA 02154; Tel: 617-890-7440; Fax: 617-890-7864.

CIRCLE 109 ON FREE INFORMATION CARD

DMM INTERFACE

The *MeterMux* DMM interface module from *Innovative Solutions* allows up to four input lead pairs to be multiplexed to a single multimeter. Any input pair can be quickly and easily selected for measurement, using the device's rotary switch (1-amp switching, 15-amp continuous current). The MeterMux

eliminates time-consuming point-to-point probing and tangled probe leads, simplifying many troubleshooting, development, and monitoring tasks. When troubleshooting, it can be used to quickly isolate problem areas by quickly checking various points in a failing circuit or system. In status monitoring, the MeterMux can be used to check multiple status signals on existing circuits or systems, and during the design/debug process, the device can verify signals at multiple points in a circuit or system.

The MeterMux DMM interface is available in benchtop and DIN-rail mounted versions, for $48 and $56, respectively. For further information, contact Innovative Solutions, 416 Stewart Hollow Road, Portsmouth, OH 45662; Tel: 614-574-4304.

CIRCLE 110 ON FREE INFORMATION CARD

VISUAL MATH

A line of graphing calculators from *Sharp* promise to make it easier for students to learn mathematics, by allowing solutions to be presented in a variety of formats. The *EL-9200c* and *EL-9300c* both feature high-contrast super twist LCD screens and user-friendly functions. An equation editor

allows equations to be entered, edited, and viewed exactly as they appear in textbooks instead of on a single line. A menu system provides quick access to various math functions and other operations, and four direct-access keys with icons allow instant access to specific functions.

For graphing applications, up to four equations can be graphed and analyzed at once in rectangular, polar, and parametric coordinates. Statistics are presented in a "card" format, with each card representing one data set or observation. Up to seven types of statistical charts can be generated. The EL-9200c has 8KB of RAM memory and the EL-9300c has 32KB of RAM. The EL-9300c also features an equation solver, a backup battery, and a port for communicating with another calculator, a printer (*Model CE-50*), or an overhead projector (*Model EL-92T*). The projector can be programmed from the EL-9300c or used independently.

The EL-9200c and EL-9300c graphing scientific calculators have suggested retail prices of $119.99 and $149.99, respectively. The EL-92T overhead projector costs $399.99.

CIRCLE 111 ON FREE INFORMATION CARD

PC WEATHER STATION

WeatherPort's WS-12 WindStation is a data-acquisition system for measuring and logging wind speed, wind direction, and temperature on a personal computer. The device interfaces via the parallel port of an MS-DOS-based computer. Measurement data can be displayed on screen, stored as disk files,

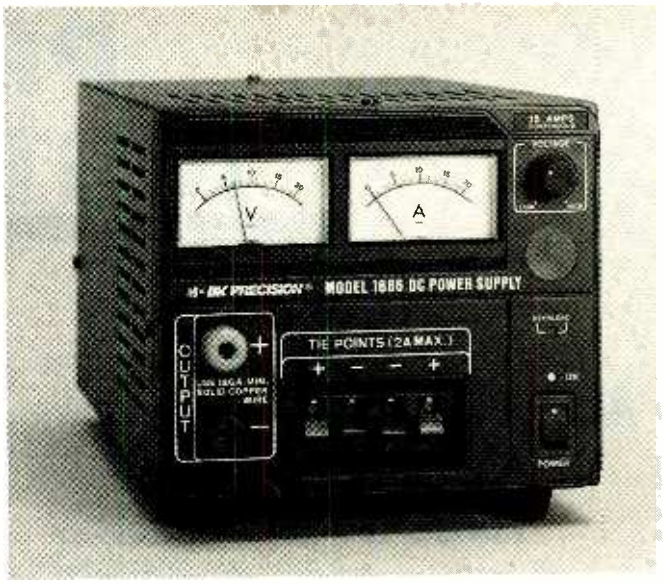
and accessed by other real-time DOS programs. An alarm function sounds the audible annunciator in the computer whenever the peak wind speed exceeds the value set by the user. An optional relay can also activate an external device whenever the wind speed alarm limit is exceeded.

The WS-12 WindStation has a suggested retail price of $295. For additional information, contact WeatherPort, P. O. Box 240, Grass Valley, CA 95945-0240; Tel: 916-477-5226; Fax: 916-477-8339. ■

CIRCLE 112 ON FREE INFORMATION CARD

A Hands-on Electronics REPORT

B+K PRECISION MODEL 1686 DC POWER SUPPLY



CIRCLE 119 ON FREE INFORMATION CARD

The perfect DC power supply for any workbench.

Sooner or later you'll realize that the DC power supply you bought, which you assumed would suit all your future needs, runs out of steam when you ask it to deliver more than a few amps. Sadly, a few amps is all most bench-top power supplies can output, and not even for extended periods of time. But that doesn't mean that typical power supplies are cheap; they're often in the $50 to $100 range.

When the job finally comes along that puts impossible demands on the old power supply, one inevitably learns that at least $200 has to be spent on a power supply that can do the job. So your original investment ends up having gone to waste on a now-obsolete power supply. That's a pitfall we should all avoid, if possible. If you're in the market for a DC power supply, and expect to be involved in electronics for a long time, then one way to avoid that pitfall is to buy the Model 1686 DC Power Supply from B+K Precision (Division of Maxtec International Corp., 6470 W. Cortland St., Chicago, IL 60635; Tel. 312-889-1448).

Except for very unusual applications, the 1686 is the only DC power supply you'll ever need. That's because the 1686 can output from 3 to 14 volts DC, and *12 amps continuous* at 13.8 volts DC! Although the 1686 has plenty of features worth mentioning, the above pretty much says it all. And the price? A very reasonable $199 for a power supply of this caliber.

Why Do You Need One? Anyone who has ever serviced car stereos or other mobile equipment knows that any good system will draw anywhere from 3 amps and up, at 13.8-volts DC (because a car's electrical system isn't exactly 12 volts). Quite often, one must resort to using a car battery to service such systems, and car batteries are unpleasant to have around, what with their acid and all.

Some exotic mobile sound systems will draw even more than 12 amps. Fortunately for people who have to work on such systems, two or more 1686's can be connected in parallel to double the current. In addition, two or more 1686's can be connected in series to double the voltage.

Other applications for the 1686 include servicing camcorders and powering ham radios. Some ham rigs are incredible power hogs! Cellular phones also need lots of current, and PA systems and ship-to-shore radios are other candidates. If you've ever experimented with Peltier devices, you're probably wishing that you had a 1686 supply at the time.

Features. One of the first things you notice on this power supply is the presence of a cooling fan on the back, which automatically cycles on and off. That enables the power supply to operate at its maximum rated output, hour after hour, without overheating. When you see a cooling fan on the back of a power supply, you know it's a serious piece of equipment.

The supply is protected from accidental short circuits and overloads by a foldback current-limiting circuit. The output is isolated from both the chassis and earth ground, so it's extremely versatile. For example, either the positive or negative output can be strapped to ground for use with positive-ground or negative-ground equipment, respectively. The unit is also reverse-polarity protected from external DC sources.

The 1686 combines strength with finesse by outputting a very clean DC voltage. Both load and line regulation are within 0.8 percent. Ripple and noise are reduced in the output to less than 10 millivolts rms. The voltage and current output of the supply can be seen at a glance on the 1686's two front-panel meters.

As far as power requirements go, the 1686 can plug into a 120- or 220-

(Continued on page 94)

PRODUCT TEST REPORTS

AudioSource Model SS Three/II Surround Sound Processor

The buzzword in home audio these days remains "Home Theater" More and more audio and video enthusiasts are combining their TV sets with surround-sound capable audio gear to recreate the experience encountered when watching a motion picture in a properly equipped, Dolby stereo theater. While many of these installations are done from scratch using all new components, what do you do if you already own high-quality audio gear with which you are otherwise quite happy?

CIRCLE 120 ON FREE INFORMATION CARD

The AudioSource SS Three/II surround-sound processor.

Fortunately, there's no need to discard your current set up just to add surround sound. For instance, your existing speakers can easily be incorporated into a surround system, and a good receiver can be augmented with an external unit such as the AudioSource (1327 N. Carolan Ave., Burlingame, CA 94010) SS Three/II surround-sound processor.

First and foremost, the AudioSource SS Three/II will decode encoded Dolby Surround information into usable signals. The unit uses Dolby Pro Logic, which means that, when properly combined with your existing stereo system and the requisite number of additional loudspeakers, you will be fully enveloped in sound, with excellent separation between front, center, and surround channels. The SS Three/II contains three amplifier channels of relatively modest power output: one for connecting a center-channel speaker (to be mounted directly below or above your TV monitor/receiver), and a pair of amp channels for driving the "surround" speakers that are normally mounted behind the listener or at the sides of the listening room.

In addition to these amplified channel outputs, there is a subwoofer line-level output to which you can connect an active, powered subwoofer or a separate mono amplifier for driving a passive subwoofer. This output delivers frequencies below either 150 Hz or 80 Hz; the crossover frequency is selectable by the user. For that matter, if you find that the power delivered by the built-in center-channel and surround-channel amplifiers is inadequate for driving your extra speakers to life-like levels, you can connect external amplifiers to center-channel and surround-channel line-level output jacks.

For those program sources that are not Dolby Surround encoded, such as ordinary stereo music programming, the SS Three/II has a "Hall" setting that recreates the ambiance of a typical concert hall. There's even a "Matrix" setting that can be used with monophonic program sources to synthesize a stereo-like image that will play through all of your speakers. Also, if a center channel speaker is not available, the SS Three/II will create a "phantom" center image by sending center-channel sounds equally to the front-left and front-right speakers.

CONTROLS

The front panel layout of the AudioSource SS Three/II is elegantly simple and almost requires no instruction manual to figure out. The red on/off button is at the extreme left. Nearby are eight "mode" selection buttons. Included are Dolby 3 (in which only front and center channel speakers are used), Dolby Surround, Hall, and Matrix (for simulated stereo) buttons; a Normal/Phantom (center-channel) button; a button to select a 20- to 30-millisecond time delay to the surround channels (the choice depending upon room size and listener's position); a "test" button that sends a "pink-noise" signal to each speaker in turn, enabling accurate level setting of all speaker outputs; and a monitor button that activates a tape monitor in/out loop on the

rear panel of the unit—that's needed since the SS Three/II is inserted in the tape-monitor loop of the receiver it is used with.

Four vertically oriented groups of LED's on the front panel provide input-level displays for the surround, left-front, center, and right-front channels. In addition, the LED's will also display the relative volume settings assigned to the rear, center, and master channels when the corresponding volume controls (located at the right end of the front panel) are touched. The front panel also houses an input level control that should be set so that the upper red-colored LED in each level-indicator bank is not continuously triggered.

A wireless remote control is, of course, included with the unit. It duplicates most of the control functions and, more important, allows you to properly balance the surround system from your listening location.

Rear-panel controls include a center-speaker on/off switch, subwoofer level and crossover-frequency selector controls, a pair of line-level input jacks, a pair of front-channel line-level output jacks, center- and surround-channel output jacks, the tape-monitor loop's input and output jacks, a subwoofer output jack, and spring loaded terminals for the center- and surround-channel speakers (if you choose to use the unit's built-in amplifier channels).

LAB MEASUREMENTS

There are relatively few performance measurements that can be made on a surround-sound processor. That's because the decoding process involves phase reversals and time delays (for the surround channels) that tend to "confuse" even the most sophisticated test instruments. Still, some basic measurements supplemented by extensive listening tests and hands-on evaluations can serve to evaluate the relative merits (and, in some cases, demerits) of such components.

Figure 1 shows the frequency response at the front-channel left and right output jacks. Tested in the normal Dolby Surround mode, the nearly perfectly flat response from 20 Hz to 20 kHz indicates that signals fed to the unit will not be degraded, as far as response is concerned.

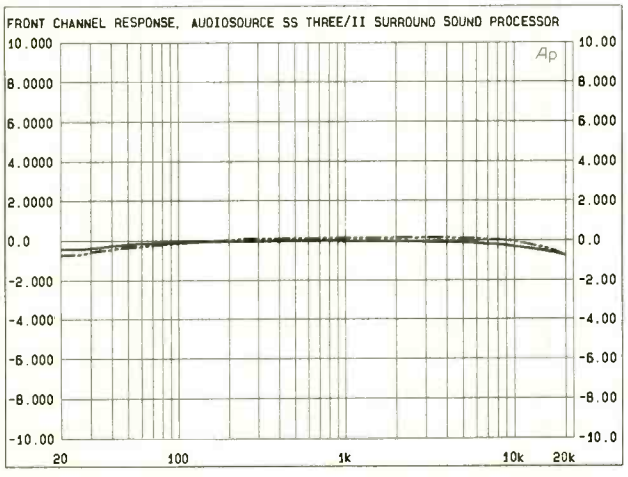


Fig. 1. The frequency response at the front-channel left and right output jacks (tested in the normal Dolby Surround mode) was nearly perfectly flat from 20 Hz to 20 kHz.

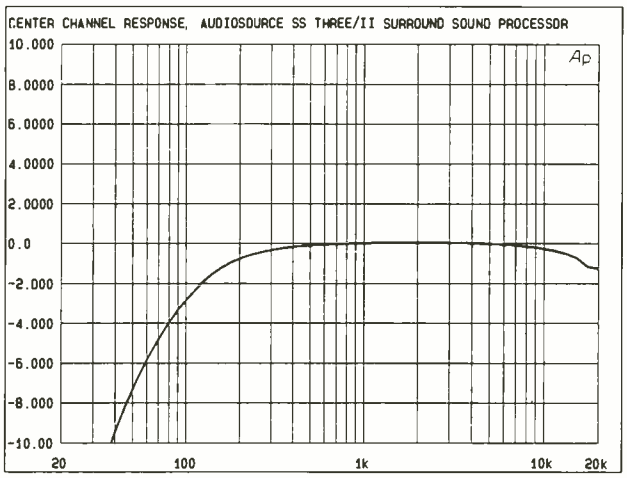


Fig. 2. The low-frequency roll-off of the center channel is deliberate, and is prescribed by the Dolby Surround system. The center channel deals essentially with spoken dialogue, so ultra-low frequency response is not required.

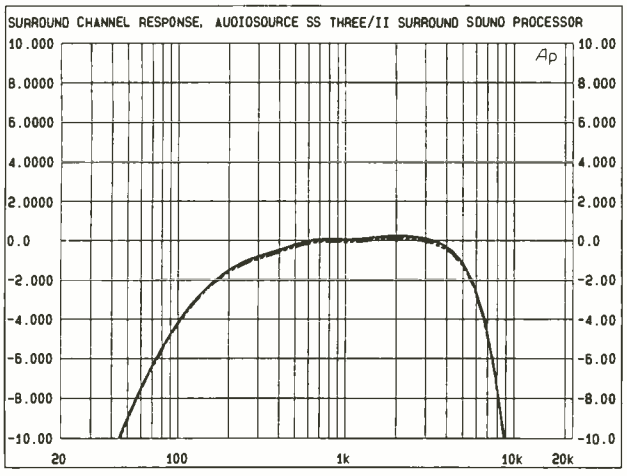


Fig. 3. The response curve for the surround channels (shown here) was obtained by feeding out-of-phase left and right signals to the line inputs of the SS Three/II.

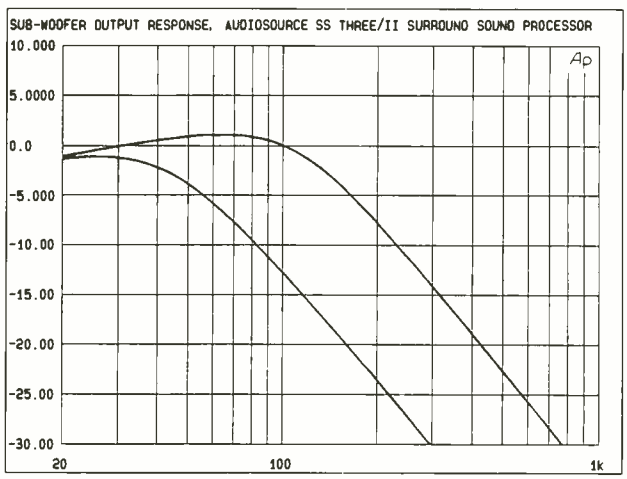


Fig. 4. This plot shows the response available at the subwoofer line-level output jack. Note that two crossover frequencies (80 and 150 Hz) are available, and the response for each is shown.

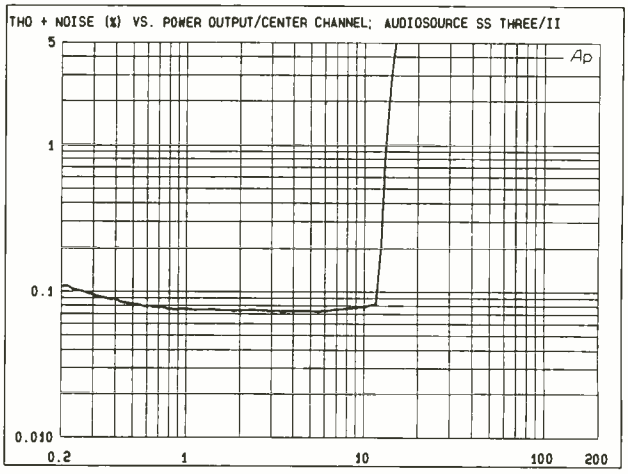


Fig. 5. The actual continuous power rating of each of the amplifier channels was about 12 or 13 watts; above those levels, overload and high distortion levels occur. Below that output level, total harmonic distortion was a comfortably low 0.08%, or even a bit lower.

We connected an 8-ohm speaker load to the center-channel speaker terminals and, at a nominal output of around 1 watt, plotted the response available at that output; the results are shown in Fig. 2. The low-frequency roll-off of this channel is deliberate, and is prescribed by the Dolby Surround system. The center channel deals essentially with spoken dialogue, so ultra-low frequency response is not required.

By the same token, surround-channel response, which is plotted in Fig. 3, is limited to the range from around 100 Hz to 7 kHz. Among other things, that makes it practical to use less expensive, smaller speakers for the surround or rear channels than are used for the main, front speakers. The response shown in Fig. 3 was obtained by feeding out-of-phase left and right signals to the line inputs of the SS Three/II. Had we used in-phase signals, there would be no surround-channel output at the surround output jacks since, by definition, sounds intended for surround channels are essentially "difference" signals. If left and right input signals were identical, there would be no difference signals available.

Most providers of surround-sound equipment heartily recommend the use of a separate subwoofer in order to reproduce the thunderous sounds often associated with blockbuster films. Figure 4 shows the response available at the subwoofer line-level output jack. Note that two crossover frequencies (80 and 150 Hz) are available, and the response for each has been shown.

Our only disappointment with the unit came when we measured the power output capabilities of the center channel amplifier (the power output of the rear-channel amplifiers was similar). AudioSource's published specifications claim amplifier power outputs of "30 watts peak center + 30 watts peak rear, or 30 watts peak rear + 30 watts peak rear." There are several things wrong with that published specification. For one thing, no distortion rating is provided. Also, power ratings, according to a Federal Trade Commission rule established way back in the

1970's, are supposed to refer to continuous power-output capabilities and not to "peak" power levels.

Be that as it may, we measured the total harmonic distortion of a 1-kHz test signal versus increasing power output level for the rear-speaker amplifier, using an 8-ohm load. The results are shown in Fig. 5. As you can see, the actual continuous power rating of each of these amplifier channels should be more like 12 or 13 watts—the point at which overload and high distortion levels occur. Below that output level, total harmonic distortion was a comfortably low 0.08%, or even a bit lower. While 10 watts of power is probably enough to drive many of the high-efficiency speaker systems used for the center channel of an audio/video surround-sound system (remember, only dialogue is intended to be handled by that channel), surround-sound channels often require more than that and you may want to use separate, external amplifiers for those channels rather than the built-in surround-channel amplifiers found in the SS Three/II.

HANDS-ON TESTS

Hooking-up the SS Three/II was virtually fool-proof thanks to the excellent diagrams provided in the brief, but adequate owner's manual supplied with the unit. Three sample setups are shown: an in-line system (in which the TV set's stereo speakers serve as the left and right front speakers); the tape-monitor loop setup (in which the TV set, the SS Three/II, and an existing stereo system are combined); and an "expanded" home-theater system in which additional amplifiers are used for the surround, center, and subwoofer speakers. We chose the second of these hookups in order to fully evaluate everything that's provided in the SS Three/II. To yield the best possible performance during our auditions, we used relatively high-efficiency speakers, taking into account the limited power output capabilities of the unit's built-in amplifiers.

Dolby Pro Logic decoding was excellent—as good as we've heard from far more expensive processors. While we did not use a subwoofer in our tests, we sensed that the addition of one would have made the surround effects even more enjoyable and effective, especially when we watched and listened to excerpts from action-oriented motion pictures (on tape) such as "Top Gun" and "Raiders of The Lost Ark." All in all, we were quite surprised at the high level of performance provided by the AudioSource SS Three/II. At its suggested retail price of $399.95, this unit can provide a most economical entry into the exciting world of "Home Theater," especially for those who already own much of the other required equipment.

For more information on the AudioSource SS Three/II surround-sound processor contact the manufacturer, or circle no. 120 on the Free Information Card, which can be found on page 127. ■

"I've got a great low-cost project that you can try."

THINK TANK

By John J. Yacono

On Displays

No, the title of this column is not a misprint (just a bad pun) as this month we'll look at various display circuits sent in by readers. As promised, it'll be business as usual now that I've closed the door on the pinewood-derby circuits, so I'll start things off with some information on logic IC's before we get to the letters.

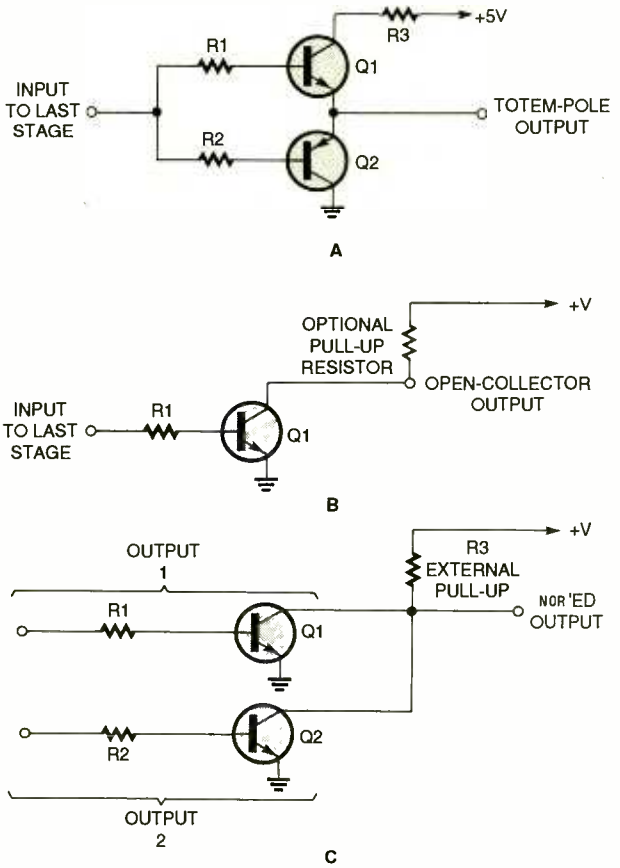


Fig. 1. These are crude representations of logic-IC outputs. In A a totem-pole output is depicted. In B we show an open-collector output. In C we show how two open-collector outputs can be NOR ed together.

BIPOLAR OUTPUTS

Last time we discussed logic IC's (back in September, 1993), I presented a little chip architecture, particularly with regard to inputs and outputs. That was a handy way of explaining the internal differences between the various bipolar-logic families; however, each family has members with special inputs and outputs. Typically only a chip's data sheets will reveal such strange distinctions (the information is often absent from chip designations).

With regards to special inputs, there are some bipolar chips that can handle inputs of up to 15 volts. There are others with built in 20k pull-up resistors at their inputs. Such chips are designed with industrial applications in mind, but still and all, it's good for the hobbyist to know they're out there.

With regard to outputs, you probably know they fall into three groups: totem pole, open collector, and Tristate. To briefly discuss them, a totem-pole output can be visualized like two transistors in a push-pull configuration (see Fig. 1A). When Q1 is on, Q2 is off, and the stage sends out a high; when Q2 is on, Q1 is off and the stage sends out a low. The output is said to be able to produce both "active" highs and "active" lows.

An open-collector (or OC) circuit, on the other hand, has no transistors to produce active highs; only transistors to pull the outputs low. The collector of an output transistor is left floating or open (as shown in Fig. 1B). If highs are desired of such an output, an external pull-up resistor must be used to provide them. This form of output is very useful for reducing the number of gates in a circuit as several of them can be tied together if one wishes to take the NOR of their values. As you can see from Fig. 1C, if either Q1 or Q2 is on, the output would be low; both must be off to produce a high.

While many might be familiar with OC chips, it is not common knowledge that they can work with a variety of pull-up voltages (V+ in Fig. 1). That is so that the pull-up resistor can actually be replaced with a load (a relay, or display element for example), perhaps in series with a current-limiting resistor, eliminating the need for some interface component like a power transistor. Such outputs come in 5.5-, 7-, 15-, 30-, 60-, and 70-volt varieties. Open-collector outputs can also be designed for low leakage (or off-state current) to handle very current-sensitive loads.

The last common style of output, Tristate, is an exception to a rule I laid down months ago. Remember when I said that outputs could be high or low? That's not entirely true. On a Tristate chip, if the outputs are not given an enable signal via a special input, they float in a high-impedance state (the third state). They neither source or sink current. That allows multiple such outputs to share a single line, provided that each takes turns using that line (each output must be exclusively enabled.

While Tristate chips are common, especially in computers where memory chips and all manner of devices must share address- and memory-bus traces, you may not have

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1P18770	1.60 x 1.60 x .620	12 VDC	6	8.95	7.95
1P75344	1.75 x 1.60 x .800	12 VDC	5	8.95	7.95
1P75352	2.35 x 2.35 x 1.00	12 VDC	14	7.95	6.95
1P75361	3.15 x 3.15 x 1.00	12 VDC	24	7.95	6.95
1P16993	3.15 x 3.15 x 1.00	12 VDC	27	9.95	8.95
1P75395	3.15 x 3.15 x 1.25	12 VDC	22	6.95	5.95
1P75441	3.63 x 3.63 x 1.00	12 VDC	35	7.95	6.95
1P75467	4.68 x 4.68 x 1.00	12 VDC	53	11.95	10.95
1P94625	4.68 x 4.68 x 1.50	12 VDC	75	12.95	11.95
1P100909	1.50 x 1.50 x .750	12 VDC	22	6.95	5.95
1P100925	3.15 x 3.15 x 1.25	24 VDC	25	8.95	7.95
1P100933	3.15 x 3.15 x 1.60	24 VDC	35	8.95	7.95
1P100941	3.63 x 3.63 x 1.00	24 VDC	35	9.95	8.95
1P100950	4.69 x 4.69 x 1.00	24 VDC	60	10.95	9.95
1P100968	4.69 x 4.69 x 1.50	24 VDC	80	10.95	9.95
1P100976	4.69 x 4.69 x 1.50	28 VAC	75	10.95	9.95
1P75408	3.15 x 3.15 x 1.0	115 VAC	18	6.95	5.95
1P16969	3.15 x 3.15 x 1.50	115 VAC	23	7.95	6.95
1P16977	3.15 x 3.15 x 1.50	115 VAC	25	10.95	9.95
1P75432	3.63 x 3.63 x .80	115 VAC	47	10.95	9.95
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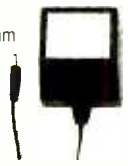 1P15392

Part No.	Voltage	Current	Plug	Price
1P10129	9 VAC	500mA	Male	4.95
1P100061	9 VAC	780mA	Female	4.95
1P10073	12 VAC	500mA	Male	5.49
1P101258	12 VAC	500mA	Female	5.95
1P10081	12 VAC	1000mA	Female	5.95
1P10428	12 VAC	1000mA	Male	5.95
1P100108	16 VAC	1100mA	Female	5.95
1P100191	18 VAC	80mA	None	3.95
1P100036	20 VAC	400mA	None	5.95
1P87581	24 VAC	500mA	Female	4.95
1P10102	24 VAC	1000mA	Male	7.95
1P101119	26 VACT	1200mA	None	7.95

Part No.	Voltage	Current	Plug	Price
1P100159	4 VDC	700mA	Male[2]	$4.95
1P15544	6 VDC	500mA	Male[2]	5.95
1P101266	6 VDC	500mA	Female[2]	5.95
1P100845	9 VDC	200mA	Female[2]	5.19
1P100837	9 VDC	200mA	Male[2]	4.95
1P100853	9 VDC	500mA	Female[2]	4.95
1P15561	9 VDC	500mA	Male[2]	4.95
1P100095	12VDC	200mA	Female[2]	4.95
1P15368	12 VDC	500mA	Female[1]	5.95
1P17267	12VDC	500mA	Male[2]	5.95
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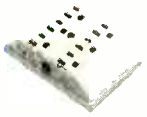

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1P40125	2732A-25	4.49
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1P39829	27C64-15	4.49
1P39933	27128-25	7.75
1P39968	27128A-20	4.95
1P39984	27128A-25	3.95
1P39677	27C128-15	5.75
1P40037	27256-15	5.49
1P40061	27256-25	4.75
1P39714	27C256-15	5.25
1P39722	27C256-20	4.95
1P39781	27C512-15	6.49
1P65699	27C020-15	10.95
1P43692	68766-35	4.95

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1P46287	74LS02	.29	.25
1P46316	74LS04	.29	.25
1P46375	74LS08	.29	.25
1P46640	74LS14	.39	.35
1P47458	74LS30	.29	.25
1P47466	74LS32	.29	.25
1P48004	74LS74	.35	.29
1P48039	74LS76	.69	.59
1P48098	74LS86	.35	.29
1P46447	74LS112	.39	.35
1P46480	74LS123	.39	.35
1P46607	74LS138	.39	.35
1P46957	74LS175	.39	.35
1P47036	74LS193	.59	.49
1P47183	74LS244	.69	.59
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1P37401	16MLP	16 pin	.65	.55
1P65584	18MLP	18 pin	.75	.65
1P38623	20MLP	20 pin	.79	.69
1P39351	24MLP	24 pin	.85	.75
1P39386	24SMLP	24 pin	.89	.79
1P40328	28MLP	28 pin	.99	.89
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1P15034	DA15P	M	.55	.45
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1P15114	DB25P	M	.65	.55
1P15157	DB25S	F	.75	.63
1P15472	DC37P	M	1.19	.95
1P15499	DC37S	F	1.25	.99
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come across a peculiar cousin to this family: the open-collector Tristate chip. Basically they give all the advantages of Tristate operation, and allow you to NOR outputs or connect loads directly.

That's all we'll cover about strange inputs and outputs this time. Next month we'll look at some other exceptions to "well-established" rules of bipolar IC designations; like IC's with the same part number but different pinouts!

Now, let's get to our letters for this month.

PORTABLE NEON

I am a 16-year-old electronics hobbyist and would like to present you with a circuit for powering a neon lamp from a 1.5-volt battery. The circuit (shown in Fig. 2) is a very simple inverter. It's based on a miniature two-transistor pulse generator, and a 6.3-volt power transformer used in the step-up voltage configuration.

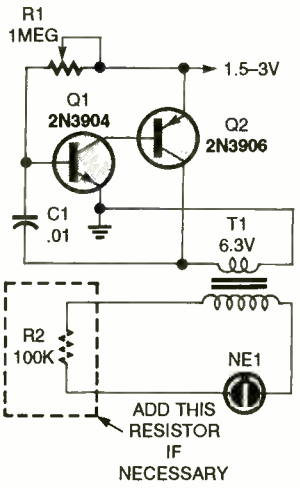

Fig. 2. This neon-light driver might just come in handy in your next blackout!

Transistor Q1 is configured so that it turns on every time C1 is charged through R1. It then discharges the capacitor. Transistor Q2, which oscillates in step with Q1, is configured as a current provider for T1's secondary coil. The current oscillations cause a high AC voltage to appear at T1's primary, lighting the white-light neon bulb.

—Bernard Vanerio, Miami, FL

Good going! I suppose R1 should be adjusted for maximum illumination. By the way, Bernard also mentions a centered-tapped 12.6-volt transformer may be substituted for T1 (provided you use only half its primary), and that everything with the exception of the transformer (T1) can be fitted inside the body of a flashlight.

A SHIFTY IDEA

This circuit (shown in Fig. 3) is used to make a tri-color LED gradually change color from yellow to red to yellow to green, and then back to yellow, where the cycle repeats. It is very simple to make, and the theory of operation is also simple. Both of the timers in the 556 dual oscillator/timer are configured for astable operation with a 50% duty cycle. One timer is set to oscillate much faster than the other. The timing capacitor voltage of each is sent to two comparators, which apply a voltage across the tri-color LED whose polarity depends on which capacitor voltage is higher. The rapidly changing capacitors' voltage causes the red and green elements of the LED to be alternately lit, thus giving the illusion of yellow light. As the slowly rising and falling voltage from the slower timing capacitor changes in average value, it shifts the duty cycle to favor one color or the other. That gives the transition between colors a smooth appearance. Hopefully, the effect will be put to many uses.

—Mark Valentine, Keesler AFB, MS

This puts me in mind of a project of long ago. It consisted of a bank of lights that blinked on and off randomly, liked some background prop from a B-grade sci-fi movie. Those things had a somewhat hypnotizing effect (similar to TV white noise) because the brain tries to find a pattern in the randomness. It would be neat to build such a device from several copies of the circuit you've provided, as the indicators in that display would do much more than just blink on and off at random.

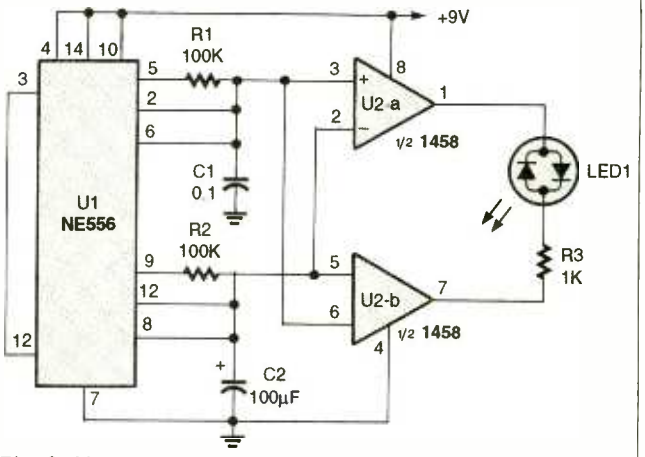

Fig. 3. If you want a really unusual display, check out this LED circuit which slowly shifts between three colors automatically.

LESS POWER, MORE PIZZAZ

I especially look forward to your column, *Think Tank,'* in **Popular Electronics** each month. I've enjoyed it (and *Circuit Circus*) so much that I finally subscribed to the magazine. While looking through a back issue (September, 1991), I saw a circuit in *Think Tank*—called the "Nothing Box" (by Dave Litke of Saint Catherine's, Ontario, Canada)—that really caught my eye. I sat down, assembled the device, and hooked it up to my stereo. Unfortunately, I only have a portable stereo with detachable speakers; the stereo didn't seem to deliver enough power to drive the display unless its volume was turned up to speaker-distortion level.

Well, I still liked the idea, and I felt that the circuit was certainly worth modifying to make it more sensitive to my low-powered stereo. But when I modified the original circuit, the display didn't seem uniform. After some more time (and some more effort), I eventually came up with a circuit (shown in Fig. 4) that can be moved from one stereo to another. It's basically the same idea, except that it is more sensitive, the display is more uniform, and the circuit has two display modes (bar and dot).

The circuit is built around two LM3915 dot/bar-display drivers. That reduces the parts count significantly since the voltage dividers, the voltage reference, and the adjustment inputs are contained on the same IC. The circuit is also expandable to 20 or more segments by cascading the LM3915's.

In my prototype, I used tri-colored bargraph displays from Radio Shack, however, a plain 10-segment bargraph display will work, or you can use any color-combination of discrete LED's instead. I also used a 100k stereo-control potentiometer for the adjustment control (R3). That eliminates having two separate adjustments and also ensures that both sides can get an equal signal. Switch S1 selects between bar mode and dot mode.

This circuit was designed primarily for smaller stereos, I don't know exactly how much power it will handle. The circuit draws approximately 300 mA when in bar mode and at full scale. You can build your own power supply, as I did, or you can use batteries or even the stereo's power for the meters. I hope that this circuit will prove interesting and useful for anyone that had the same trouble I did. Incidentally, I would also like to thank Dave Litke for inspiring me to actually build this thing.

—*Chris Savage, Schenectady, NY*

Those out there who feel similarly inspired should note the output-pin arrangement on the LM3915's makes connecting them to the bargraph displays very easy. If you insert the displays and IC's parallel and right next to one another in a piece of perfboard (so that the cathodes of nine of the LED's face their respec-

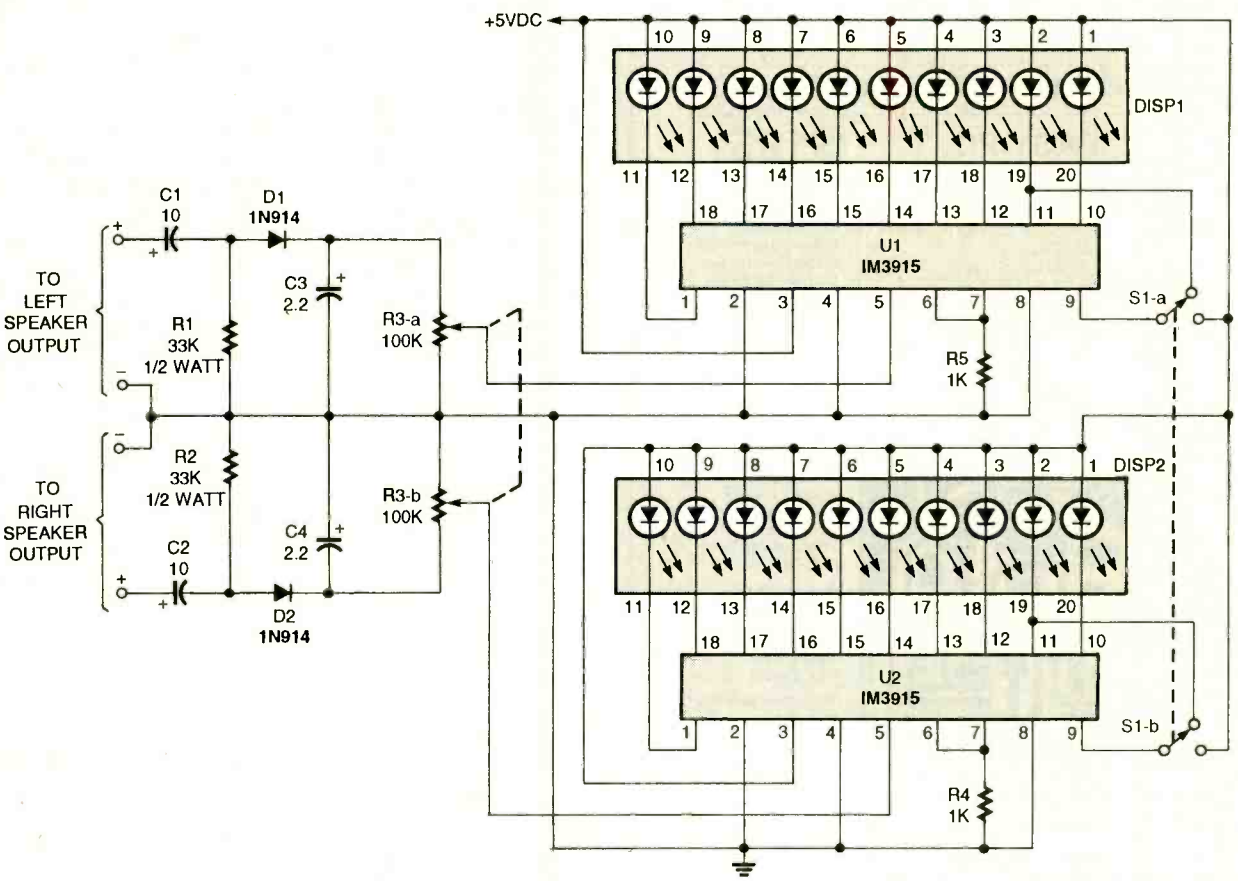

Fig. 4. This channel-output display would be a nice add-on to any stereo system. However, if your stereo has outputs with isolated grounds, that isolation should be maintained by the project through the use of two audio transformers.

tive IC pins), you can easily connect the LED's to the IC's by tack-soldering tiny pieces of wire between the pins.

Also beware that not all amplifier outputs share a common ground. In such circumstances, the amplifier outputs should be isolated from the project (and thus remain isolated from one another) by inserting a 1-to-1 audio transformer between each amplifier output and its display input.

STROKE, STROKE . . . .

I have a circuit for all those golfers who, like me, spend more time trying to remember how many strokes they made rather than playing golf. The circuit (shown in Fig. 5) is simply a counter with a display. The circuit is powered by a 9-volt battery that is regulated to 5 volts by a 7805 regulator IC.

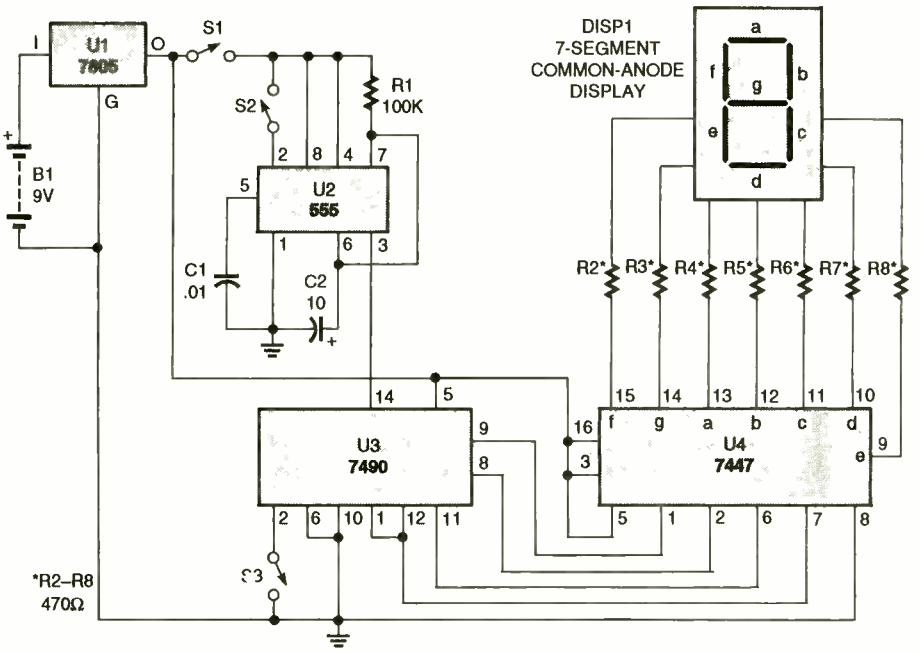

Fig. 5. Do you ever lose your stroke count in the middle of sizing-up a shot? Try this never-fail memory aid!

Switch S1, a SPST switch, is used to turn the counter on and off. A 555 timer (U2) is configured as a monostable multivibrator. Whenever S2, a normally-closed monetary-contact switch, is opened, the 555 is triggered, sending a 1-second pulse to pin 14 of U3, a 7490 decade counter. The 7490 keeps track of how many times you've pushed S2 to trigger the circuit. That count is translated by U4, a 7447 BCD decoder/driver, which is connected to a common-anode 7-segment display.

After each stroke, the golfer hits S2, and the counter keeps track of the strokes. At the end of each hole, the counter can be reset to zero by pressing S3, another normally-closed momentary-contact switch. Switch S3 is connected between pin 2 of the 7490 and ground. Opening the switch allows pin 2 to float high, resetting the counter to zero.

—*Elmer Perry, Jr., Ft. Hood TX*

If anyone out there finds the circuit drains their batteries too fast (which can be frustrating in the middle of playing a hole), try placing a normally-open momentary-contact switch between the display's anode pin and the 5-volt line. That way the display will only be active when you depress the switch to check the stroke count, and not while you're just walking.

Well, its time to close the corral for this month. Until next time, please send your submissions to *Think Tank*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. All contributions appearing here will be reciprocated for with a *Think Tank II* or other book. ■

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analog amplifier by R1 and R3 to be nulled out.

The differential output of the analog amplifier (at pins 8 and 7 of U2-c and U2-b, respectively) is fed to the differential analog input terminals of U3 (an A/D converter that contains all the necessary circuitry to drive a 3½-digit LCD readout), shown in Fig. 2. Analog-input sensitivity for a full-scale display of 1999 is determined by the reference voltage applied between pins 35 and 36 of U3, and is equal to twice the reference input. In this project, only the three full digits of the A/D converter are used. The half digit, 1, is not required. But a leading "2" or "3" is required; let's see how it is generated.

Since the circuit uses a readily available 3½-digit A/D converter and is required to respond only to a limited range of pressure, an unusual readout system was used to produce a display containing four digits. The A/D converter generates the three least-significant digits (LSD's) of the display. A simple logic circuit provides the most significant digit (either a "2" or a "3"). The reference voltage (0.1-volt) applied between pins 35 and 36 of U3 is

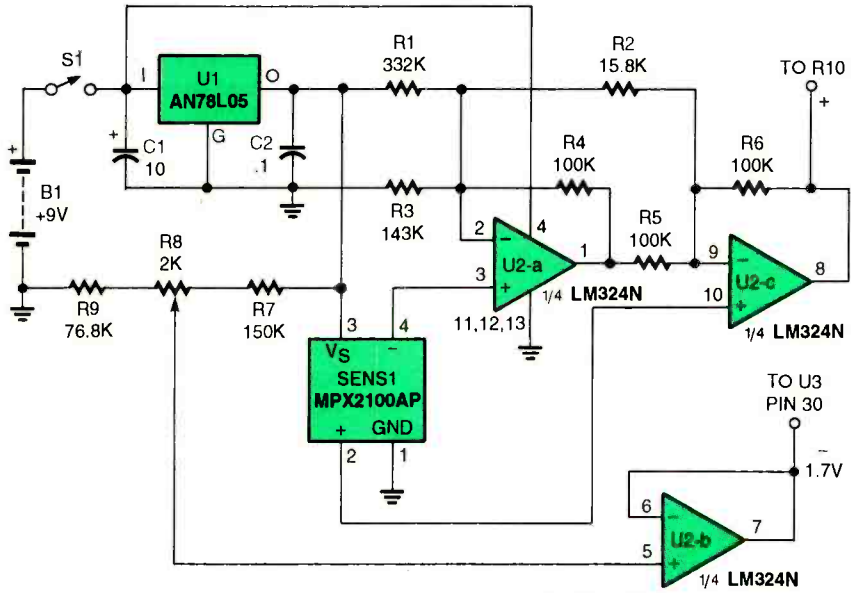


Fig. 1. At the heart of the Digital Barometer is the MPX2100AP 15-PSIA pressure sensor, SENS1, which outputs a differential voltage that is fed to an amplifier arrangement built around U2, an LM324 quad op-amp.

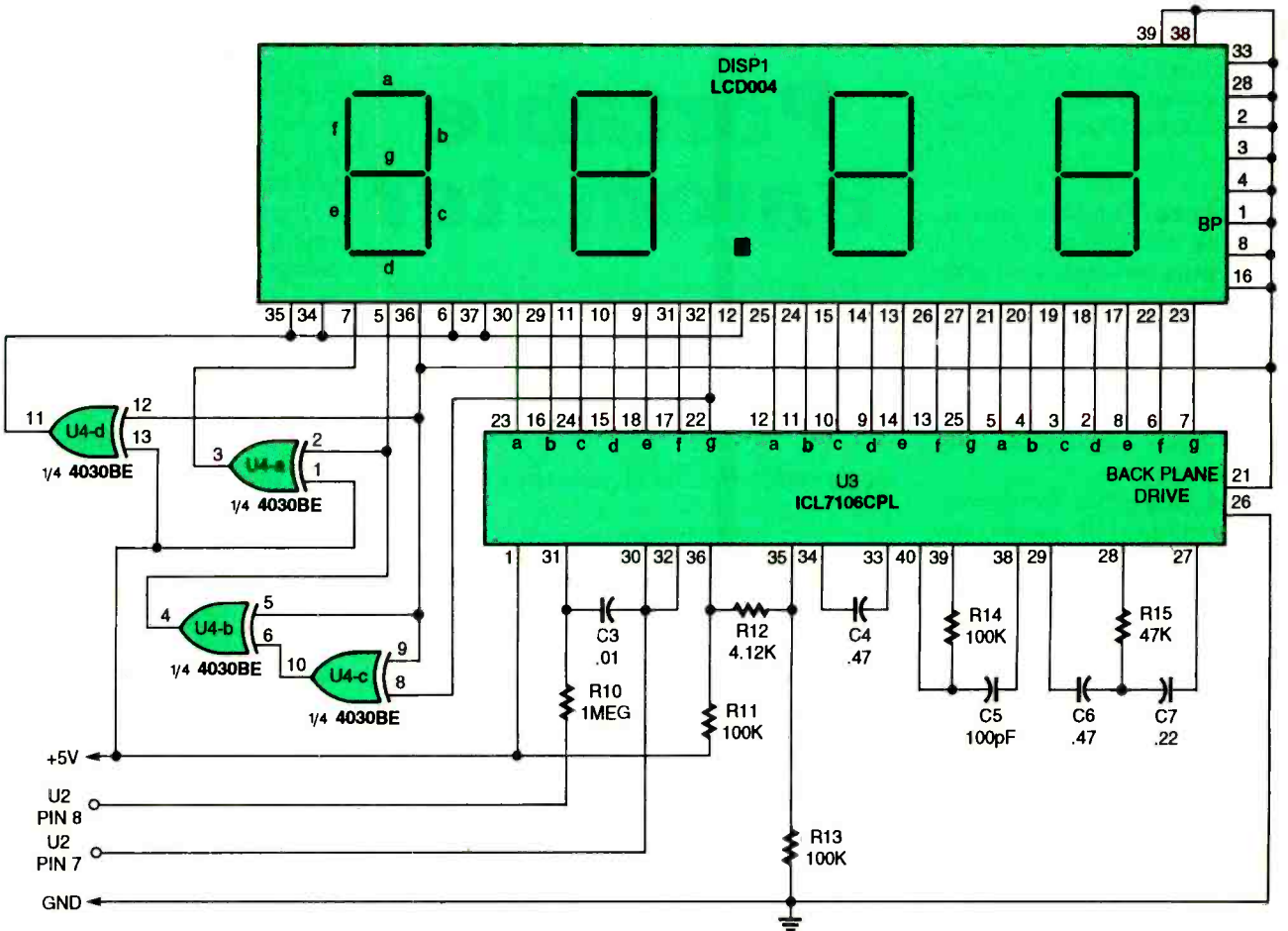


Fig. 2. The output of the op-amp arrangement in Fig. 1 (at pins 8 and 7 of U2-c and U2-b, respectively) is fed to the differential analog-input terminals of A/D converter U3, which processes the input signal and displays that information as a barometric-pressure reading.

Build a Portable Barometer

Be your own weather forecaster with an easy-to-build circuit that, by sensing small changes in the barometric pressure, lets you predict the next weather front.

BY ANTHONY J. CARISTI

Everyone is interested in the weather. Some of us even have our own temperature and humidity gauges to tell us what's happening day by day. But perhaps the weather forecasting instrument that holds the greatest mystery for most people is the barometer—a device that is used measure absolute air pressure. Weather forecasters rely on the prevailing atmospheric pressure (specifically the direction of the change in pressure) to predict the next weather front. For that reason, it is important that small changes in the barometric reading be detected.

Unfortunately, some home analog barometers may not be sensitive enough to detect minute changes in pressure. But the *Digital Barometer* described in this article is designed to address the deficiencies of such units. The Digital Barometer—an easy-to-build, reliable, portable weather-forecasting instrument that will provide years of accurate barometric readings—uses a 4½-digit LCD readout to display readings from 28.00 to 31.99 inches of mercury.

Pressure Fundamentals. Pressure can be expressed in many ways. Barometers are often calibrated in inches of mercury—14.7 PSI is equivalent to 29.92 inches of mercury; that is the typical barometric reading obtained at zero altitude or sea level under average weather conditions.

Most people are accustomed to the concept of gauge pressure, often specified as pounds-per-square-inch gauge (PSIG). That specification refers to differential pressure with sea-level atmospheric pressure (14.7 PSI or 29.92 inches of mercury) as the reference. A barometer, however, displays absolute pressure (PSIA), which is the difference between the current pressure and zero pressure (a perfect vacuum). A barometer, therefore, is a differential pressure gauge that is referenced to zero pressure.

Pressure Sensor. Before one can understand the operation of the Digital Barometer, it is important to know the theory of operation of an absolute pressure sensor. The pressure sensor used in our barometer (developed by Motorola Semiconductor Products, Inc.) contains a monolithic silicon piezoresistor that generates an output voltage that varies with applied stress.

The pressure sensor is a four-terminal device that contains two chambers that are separated by a silicon diaphragm and piezoresistive element. The resistive element is designed to respond to absolute atmospheric pressure (pressure measured with respect to a perfect vacuum—zero pounds-per-square-inch-absolute or 0 PSIA).

One chamber of the sensor is exposed to atmospheric pressure by means of an external port. The other chamber (evacuated to as perfect a vacuum as possible by modern manufacturing techniques) is sealed. In that way, the diaphragm of the sensor is under constant stress from the difference between atmospheric pressure on one side, and essentially a perfect vacuum on the other. The mechanical stress placed on the diaphragm (and piezoresistive element) by atmospheric pressure causes the sensor to generate an output voltage that is proportional to the applied pressure as seen by the open port of the sensor.

About the Circuit. Refer to Fig. 1. Power to the circuit is provided by a 9-volt transistor-radio battery (B1). The circuit draws about 6 mA of current.

Since battery voltage falls off with use, a fixed 5-volt regulator, U1, is used to maintain a constant voltage to the circuit, thereby ensuring retention of barometer accuracy as the battery is depleted.

The piezoresistor within SENS1 is connected between pins 1 and 3 of the sensor assembly, and is driven by the regulated 5-volt supply. The taps on the piezoresistor (which are internally connected transversely across the element and are brought out to pins 2 and 4) sense the differential voltage developed across the pressure-sensitive element in SENS1 to provide an output voltage that varies linearly with absolute pressure.

Under normal conditions (in which atmospheric pressure places stress on the piezoelectric resistor), the sensor's output voltage is a finite, but very small in value. At sea level that voltage is typically about 20 mV. Over a range of 29 to 31 inches of mercury, the output of the sensor changes by only about 1.3 mV.

A differential analog amplifier, comprised of U2-a and U2-c, boosts the output of the sensor by an amount determined by the values of resistors R1 through R6. The output voltage at pin 8 of U2-c represents the amplified output voltage of the sensor, offset by a DC bias of 1.5 volts that's generated by a 100k Thevenin equivalent, comprised of R1 and R3.

Op-amp U2-b (which is configured as a voltage follower) is fed from the wiper of potentiometer R8. That combination forms an altitude correction/calibration adjustment and is used to compensate for circuit tolerances as well as for any error caused by the altitude of the barometer. It also permits the DC bias generated in the

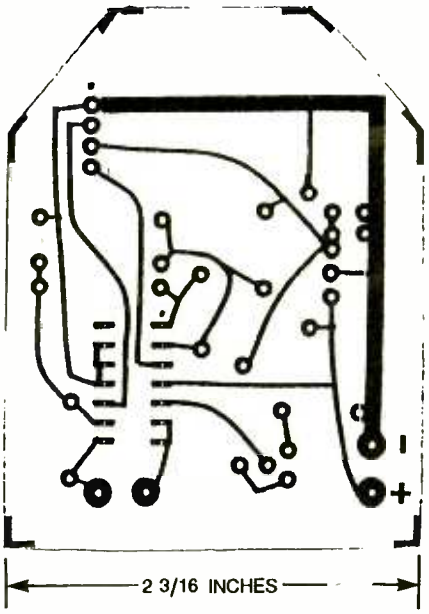


Fig. 3. The Digital Barometer was built on two single-sided, printed-circuit boards—one of which (the one shown here) is referred to as analog board. You can use this full size template (and the one in Fig. 4) to etch your own boards or purchase a set from the supplier listed in the Parts List.

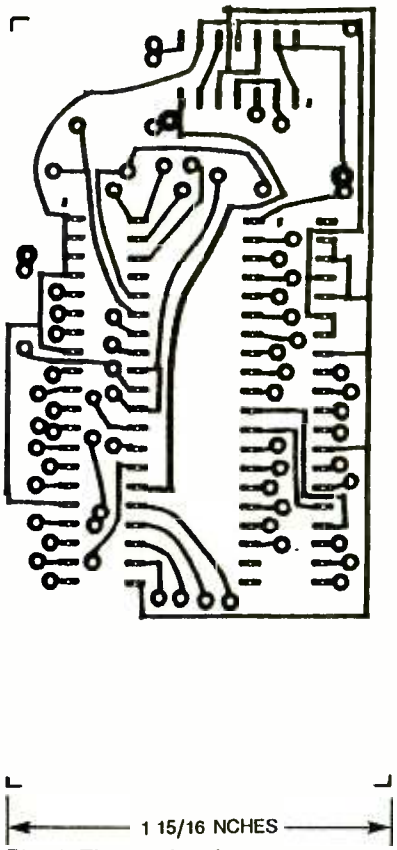


Fig. 4. The template for the other board—called the display board (which contains the A/D converter, digital logic, and LCD readout)—is shown here full scale.

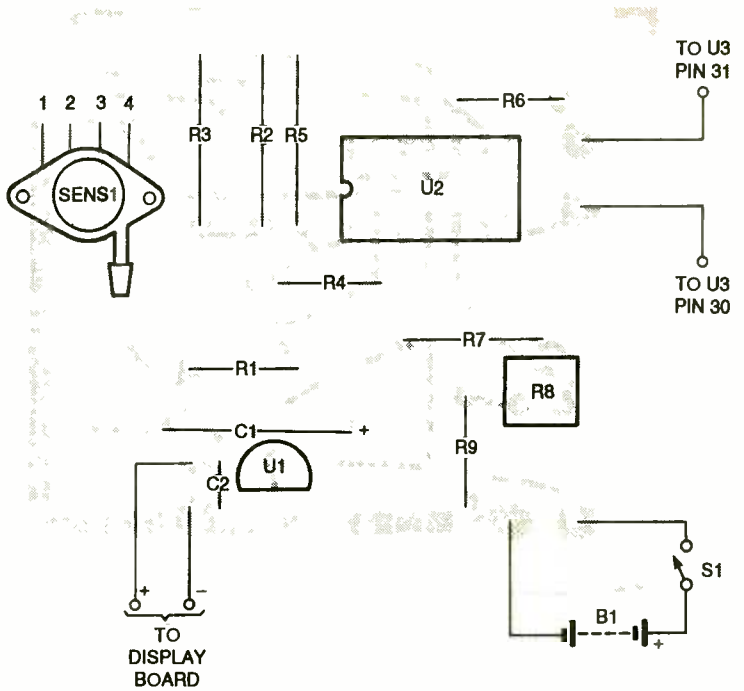


Fig. 5. When assembling the analog board (guided by this parts-placement diagram), it is recommended that sockets be used for the DIP IC's.

determined by voltage divider comprised of R11–R13.

The decimal point of the LCD readout is hard wired for a display resolution of 0.01 inches of mercury. That causes the three least-significant digits of the display to read 8.00 for a differential input voltage of 0.08 volts, 9.00 for 0.09 volts, 0.00 for 0.10 volts, and 1.00 for 0.11 volts.

The gain of the analog amplifier is chosen so that a variation of 1.00 inch of barometric reading as detected by the sensor is translated into a change of 0.01 volts at pin 8 of U2-c. That causes the display's three least-significant-digits to read 8.00 at 28.00 inches, 9.00 at 29.00 inches, 0.00 at 30.00 inches, and 1.00 at 31.00 inches.

Generation of the most-significant digit of the display (2 or 3) is accomplished via U4 (a 4030 quad two-input exclusive-OR gate). The XOR gate produces a logic 1 output only when the signals applied to its two inputs are opposite to each other. The key to generating either a 2 or 3 is determined by examination of the "g" segment of the second most-significant-digit, since the barometer need display only 28 to 31 inches of mercury. If that digit is either an 8 or a 9, its "g" segment is energized and the most-significant digit must then be a 2. If the second most-significant digit is either 0 or 1, the "g" segment is dormant and the most-significant-digit must then be a 3.

Integrated circuit U4-c simultaneously examines the "g" segment of the second most-significant digit and the back-plane waveform generated by U3. When the "g" segment is active (8 or 9), the output at of U4-c at pin 10 is at a logic 1. Otherwise it is zero for digits 0 and 1. Integrated circuit U4-b is used to conditionally invert the back-plane waveform, so that its output is identical to back-plane when the digit is 0 and 1, and is an inverted back-plane when the digit is 8 or 9.

Integrated circuit U4-b pin 4 feeds segment "e" of the most-significant-digit, which must be displayed as a "2" when the next digit is 8 or 9. Similarly, U4-a is used as a conditional inverter so that the "c" segment of the most-significant-digit is always driven opposite to the "e" segment as required for a "3."

Finally, U4-d is used as an inverter so that the remaining segments, common to display a digit of 2 and 3, are always energized. The logic circuit, comprised of U4, always generates the correct most-significant-digit of the barometric reading, but cannot display any digit other than 2 or 3.

Construction. The Digital Barometer was built on two single-sided, printed-circuit boards; one is referred to as

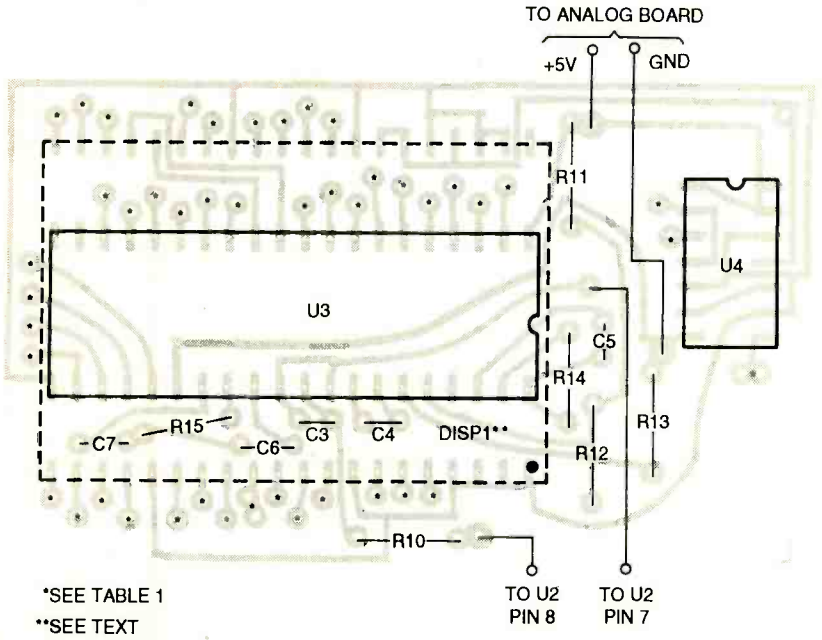


Fig. 6. After assembling the display board, install all of the jumper connections listed in Table 1 on the component sided of the board. The LCD module is then mounted to the copper side of the board.

analog board (which contains the analog circuit and regulated power supply) and the other is called the display board (which contains the A/D converter, digital logic, and LCD readout). Splitting the circuit into two sections allows stacked printed-circuit construction so that the entire project can be assembled into a small enclosure, complete with the battery. The readout was mounted on copper side of the digital board to allow it to protrude through the cover of the housing, for ease of viewing.

If you do not wish to etch your own boards, they are available from the source given in the Parts List. Templates for the two printed-circuit boards are shown in Fig. 3 (the analog board) and Fig. 4 (the display board) full scale. The parts-placement diagrams of the analog and display boards are shown in Fig. 5 and 6, respectively. Also shown in those diagrams are the hard-wire connections between the boards and to the external components.

It is recommended that sockets be used for the DIP IC's. Because of the limited space in the recommended enclosure, only low-profile sockets should be used. The LCD readout can be soldered directly into the digital board. If desired, a socket for the readout can be fabricated by cutting a 40-pin DIP socket in half lengthwise. Do not install the readout or IC's into the boards until you are instructed to do so later on during the checkout procedure.

TABLE 1—JUMPER CONNECTIONS

From	To
U3 pin 2	DISP1 pin 18
U3 pin 3	DISP1 pin 19
U3 pin 4	DISP1 pin 20
U3 pin 5	DISP1 pin 21
U3 pin 6	DISP1 pin 22
U3 pin 7	DISP1 pin 23
U3 pin 8	DISP1 pin 17
U3 pin 9	DISP1 pin 14
U3 pin 10	DISP1 pin 15
U3 pin 13	DISP1 pin 26
U3 pin 14	DISP1 pin 13
U3 pin 15	DISP1 pin 10
U3 pin 16	DISP1 pin 29
U3 pin 17	DISP1 pin 31
U3 pin 18	DISP1 pin 9
U3 pin 22	U4 pin 8
U4 pin 8	DISP1 pin 32
U3 pin 23	DISP1 pin 30
U3 pin 24	DISP1 pin 11
U3 pin 25	DISP1 pin 27
U4 pin 2	DISP1 pin 5
U4 pin 3	DISP1 pin 7
DISP1 pin 12	DISP1 pin 6
U4 pin 11	DISP1 pin 12

Pay strict attention to the orientation of all polarized components; if any of the polarized components (electrolytic capacitors and IC's) are inadvertently installed backwards, the circuit won't work and there is the possibility of damage to one or more of the components.

The accuracy of the barometer relies on the tolerance and stability of

PARTS LIST FOR THE DIGITAL BAROMETER

SEMICONDUCTORS

U1—AN78L05 5-volt, 100-mA, voltage regulator, integrated circuit
U2—LM324N quad op-amp, integrated circuit
U3—ICL7106CPL 3½-digit A/D converter, integrated circuit
U4—CD4030BE quad exclusive-OR gate, integrated circuit
DISP1—LCD004 4½-digit or similar LCD readout (Digi-key)
SENS1—MPX2100AP 15-PSIA pressure sensor (Motorola)

RESISTORS

(All fixed resistors are ¼-watt, 1% metal-film units, unless otherwise noted.)
R1—332,000-ohm
R2—15,800-ohm
R3—143,000-ohm
R4–R6, R11, R13—100,000-ohm
R7—150,000-ohm
R8—2,000-ohm PC mount, cermet potentiometer
R9—76,800-ohm
R10—1-megohm ¼-watt, 5%, carbon
R12—4120-ohm
R14—100,000-ohm, ¼-watt, 5%, carbon
R15—47,000-ohm, ¼-watt, 5%, carbon

CAPACITORS

C1—10-μF, 15-WVDC, axial-lead electrolytic
C2—0.1-μF, ceramic-disc
C3—0.01-μF, ceramic-disc
C4, C6—0.47-μF, ceramic-disc
C5—100-pF, ceramic-disc
C7—0.22-μF, ceramic-disc

ADDITIONAL PARTS AND MATERIALS

B1—9-volt transistor-radio battery
S1—SPST miniature toggle or slide switch
Printed-circuit materials, enclosure (Radio Shack 270-222 or similar), IC sockets, battery holder and connector, wire, solder, hardware, etc.

Note: The following items are available from A. Caristi (69 White Pond Road, Waldwick, NJ 07463): Pressure sensor (SENS1), $39.50; a set of two printed-circuit boards, $19.75; 78L05 5-volt regulator (U1) 2.00; LM324 op-amp (U2), $2.00; ICL7106CPL A/D converter (U3), $16.50; 4030 quad XOR gate (U4), $2.00; set of eleven 1% metal-film resistors, $4.95. Please add $3.00 postage/handling to all orders. New Jersey residents please add appropriate sales tax.

the amplifier and A/D converter resistor values. For that reason, it is necessary to use only 1% metal-film resistors where specified in the Parts List. Ordinary carbon resistors are not stable enough for the circuit, and should **not** be used in place of the metal-film types.

Analog Board. The pressure sensor is a reasonably sturdy device, but care must be taken when forming the leads at right angles so that the body lies flat on the board. Use two long-nose pliers when bending the leads—one to prevent stress on the lead where it enters the plastic body and the other to bend the terminals to the proper position.

Before forming the leads, locate pin 1 of SENS1, which is identified by a small indentation cut into the flat terminal of pin 1. Once you have identified pin 1, you'll be able to form the leads in the correct direction so that the sensor can be properly installed in the circuit. The use of mounting hardware for the sensor is optional; if used, place the head of the screws on the bottom side of the board to allow it to rest on the bottom of the enclosure. No pneumatic connection to the pressure port of the sensor is required for the barometer except during an optional calibration procedure (that is discussed later).

After completing the analog board, examine it very carefully for opens, shorts, and cold solder joints. It is much easier to correct a problem at this stage rather than later on should you discover that the barometer does not work.

Digital Board. To keep the size of the barometer as small as possible, the LCD readout was mounted on the copper side of the board. That allows you to mount the display board to the cover of the enclosure with the display protruding through a 2 1/16 by 1 5/16-inch rectangular opening. Drill four holes in both the display board and cover to accommodate the mounting hardware. Be careful not to drill through any of the copper conductors.

The display board requires a number of jumper wires to complete the circuit; a listing of those connections are given in Table 1. Use #24 or #26 insulated, stranded wire for the jumper connections. All jumper wires must be placed on the component side of the display board to allow room for the readout module on the opposite side.

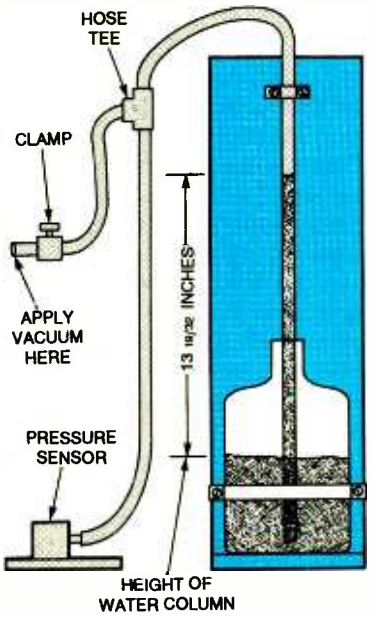


Fig. 7. For those who wish to obtain the greatest possible accuracy from the circuit, this set up can be used to calibrate the Digital Barometer using a procedure founded in some basic laws of physics.

After all other components have been installed, install the LCD's socket (as described earlier), if one is to be used, on the copper side of the display board. Do not install the LCD at this point; the circuit must be determined to be bug-free first, with no opens, shorts, cold solder joints, or other construction errors.

Final Assembly. There are 4 connections that must be made between the analog and display boards; +5 volts, ground, and the two differential outputs from U2-c and U2-b. Use different color insulated stranded wire for those connections and be sure to allow sufficient lead length to permit the boards to be placed as required in the enclosure.

In the author's prototype, two corners of the analog board were cut off at 45° angles to permit the board to be positioned near one end of the specified enclosure, allowing sufficient room for B1 next to the board. It is not necessary to fasten the analog board to the recommended enclosure; it will automatically be held in place when the cover is screwed down.

The wiring between the two circuit boards must be positioned so that it does not lie across the top of U3 when the cover of the enclosure is put in place; otherwise, there may be insufficient clearance when attempting to seal the enclosure that is specified in the Parts List.

Connect a battery clip to the circuit. When wiring the clip to the circuit, be sure to observe proper polarity as indicated in the parts-placement diagram. Switch S1 can be installed on the side of the enclosure. Because of the limited space within the enclosure, use a miniature toggle or slide switch.

Checkout. For the initial checkout of the circuit, do **not** install the IC's (U2, U3, or U4) or the display (DISP1) on the boards. The power supply will be checked first, using any DVM or VOM. Connect a fresh battery to the circuit. Connect the negative lead of the voltmeter to the circuit ground (negative battery terminal) and turn on S1. Measure the output of the regulated 5-volt supply at pin 3 of SENS1. You should get a reading of from 4.8 to 5.2 volts. If that checks out, proceed with the remainder of the test. If you do not obtain the proper reading, troubleshoot the circuit and correct the problem before proceeding.

If the power supply is not delivering the correct voltage, check the terminal voltage of the battery when powering the circuit: The minimum permissible voltage is 7 volts. Check the orientation of U1. With the battery disconnected, measure the resistance between the 5-volt bus and ground to be sure that there is no short circuit in the wiring.

When you are satisfied that the power supply is operating properly, disconnect the battery. Very carefully insert U2–U4 and DISP1 into their respective sockets, with the correct orientation. When installing those components, be sure that none of the IC pins are inadvertently bent underneath the body of the IC.

With all of the components installed, apply power to the circuit, and measure the voltage at pin 8 of U2, with respect to ground. You should get a reading of about 1.8 volts. If your reading does not coincide with that

voltage, carefully check to make sure that R1 through R6 are of the correct values. If in doubt, use an ohmmeter to measure the resistance of any resistor after disconnecting one end from the board. Try a new LM324N. Check the sensor for correct orientation in the circuit. Set R8 to mid-position and measure the voltage at pin 7 of U2. A reading of about 1.7 volts is normal. If you do not get the correct reading, check R7–R9 for the correct values.

The next step involves checking the operating range of R8, and if necessary changing R7 and/or R9 to compensate for normal tolerance variations in the sensor and other circuit components.

Connect the negative lead of the voltmeter to pin 7 of U2, and the positive lead to pin 8 of U2. Set the voltmeter to a sensitive range (such as 200-mV full scale). Apply power to the circuit and record the reading as R8 is adjusted to each end of its range. Ideally, the maximum and minimum readings should be centered around 100 mV (0.1 volt), with an adjustment range of at least ±10 mV. It may be necessary to tailor the values of R7 and/or R8 in order to obtain a voltage-adjustment range that covers 90 to 110 mV as R8 is varied from one extreme to the other.

Once R8 has been centered about 100 mV, very slowly adjust R8 over its range and note the reading of the display. You should be able to obtain barometric readings of at least 29.00 to 31.00 inches of mercury. Remember, the circuit is not capable of displaying numbers such as 27 and 32, so ignore such readings, which can occur at either end of the adjustment range.

If you do not obtain a legitimate barometric display, or if the display is totally blank, the problem probably lies with the display board. A totally blank display indicates that the backplane-drive signal generated at U3 pin 21 (a 5-volt peak-to-peak squarewave of about 50 Hz) is absent. Check all of the components associated with U3. Check the orientation of DISP1 to be sure it is installed correctly.

Check the wiring to be sure that there are no solder bridges across the closely spaced conductors. If possible try a new A/D converter (U3) and XOR gate (U4). If the display is energized, but one or more of the digits has segments that are either incorrectly energized or extinguished, the problem is most likely with the connections between U3, U4, and DISP1.

Carefully review Table 1 to determine whether all of the jumpers are correctly wired. Check the solder connections to DISP1 for opens and shorts. When the barometer is operating properly, set R8 to the current barometric reading, which can be obtained by calling a local airport or tuning into a radio or TV weather report.

Precision Circuit Calibration. The Digital Barometer can provide reliable and accurate readings since the tolerance of the sensor and circuit components are reasonably good. For those who wish to obtain the greatest possible accuracy from the circuit, a simple calibration procedure using some basic laws of physics can be used to trim the amplifier gain for the particular sensor used in the circuit.

Calibration involves using a water-column manometer, which can be assembled from easily obtainable materials. The manometer is used to simulate a pressure difference of 1 inch of mercury so that the circuit is checked at two different pressure readings, 30.00 and 29.00 inches. Resistor R2 can then be trimmed to provide a precise circuit gain for a change in pressure of 1 inch of mercury.

Figure 7 illustrates the manometer setup. The materials require include a clean bottle, clear plastic tubing, a hose "tee" to make a 3 way connection, a hose clamp, a short length of wood, and a scale. (A small amount of food coloring can be used to make the water level easier to see.) The accuracy of this procedure is determined by how precisely you can measure and set the height of the water column, which can be marked on the length of wood.

The bottle and plastic hose can be secured to the wood to keep the tubing above the top of the bottle as straight as possible. Keep the assembly vertical during the procedure. With the pressure sensor connected to the manometer as shown in Fig. 7, apply power to the circuit. Open the clamp and be sure that there is no water or bubbles in the tubing above the water level in the bottle. Set potentiometer R8 so that the display reads 30.00 inches.

Now gently apply suction to the open end of the tubing so that the water level rises in the tube. Carefully raise the level of the water 13 19/32 inches (34.5 centimeters) above the level in the bottle. Close the clamp so that the water in the tubing remains at the desired level. Note the reading of the barometer, which should be 29.00 inches.

If the reading is greater than 29.00, the amplifier's gain is set too low, and the value of R2 needs to be reduced. If the reading is below 29.00, R2 needs to be increased. The required change in R2 will be extremely small, possibly less than 100 ohms. It's best to use a small carbon resistor connected in series to raise the value, or a large carbon resistor connected in parallel to reduce the value.

Once the optimum value for R2 has been determined and placed in the circuit, the barometer is calibrated. Adjust R8 for the prevailing barometric pressure.

Using the Barometer. Once R8 has been adjusted, it needs no further attention unless the altitude of the barometer is changed by moving it to another location. If so, reset R8 by obtaining a current barometric reading from an airport or weather report. When operating the barometer, you may see some fluctuation in the least-significant digit of the display; it should hover between two readings. That's normal for the A/D converter used in the circuit.

Also note that the circuit is far more sensitive than the common analog barometer, and will give a continuously updated pressure reading. Thus, you may see small changes in readings as the ambient air pressure varies. That can be very noticeable on a windy day. To use your barometer for weather forecasting, note the direction of change in readings taken an hour or more apart. Increasing readings usually indicate fair weather ahead; falling barometric pressure indicate stormy or unstable weather is on its way.

Be sure to turn off the instrument when not in use. That ensures long battery life. ■

Build this simple and inexpensive wind-speed measuring device and become your own meteorologist

Build an Anemometer

BY BOB SIMCOX

Spinning pinwheel-like devices are frequently seen mounted atop the masts of ships, the masts of weather and air-sampling stations, and atop tall towers located at airports and air fields. Those wind-driven spinning devices are mechanical sensors that are part of an instrument—known as an anemometer—that is used to measure the force of the wind and hence its speed. Hikers, campers, bikers, home owners, drivers, pilots, and sailors are interested in wind speed and force because it allows them to anticipate hazardous weather conditions and plan activities accordingly.

In this article, we'll show you how to build a simple, effective, and inexpensive anemometer. But before we get into details of the circuit, it is wise to review some background material.

Theory. Wind consists of air molecules in motion. When those molecules strike an object, they impart a force (pressure) on the object that is proportional to their velocity. The total force on an object is the sum of the pressure per unit area multiplied by the total effective area of the object.

Paddles or cups mounted to a rotor can be used to convert the wind force into torque. That torque can then be used to turn a wire loop or coil that is positioned between two permanent magnets (a DC motor or generator) to produce a voltage that is proportional to the torque or wind speed. The resulting voltage can then be processed and displayed on a DC ammeter (calibrated to read miles per hour, mph, instead of amps) as wind velocity.

That is the essence of the anemometer described in this article. The author used a simple DC motor as the generator. A rotor was then fabricated from parts obtained locally, and combined with the generator.

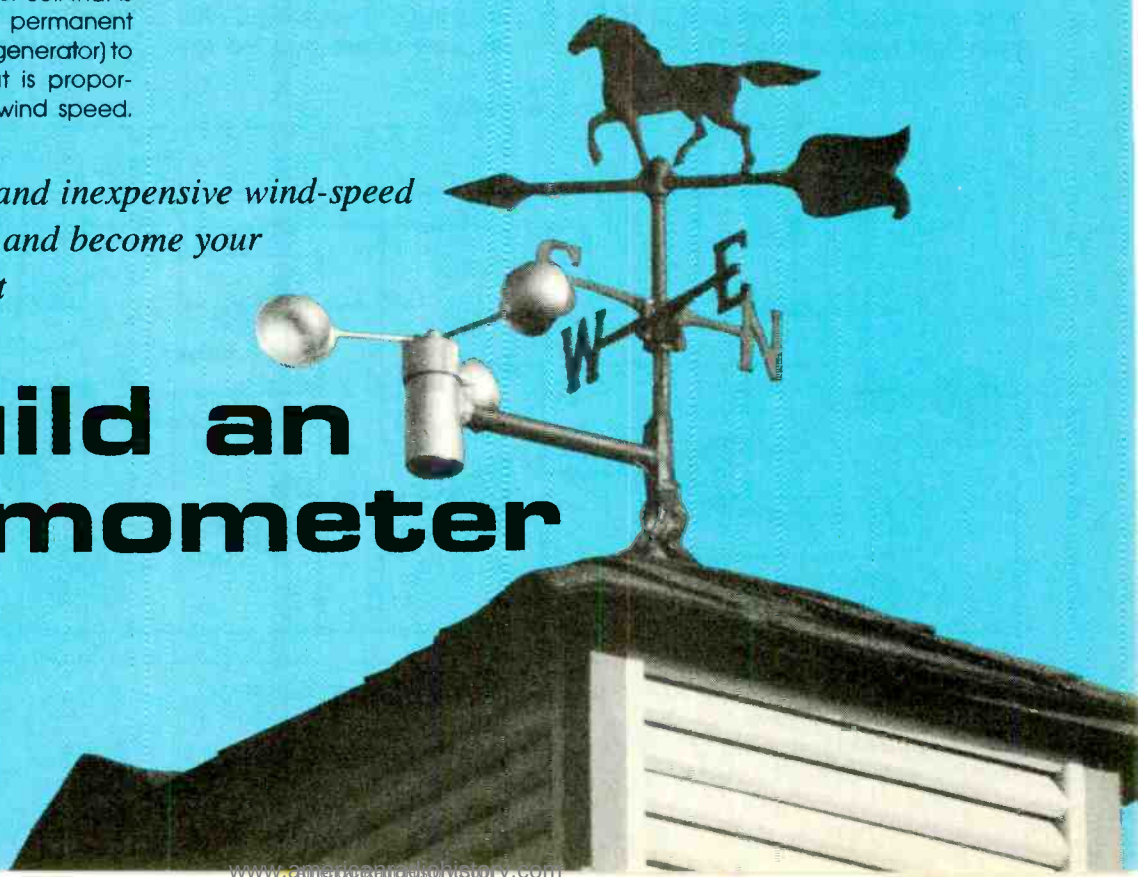
To calibrate the generator/rotor assembly, it was mounted on a board that was, in turn placed on top of the author's van. On a windless evening, the van was driven at speeds ranging from 5 to 45 miles per hour (MPH) in 5 MPH increments. The generator's output voltages were measured at various vehicle velocities, using a high-impedance voltmeter. The measurements were recorded, and data was then statistically processed and used to develop the graph shown in Fig. 1. As shown, the generator's output voltage varied linearly from 0 to 300 millivolts (mV) over the vehicle's speed range (0 to 45 mph).

A Look at the Circuit. Figure 2 is a schematic diagram of the Anemometer. That circuit, which is shown separated into two parts (the processor and the monitoring circuit) is comprised of the generator (denoted MOT1 in Fig. 2), an LM324 quad op-amp (U1, whose individual op-amps provide pre-amplification, integration, and buffering), a pair of light-emitting diodes (LED1 and LED2), a 0- to 15-mA meter (M1), and a few support components.

A reed relay (K1) and decoupling capacitors (C1 and C3) were included in the processor portion of the circuit to insure that the generator voltage was not applied to the input op-amp before the ±9-volt supply voltages were present.

The input to the circuit (the voltage derived from the generator) is fed through K1 to the non-inverting input of op-amp U1-a. The output of U1-a is then fed to the inverting input of U1-b, whose output is then fed to the inverting input of U1-c. The output of U1-c is then fed to the final op-amp stage, U1-d, which is configured as a voltage follower. The output of U1-d is fed through a voltage divider network consisting of three fixed resistors (R10–R12) and a potentiometer (R13), to the DC ammeter, M1. That resistor string allows the meter to be set for full-scale deflection at 45 MPH. Switch S1 (a momentary-contact DPDT unit) is used to initiate a measurement.

Power for the circuit is provided by a



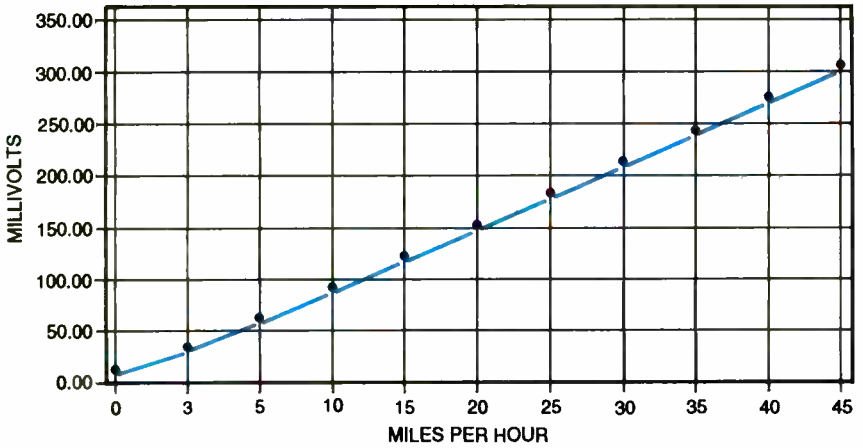


Fig. 1. The generator/rotor assembly was mounted on top of the author's van, which was driven at speeds ranging from 5 to 45 miles per hour (mph) in 5-mph increments on a windless evening. The generator's output voltages—measured at various vehicle velocities, using a high-impedance voltmeter—were recorded, and the data was used to develop this graph.

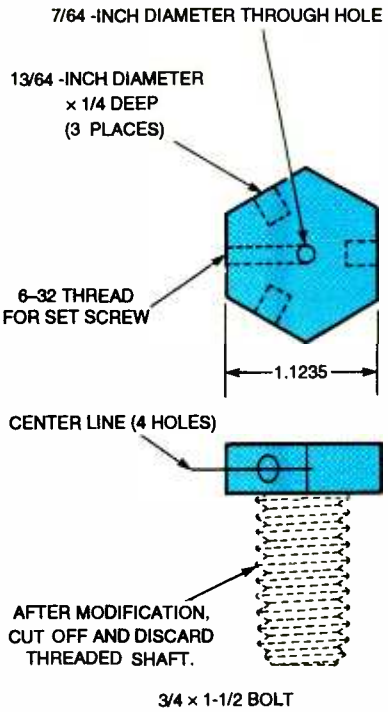


Fig. 3. The rotor hub was fabricated from a ¾-inch × 1½-inch bolt head. The bolt head was drilled (as shown in this diagram) and shaft of the bolt was cut off. The bolt head was retained as the rotor hub and the shaft was discarded.

pair of 9-volt transistor-radio batteries (B1 and B2), to produce a ±9 volts DC. That dual-voltage arrangement allows the output of the op-amps to go to zero volts instead of half of the supply rail. Two LED's, LED1 and LED2, are used to monitor the positive and negative supply voltages (LED1 for B1 and LED2 for B2).

Electronics Construction. The electronics portion of the project was assembled in two parts called the processor and the monitoring circuit. The processor portion of the circuit was assembled in a small section of perfboard (approximately 1½ × 2⅝ inches), and enclosed in the generator housing (more on that later). Resistor R3 in the processor board is actually a pair (3.3k and 15k) of series connected resistors. The monitoring circuit was hard wired on a barrier strip that was mounted in a 5- × 7- × 2-inch electrical breaker box. The two portions of the circuit were then connected to each other through a 50-foot length of 4-conductor cable.

Mechanical Construction. The rotor hub was fabricated from a ¾-inch × 1½-inch bolt head. The required drilling and cutting is shown in Fig. 3. After all holes were drilled and the set-screw hole threaded, the shaft of the bolt was cut off and discarded. The bolt head was retained as the rotor hub. To assist in locating the holes, the faces and top of the bolt head were coated with a permanent marker

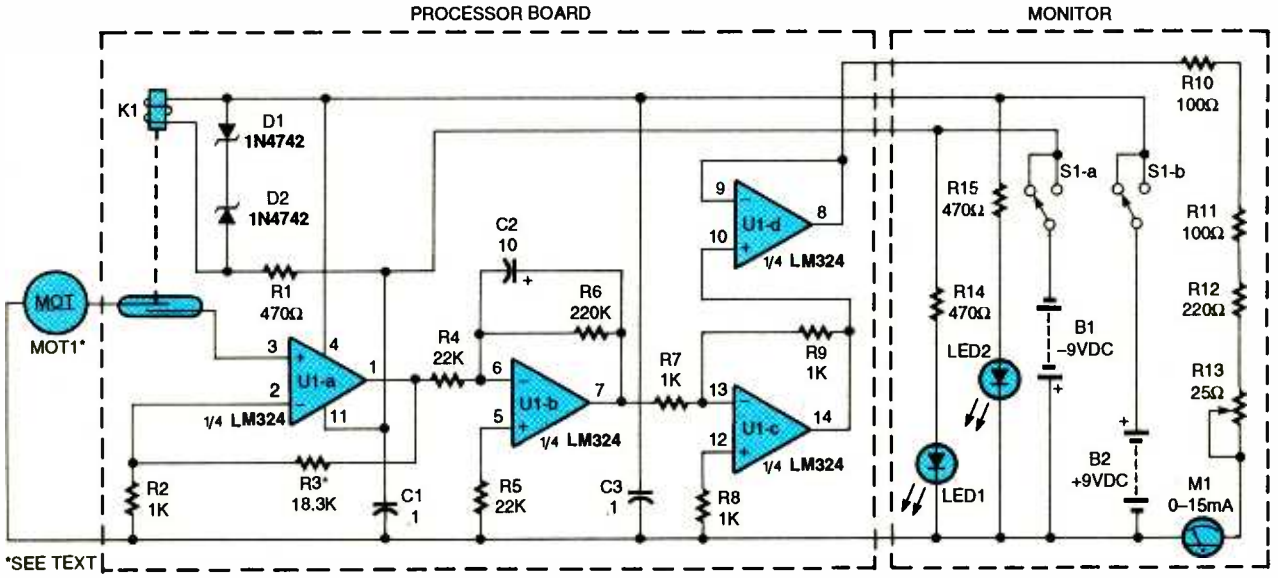


Fig. 2. The anemometer is comprised of the generator (denoted MOT1), an LM324 quad op-amp (U1, whose four op-amps form a preamp, an integrator, and buffer); a pair of light-emitting diodes (LED1 and LED2, which are used to monitor battery voltage), an ammeter (M1), and a few support components.

PARTS LIST FOR THE ANEMOMETER

SEMICONDUCTORS

U1—LM324 quad op-amp, integrated circuit
D1, D2—1N4742 12-volt, 1-watt, Zener diode
LED1, LED2—Light-emitting diode

RESISTORS

(All fixed resistors are ¼-watt, 5% units.)
R1, R14, R15—470-ohm, 1/2-watt
R2, R7–R9—1000-ohm
R3—18,300-ohm (see text)
R4, R5—22,000-ohm
R6—220,000-ohm
R10, R11—100-ohm
R12—220 ohms
R13—25-ohm potentiometer

CAPACITORS

C1, C3—0.1-μF, ceramic-disc
C2—10-μF, 35-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

MOT1—9–18-volt DC motor (Radio Shack #273-563), see text
M1—0–15 mA DC meter (Simpson SK-525-T2) or 0–15-volt DC meter (Radio Shack #270-1754), see text
K1—1-amp, 12-volt reed relay (Radio Shack #275-233)
S1—DPDT 6-amp momentary-contact, toggle switch
B1, B2—9-volt transistor-radio battery
Perfboard materials, enclosure, IC socket, pegboard hangers, electrical box connector, ¾ × 1½ inch bolt, soup ladle, set screws, sheet metal screws, 1½-inch diameter PVC pipe, 1½-inch PVC end caps, ½-inch diameter electrical conduit, 3 × 1 × ¼-inch mounting plate (see text), epoxy, paint, 4-conductor wire, battery holder and connector, wire, solder, hardware, etc.

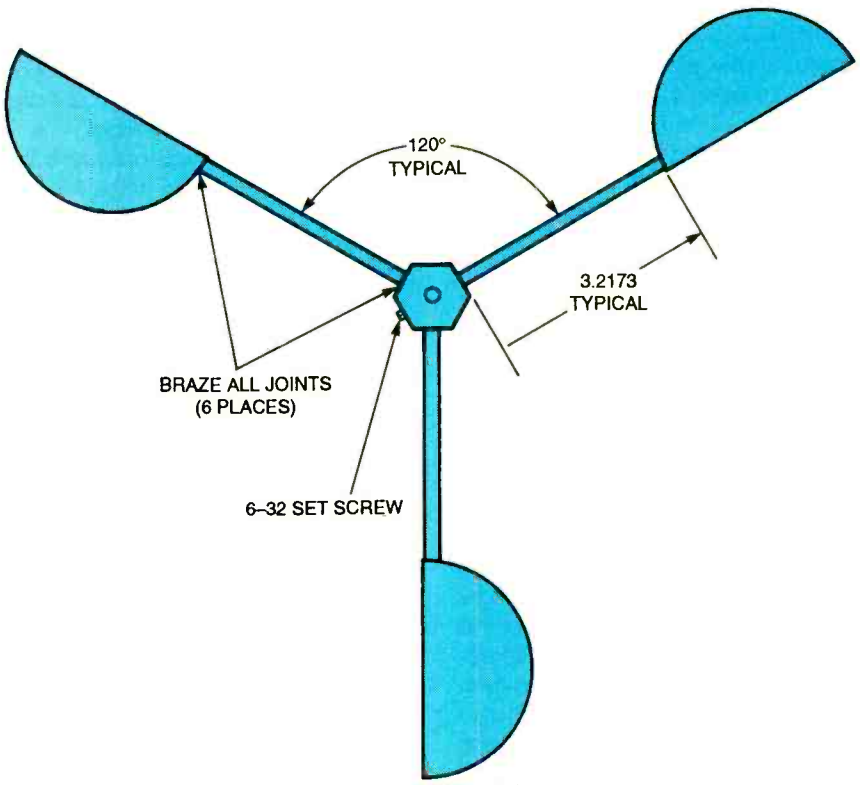


Fig. 4. Three rotor spindles were fabricated from 3½-inch lengths of straight ¼-inch diameter peg board hanger, and the wind cups were fabricated from 2⅞-inch diameter soup ladles.

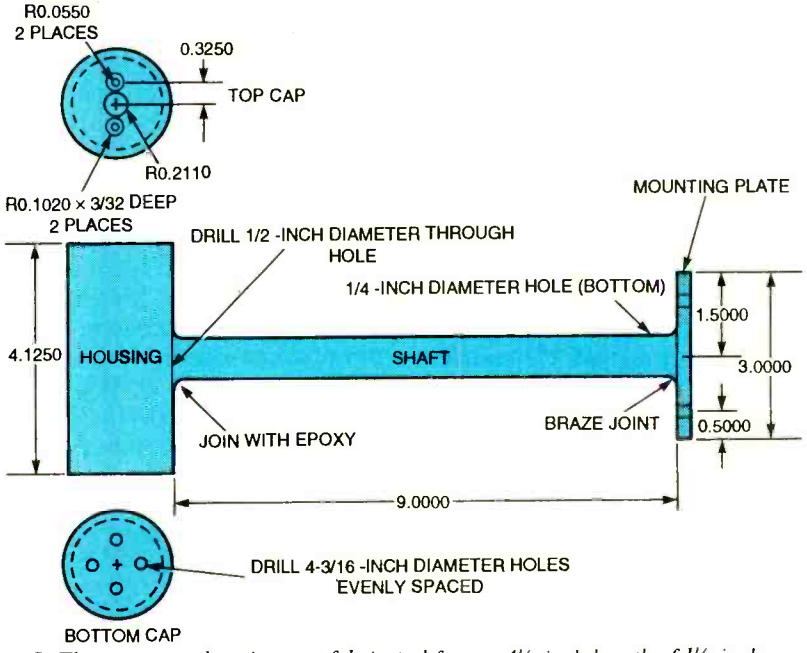


Fig. 5. The generator housing was fabricated from a 4⅛-inch length of 1½-inch diameter PVC pipe, a ½-inch length of electrical conduit, a 1- × 3- × ¼-inch strap, and two 1½-inch PVC end caps.

and then scribed across opposing corners to locate the center of each face and the center of the top.

Each of the three rotor spindles (see Fig. 4) were fabricated from 3½-inch lengths of straight ¼-inch diameter peg board hanger. Once the peg board hangers were cut to length, the spindles were beveled (using a grinder) to match the slope of the wind cups.

The three wind cups were fabricated from 2⅞-inch diameter soup ladles. The ladle handles were cut off and discarded. The cups from the ladles were clamped face down on an insulated surface. The spindles were then clamped so that the beveled edges contacted the wind cups—coplanar with the mouth of the cups and centered. A single setup was used for all three spindles. The spindle-to-wind-cup joints were then brazed and allowed to cool. The hub ends of the three spindles were flattened slightly to form a force fit when inserted in the ¼-inch holes in the hub. The spindles were arranged so that all cups opened to the left when

viewed from the top and were at right angles to the plane of the spindles. The three spindles were then brazed to the hub to complete the fabrication of the rotor assembly.

Generator Housing. The generator housing (see Fig. 5) was fabricated from a 4⅛-inch length of 1½-inch diameter PVC pipe, a ½-inch length of electrical conduit, a 1- × 3- × ¼-inch strap, and two 1½-inch PVC end caps.

First, the 1½-inch PVC pipe was cut to length and a ½-inch hole was drilled through one wall at the center of the pipe (see Fig. 5). Next the ½-inch electrical conduit was brazed to the 1- × 3 × ¼-inch strap (as shown) to form the shaft and mounting plate. The shaft was then clamped to the housing so that the hole in the wall of the housing matched the internal diameter of the conduit. That joint was then coated with epoxy putty so that a smooth ½- to ¾-inch radius fillet was established between the shaft and the housing. Next the top end cap was drilled and then cemented to the housing with PVC cement. The generator was then mounted to the top cap. The mounting screws were coated with Elmers "Stix All" cement before installation. After mounting, the recessed counter bores were filled with "Stix All" for waterproofing.

Once the generator housing was complete, the processor circuit was connected to the generator (MOT1) using a twisted wire pair. Sufficient slack was left in the cable and generator wires so that the processor board could be removed from the housing for maintenance. Next, a 4-conductor cable was routed through the bottom ¼-inch hole in the shaft, through the shaft, through the ½-inch hole in the housing to the processor board. After connecting the 4-conductor cable to the board, the board was placed into the housing behind the generator, and the bottom cap was pressed onto the housing.

Holes for two #6 × ⅜-inch sheet metal screws were drilled through the bottom cap into the PVC housing and the bottom end cap was secured to the PVC housing by the sheet metal screws. The entire assembly was then painted with silver epoxy paint.

The Control Box. The control box was fabricated from a 5- × 7- × 2-inch electrical breaker box (from the author's junk bin). However any metal or plastic enclosure with a minimum size of 4 × 4¾ × 2 inches will do.

The control box was prepared by drilling four mounting holes for the meter using a template provided with the unit. Three additional holes were then drilled along the right side of the enclosure, next to the meter, to accommodate LED1 and LED2, and the momentary contact switch. Grommets were placed in the two LED holes to make a snug fit.

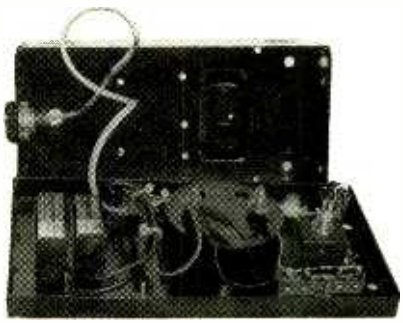
Next the meter has to be recalibrated for wind velocity. The relationship between wind velocity in MPH and current in milliamperes is given by:

$$X\ \text{MPH}/45\ \text{MPH} \approx Y\ \text{mA}/15\ \text{mA}$$

That equation was used to determine the new indices for the meter.

Once wind velocity conversion was calculated, the cover plate was removed from the meter, the milliamp markings were covered using correction fluid ("White Out"), and wind speed in miles per hour were placed on the meter face with an indelible-ink marker. After that, the meter's cover plate was placed back on the meter, and the meter was then mounted to the enclosure. Note that while a Simpson SK-525-T2 0- to 15-mA meter (also from the author's junkbox) was used in the prototype, a Radio Shack DC voltmeter (#270-1754) can be used if that unit's series resistor is removed. After that, the LED's were pressed into the grommets, and the momentary-contact switch was mounted just below the LED's.

A five-lug tie-point barrier strip was mounted on the upper-right meter-mounting screw, and the resistor chain (R10, R11, and R12) was mounted across the five-lug strip. The variable resistor, R13, was mounted through a 5/16-inch hole in a "Z-bracket." The Z-bracket can be nothing more than a 1-inch-wide strip of scrap metal bent at 90° angles in two places; the bends should be about an inch apart.



Most of the monitor circuit was assembled inside an electrical breaker box on a five-lug tie-point barrier strip, and connected to the meter, the power source, switch and LED's via hook up wire.

The battery clips were mounted on the inside surface of the panel using the two ⅛-inch holes and were fastened with ⅛-inch pop rivets.

One end of a 4-conductor cable was brought into the box through a ½-inch electrical clamp. The metering section of the circuit was then connected to the sensor portion of the circuit via the 4-conductor cable.

Testing and Calibration. The processor board and control box were bench tested using a 300-mV source. The 300-mV source was applied to the input of the circuit, producing an output of approximately 5.8 volts DC at U1-a, approximately −7.5 volts at U1-b, approximately 7.1 volts at U1-c, and approximately 6.8-volts DC at the output of U1-d. The generator was connected to the input of the processor board and a test run was made with the sensor mounted on top of the author's van.

Data from the test run was analyzed to determine that the resistor network should have a total resistance 450 ohms; R13 was then adjusted using a digital meter, to bring the network to the required value.

Variations. Design of the anemometer can be varied to accommodate variations in the size or type of wind cups, the DC generator used, the meter used, etc. The critical issues are: adjust the gain of the operational amplifiers so that the dynamic range of the generator is within the linear range of the op-amps, adjust the gain of the circuit to drive the combined meter and resistor string, and calibrate your unit using a similar process to the one used by the author.

If you wish, ±9-volt DC supplies could be used in place of the batteries to provide continuous display of wind speed. Also, the range of the meter could be increased or decreased to customize the anemometer to measure wind speeds that are typical at your location. ■

The Smart Vehicles are Here

Obstacle- and collision-warning systems are a reality now, and we cover them here.

BY BILL SIURU

Someday very "smart" cars may automatically travel down "smart" highways. Such robot cars are probably a long way off in the future, however the first "smart" devices that can detect obstacles and avoid collisions are now coming on the market. As you might expect, these systems use technology previous developed for defense and aerospace applications. Let's look at them.

Obstacle Detection. The Forewarn detection system makes a child's school-bus ride a bit safer. Forewarn was developed by Delco Electronic Corporation, a subsidiary of General Motors' Hughes Electronics. It uses two microwave radar units (see Fig. 1) to detect a child who might be in front of the bus and beside or underneath the bus toward the curb side. Those are the two most dangerous areas around a school bus. If a child is detected, the driver gets both visual and audible warnings via a display unit near the driver. The system goes into operation whenever the stop-arm is extended and the bus is stopped.

Microwave radar was chosen over other sensing techniques including ultrasonic, infrared, and laser radar. According to Delco, all three of those are degraded, or even fail, if obstructed by ice, snow, or mud. In addition, ultrasonic sensors can be blinded by heavy rain, and IR devices are temporarily blinded by bright sunlight. IR sensors can also fail to detect certain colors of clothing or not differentiate heavy clothing from the background under low-temperature conditions. Furthermore, both IR and laser radars can view only limited areas, thus requiring several sensors to provide suffiecent coverage.

Forewarn was tested over an eight-month period involving 30 bus drivers in three school districts in Indiana. The system is easily retrofitted into buses already in service. With minor modifications, it could be used in large trucks and recreational vehicles as well.

Hako International is already offering a low-cost, easy-to-install system that can detect and warn you about objects when backing up. Its Reverse Alert Back Radar system consists of three components (see Fig. 2): the detector mounted on or under the rear bumper, the control box which can be located in the trunk, and the alarm unit in the vehicle. The detector is activated when the vehicle is put into re-

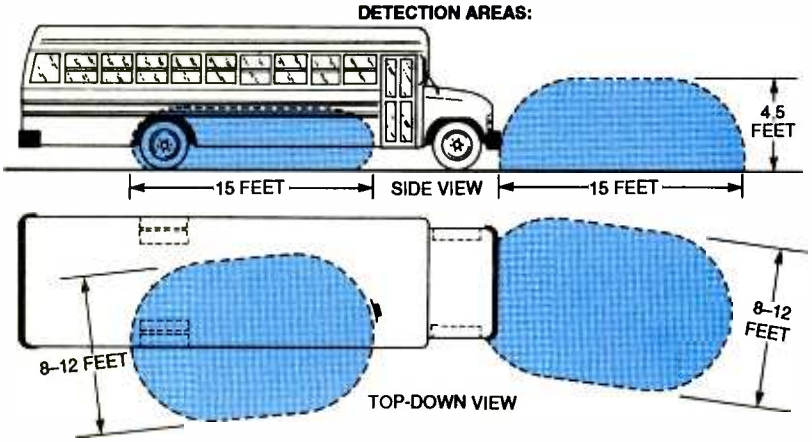


Fig. 1. Shown here are the detection areas monitored by the Forewarn two-sensor system. Note the protection corridor on the curb side of the bus.

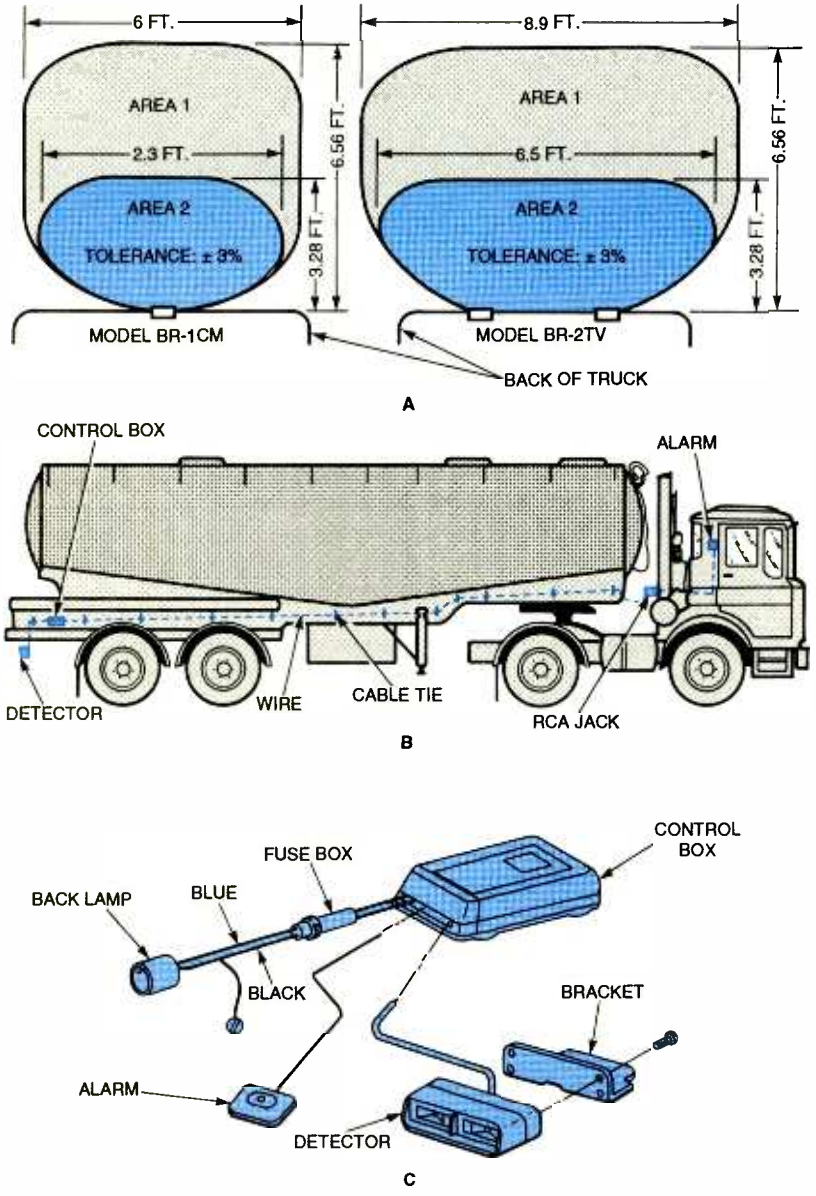


Fig. 2. Shown in A are the protection perimeters of the Hako International Reverse Alert Back Radar System. The positions of its key components, and the components themselves are shown in B and C, respectively.

verse. The "1st Alert" (an intermittent tone) is sounded when an object is within a range of 3-to-7 feet behind the vehicle. The tone becomes continuous, when the object is within 3 feet.

According to Hako, the ultrasonic system will work in heavy rain, snow, or fog provided the sensor's window is kept clean. The system with one sensor for use on a car, minivan, or small truck sells for $119. A two-sensor system, as needed for large vans and trucks, costs $155.

As the name implies, BMW's Park Distance Control (PDC) system makes parking easier and safer. PDC uses four "very ultrasonic" sensors placed in the front and rear bumpers (see Fig. 3). The sensors are positioned to monitor the entire area around the front and rear of the car at distances up to 1.5 meters (4.9 feet).

PDC is activated when the driver shifts the vehicle into reverse. It remains active until the vehicle reaches a forward speed of 30 km/hr (19 mph) or until the car has moved about 50 meters (164 feet). The driver can manually control the system by a switch on the console. For example, the system can be kept operating for longer distances or at higher speeds by flipping the switch.

PDC uses a CMOS single-chip microcomputer with a 4K ROM and 176-byte RAM memory that selects and activates sensors, generates the ultrasonic signal, analyzes the measurements, and performs system control. The individual ultrasonic sensors have an oscillating piezo-ceramic detector sealed in a membrane and are mounted with special separation and damping techniques. They are temperature compensated as well.

As soon as the sensors detect an obstacle via a reflected echo, additional measurements are made to determine the distance. Filters in the computer software validate the reflected signal. After the information has been processed, the two sound emitters, one at each end of the car's interior, start sounding. As the car comes closer to the obstacle, the sound becomes more frequent. At a minimum predetermined distance, the sound becomes continuous. The signal stops as you start moving way from the obstacle.

Safety First Systems Ltd. has de-

veloped a Back-Up and Lane Changing Warning System. The system uses FM-CW radar to help eliminate blind spots when backing up or changing lanes (see Fig. 4). The system can detect both stationary and moving objects at distance of up to 40 feet with a relative range resolution of 0.6 feet. That means objects such as children, cars, trucks, bicycles, and telephone poles are detected.

The transmit/receive antenna consists of a dual, bistatic microstrip-patch design that is mounted on the rear and sides of the vehicle. The radar operates at 10.525 GHz with a 50-MHz bandwidth. Its low average power (about 50 microwatts), 3% duty cycle, and narrow IF bandwidth prevent interference with other similar units that might be operating in the vicinity. The area of detection is divided into four zones of detection (0 to 6 feet, 6 to 12 feet, 11 to 20 feet, and over 20 feet). This capability permits multiple-object recognition and discrimination with a very low false-alarm rate.

The system detects obstacles to the rear when the vehicle is put into reverse. Next-lane obstacle detection is activated with the turn signal. The FM-CW method, can be adapted to other frequencies and bandwidths, and can provide detection and discrimination between multiple stationary and moving objects. In addition to range, relative velocity can be determined. Object position may be triangulated for cross-range position information, too.

Collision Avoidance. Studies done by Diamler-Benz a few years ago showed that giving a driver a split-second of warning could reduce rear-end collisions by 60%, intersection accidents by 50%, and head-on crashes by 30%. There are several systems appearing now that can provide that warning.

The VORAD Vehicle Collision Warning System for cars, buses, and heavy-duty trucks (see Fig. 5) is offered by Eaton VORAD Technologies. VORAD, which stands for Vehicular On-Board Radar, uses a low-power (about 20 watts for the entire system) microwave radar to simultaneously track up to 20 moving or stationary objects. The signals are relayed to the system's central processor, which continually

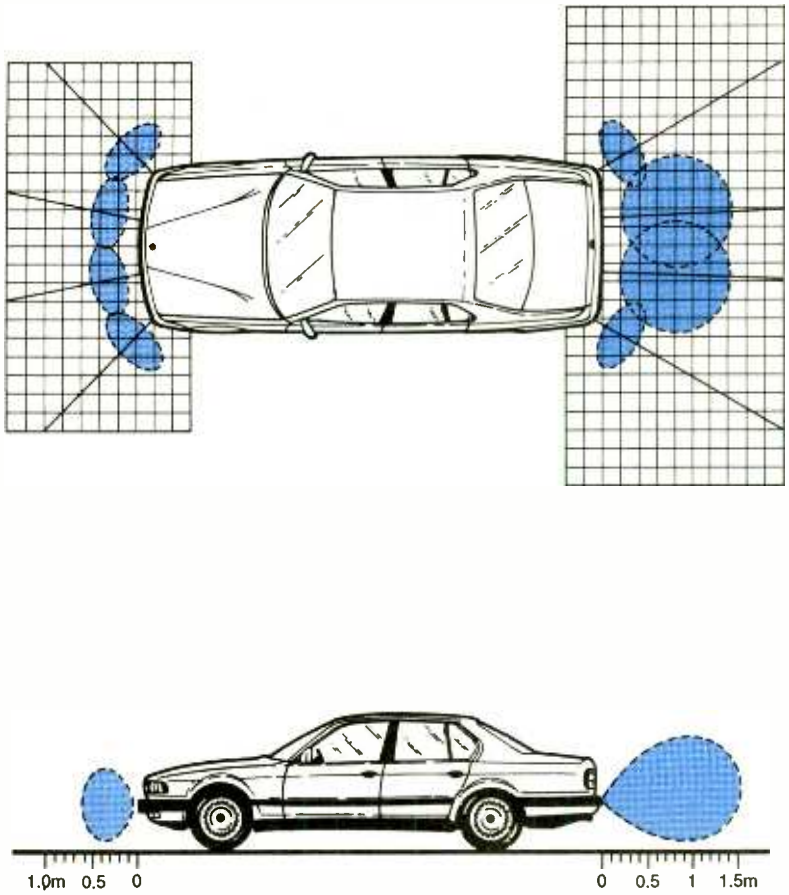
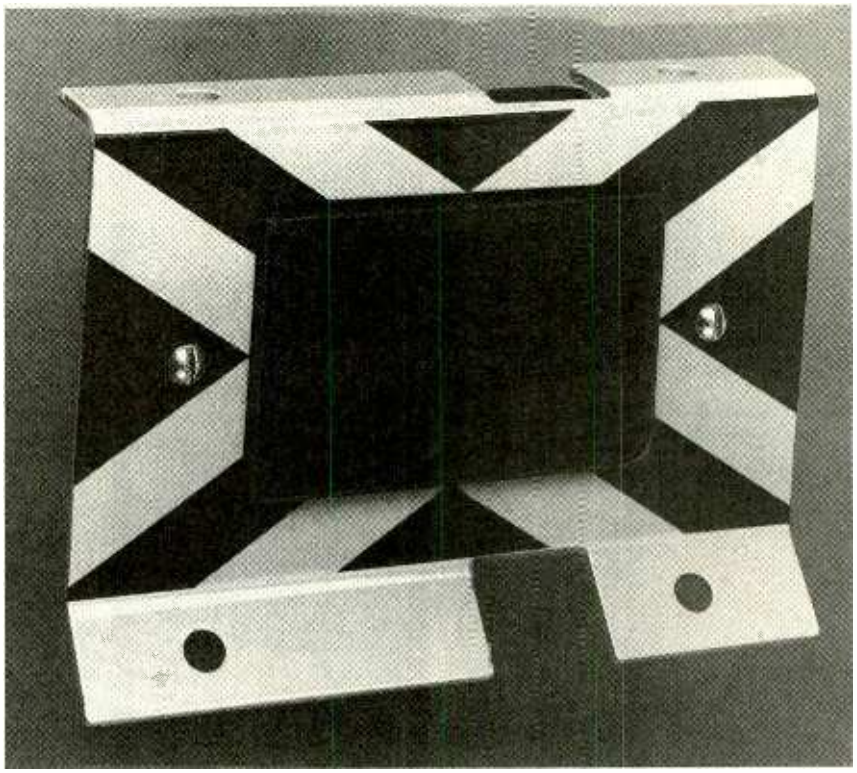


Fig. 3. Detection zones for the PDC system tend to be tight around the front of the vehicle, but less snug toward the rear.



This is the forward Forewarn radar transmitter/receiver, which mounts on the front of a school bus. It warns drivers of children that are out of sight. under the hood line.

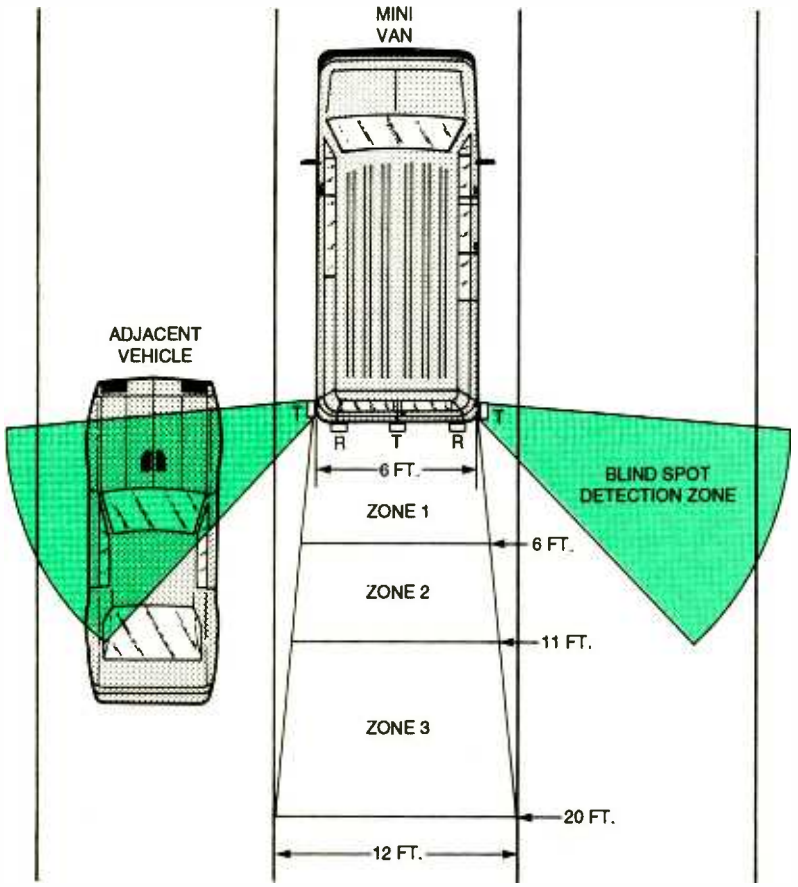


Fig. 4. The detection zones for Safety First Systems' Vehicular Obstacle Detection and Warning System can help avoid lane-change collisions by monitoring a driver's blind spots.

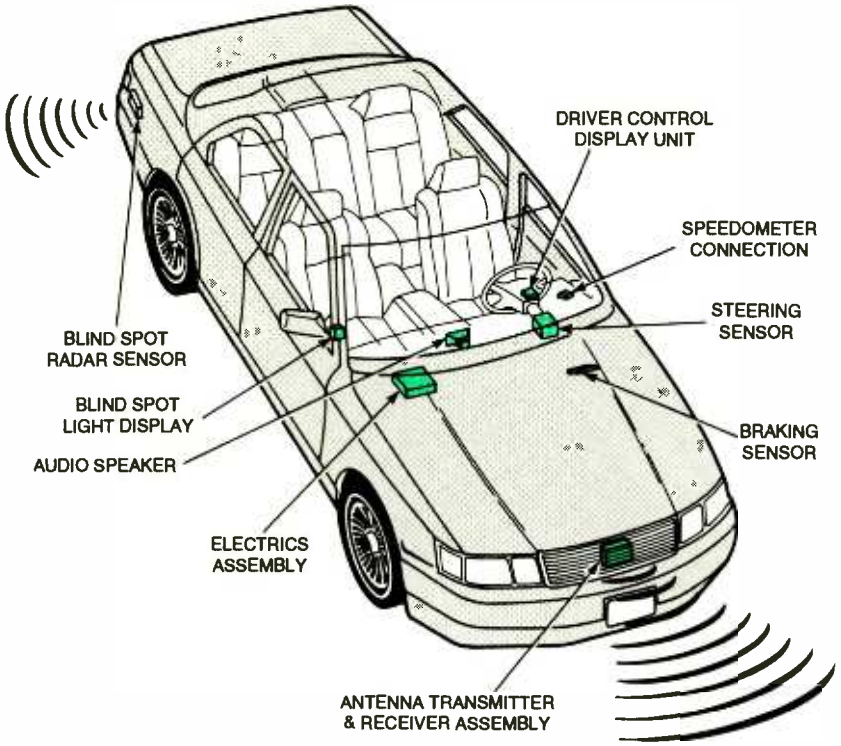


Fig. 5. Once VORAD equipment is installed in an automobile, it provides both forward, and blind-spot detection.

analyzes the relative speed and distance of the nearest three vehicles. If there is a potential hazard, such as another car braking suddenly, a warning is given via lights on a dashboard-mounted control/display unit or by an audio speaker. VORAD has a computational rate of over 10-times-per-second providing drivers with greater reaction time under poor-visibility conditions such as darkness, dense fog, dust, or smoke.

The driver can adjust both the advance-warning time and radar range to suit the driving conditions. While short distances are desirable in urban driving, the range can be increased up to 350-feet for interstate conditions. The system will work on a host vehicle traveling at up to 120 mph and for closing rates of 0.25 to 100 mph.

A 1989 National Highway Transportation Safety Administration (NHTSA) report concluded that sideswiping was the cause of 49% of the 2122 accidents studied. Most occurred during left-to-right lane changes. Thus the VORAD can be ordered with an optional "blind spot" detector. This microwave-radar sensor alerts the driver with a red light when a vehicle has entered the driver's blind spot and a yellow one when the vehicle has cleared the area. If a turn signal is turned on when the red light is lit, a warning sound is emitted to indicate a hazardous situation. The forward-looking radar operates at 24.125 GHz, whereas the blind-spot radar works at 10.525 GHz.

SmartCruise, not yet commercially available, will combine VORAD with the vehicle's cruise-control system to automatically maintain a fixed distance from any traffic ahead. When traveling at a set speed and you approach slower traffic, the adaptive cruise control automatically slows the car down to maintain a safe distance from the traffic.

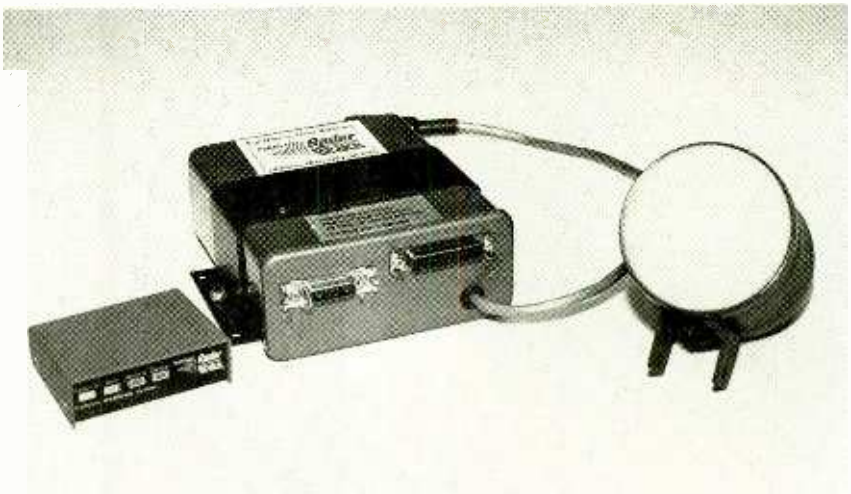
The first major user of the VORAD system is Greyhound Lines, Inc. All of the 2400 buses in its fleet will eventually be equipped with it. Their verson warns if: the preceding vehicle is less than a minimum of five seconds away, the driver is overtaking another vehicle too rapidly, the vehicle ahead suddenly decelerates, or if another vehicle is occupying the blind spot on the right side when changing lanes.

Also included is an Accident Recorder—a "black box" that records the last 10 minutes of driving for accident reconstruction by law-enforcement officials and insurance adjusters. Incidentally, accident reconstruction by such means is becoming more important as anti-lock braking systems (ABS) become more widely used. That's because ABS-equipped vehicles leave faint, if any, skid marks, so it is very difficult to determine pre-accident conditions. Also included on the Greyhound installation is VORAD's integral trip recorder, which monitors idle time, the average and maximum speeds, the average following distance, the number of hazard warnings given to the driver, and the distance traveled. The Greyhound fleet averages 200-million miles annually and the company expects the VORAD vehicle-collision warning system to cut accidents by 25%.

Vehicle Radar Safety Systems, Inc. (VRSS) is now offering its VR-1000A Rashid Radar Safety Brake collision-warning system for after-market installation on cars and trucks. The system consists of three main components. A miniaturized, 3-inch diameter microwave radar is mounted at the front of the vehicle as high or higher than the front bumper. The brain of the system is a microprocessor that interprets signal returns from the radar, performs all computations, and sends commands to the Dashboard Monitor. Uninstalled, the system costs under $1000.

The radar sends out a narrow-beam signal so the system only detects objects in the path of the vehicle and reacts only to those objects that pose a potential hazard. The system discriminates and ignores roadside objects such as road signs, buildings, stoplights, parked cars, and bridges. The system can also handle guardrails and signs while driving on curved and winding roads. According to VRSS, the system will work in the day or at night, and in all types of weather conditions, including fog, rain, sleet, snow, and even smog.

The signal processor constantly computes vehicle speed, distance to an object, difference in speed between the vehicle and an object, and "relative motion" (that is if the vehicles are changing speed with respect to each other). By evaluating that data, the system determines the type of warning the Dashboard Monitor will provide. Those include a precautionary yellow alert when your vehicle's speed is greater than that of the object ahead. If you continue to advance on the object, a red warning signal and a buzzer tell you to slow down, brake, or steer clear. If you are still advancing on a collision course, the buzzer will continue and the final "Danger" light will come on. When a danger comes up suddenly, such as a vehicle swerving into your path, all the lights and the buzzer come on at the same time.



These are the components of the Rashid Radar Safety Brake Collision Warning System. Shown are the dashboard monitor (left), electronic signal processor (center), and microwave radar antenna (right).

While the VR-1000A comes on when the you turn on the ignition, it does not start working until you are traveling at about 10 mph. This precludes interfering when parking or while maneuvering in tight quarters. The system also recognizes bumper-to-bumper traffic and does not provide continuous warnings just because other vehicles are always in your path. Instead, the system still monitors speeds and distances, but only provides warnings when these factors indicate that you should take action to avoid a collision. By having a 30-mph speed-differential threshold, warnings will not be given when vehicles approach from the opposite direction on a two-lane highway.

Though not available yet, VRSS is also working on an advanced unit that will include a Braking Assist System. With it, if you fail to heed or cannot heed the warning of an impending collision, a "Decel" light will come on to let you know the system is decelerating the vehicle. If braking is also required, the Brake light comes on indicating that the brakes are also being applied, as needed, by the system.

Even this first wave of "smart" add-ons for vehicles can offer dramatically improved driving safety. We eargerly await the next wave: totally smart cars and highways. ■

Sources of Information

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Tel. 201-307-3790

Delco Electronics Corporation
One Corporate Center
Kokomo, IN 46904-9005
Tel. 317-451-5407

Eaton VORAD Technologies
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Safety First Systems, Ltd.
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Vehicle Radar Safety Systems, Inc.
Town Square Building, 10 South Gratiot
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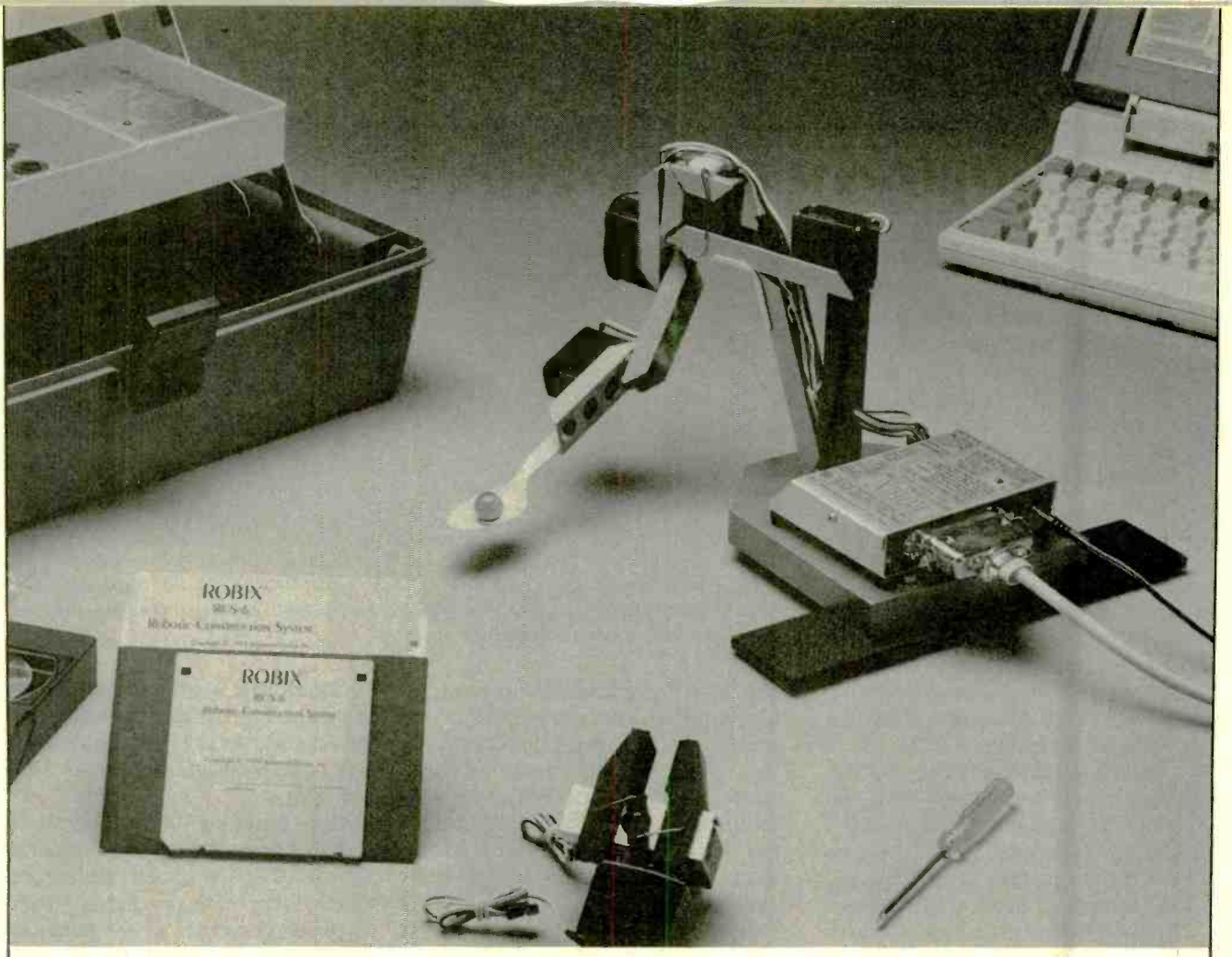
Tel. 313-463-7883



The Robix Robot-Construction Set

A great learning tool that's lots of fun to build and use.

BY MARC SPIWAK

Leisure time is a precious commodity these days. With the economy the way it is, most of us—at least those who have to work for a living—barely have enough time to do enough work to make enough money to pay all the bills. And that means that most of us just don't have time to play with "toys."

However, the Robix RCS-6 Construction System from Advanced Design, Inc. (1101 East Rudasill Road, Tucson, AZ 85718. Phone: 602 544-2390, Fax: 602-575-0703) is no toy. It is a serious educational tool that also happens to be a lot of fun.

The RCS-6 robot-construction set lets you build custom robot arms that you control from a PC. A preassembled interface unit lets you connect the arms to the PC's printer port with an ordinary printer cable. The arms can then be controlled manually or programmed to perform various tasks under computer control. And while the set is simple enough that it can be used by elementary-school kids, it's also sophisticated enough to hold interest at the university level.

Although the RCS-6's price of $550 might be a bit steep for many individuals, no science class or technical college should be without one. Students at all levels would probably find the RCS-6 to be the best class activity of the year. And for those parents that can afford it, the RCS-6 is a much better mind-sculpting investment than a Sega Genesis or Super Nintendo game system.

What's it Good For? Children's toys—good ones, anyway—are designed to help develop strong minds, and many of them actually help kids develop career interests. The same can be said of the RCS-6, except that

The Robix RCS-6 robot-construction kit comes with everything you need to build many different types of robot arms. Included are 6 servo motors, two different bases, a variety of clamps and joints, an instructional video, basic tools, and more.

For ease of access and storage, the Robix kit comes housed in a rugged tackle-type box as shown here.

the RCS-6 will probably inspire just as many career changes as it will first-time careers.

That's not to say that the RCS-6 is too complicated for kids under a certain age. There are plenty of children under the age of five that are more comfortable with computers than their parents. Besides, running some simple DOS-based software and connecting a printer cable is all you have to do on a computer to use the RCS-6. The rest of it is similar to playing with an Erector Set.

But even though the RCS-6 is educational and fun, it is, once again, not just a toy. It can be a productive and useful tool, and is, in fact, used in industry. For example, a General Electric R&D lab uses an RCS-6 robot to handle test tubes for feeding a gas chromatograph. The RCS-6 is actually a quick, simple, and relatively inexpensive way to add robotic capabilities to many light-duty industrial applications. That's because custom-made, single-purpose robots can be prohibitively expensive.

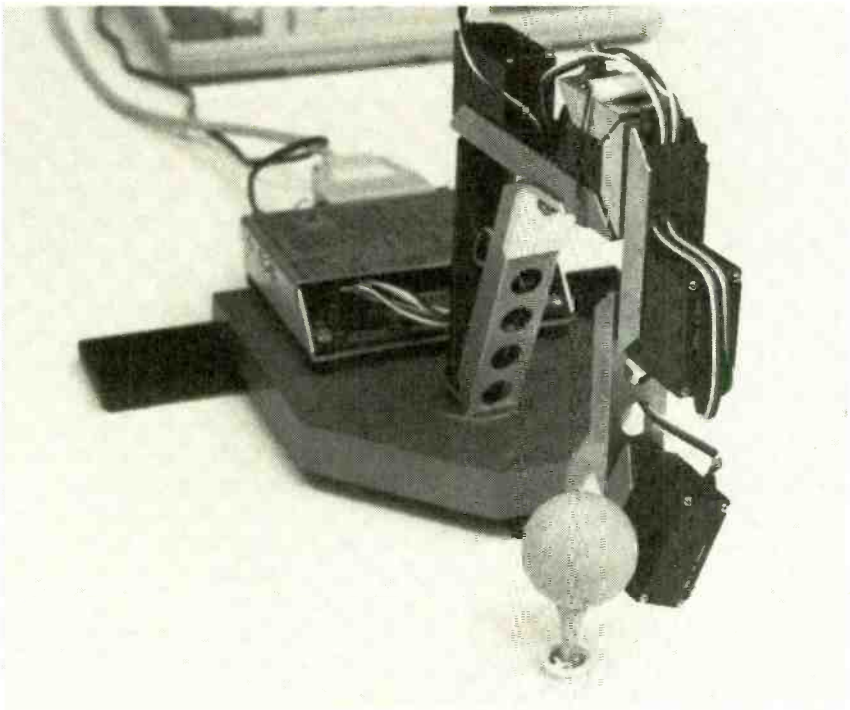
What you get. The RCS-6 comes with two different mounting bases, various sized anodized aluminum brackets, different types of clamps, and many accessories. Even the few required tools—a small Phillips screwdriver and an allen wrench—are supplied. There's even a pair of goggles to guard against the remote possibility of eye injury during construction. To round things out, the set comes housed in a rugged tackle box that provides easy access to everything.

The computer-interface unit is small in size and rests on the robot-arm base. It turns commands from your computer into control signals for the six servos. The interface also has two on/off outputs that can supply up to 150 milliamps of drive current for LED's, relays, solenoids, or whatever. Also included are 0- to 5-volt analog-sensor inputs and an 8-bit A/D converter as well as simple on/off switch-closure inputs. While an AC adapter for the interface is included, you do have to supply your own printer cable to connect the interface to your computer. However, you probably already have the printer cable if you already have the required PC.

Which brings us to the computer. Although you need a computer to control the RCS-6, a lowly 4.77 MHz PC is all the computing power you'll need. If you don't already have an old PC clone, and can't find one that someone has put out for the garbage men, you can certainly purchase one for much less than the price of the RCS-6.

The RCS-6 comes with enough parts to make all different kinds of arms—though not all at once—with up to six motorized joints, or elbows. The motors are actually Futaba S148 hobby servos, which can be readily replaced if the need ever arises. The servos provide a good degree of precision to any arm movement, although they can get the "shakes" when they try to maintain a steady position under load.

Quite often people are hesitant in using anything that connects to a computer, and on top of that the RCS-6 can seem intimidating at first simply because of all the parts included in the set. Fortunately, a VHS videotape that is supplied along with the instruction manual dissolves all



Fore! Although not the most serious application for the Robix arm, it is always up for a good game of golf. It is shown here teeing up its shot.

fears one might have of using the set. Although you can start right out and build the robot arm of your dreams, it's best to start off by watching the video or following along with it, and build the example arm shown. It's a good way to familiarize yourself with the parts and how they're used. And they are very easy to use. Using the software is also explained in the video, and it turns out that the software, too, is simple to use.

Building An Arm. When you set out to build an arm, you have to consider where you want to have movement and what sort of movement you want. You basically get to decide where you want the shoulders, elbows, wrist, and gripper. We built the arm demonstrated in the video, which makes use of all six servos. Aside from a few starts and stops, we were able to keep up with the assembly pace of the demonstration video, and had our arm assembled in about an hour.

An important part of the assembly procedure is to properly dress the servo wires so that none will be damaged by pinching or bind the arm's motion. Foam-rubber blocks and spiral wire wraps are included to help secure the wires. The servos are numbered 1 through 6 according to their position moving outward from the base. Their leads are connected to the interface outputs by a trial-and-error process. Connecting a servo lead to any output on a live interface will make that servo come to life. Then its number can be noted and its lead plugged into the proper output.

The Robix arm at work in a GE research lab.

Software Control. The software comes on a single floppy disk, and both 3½- and 5¼-inch disks are included. A customizable batch file sets up the software to run on your machine and loads the driver. The software is relatively easy to use, and Windows-like in appearance.

Various software consoles and menus let you control the arm from either the keyboard or the mouse. On the keyboard, keys 1–6 move servos 1–6 in one direction, and the keys below them ("qwerty") move the servos in the opposite direction. The two rows of six keys below those control the servos with much slower movement for more delicate maneuvers. Keys can be pressed individually or in combinations.

Any movement or combination of movements can be stored. The motion can then be repeated with a keystroke or mouse click. A motion sequence can also be stored as a macro that can be used to control the arm under higher-level software so that a PC can control an entire system incorporating a Robix arm to do some task. Also included are C and Quick-BASIC libraries to run your robots.

Is It Worth It? We had a lot of fun building just one robot with the Robix RCS-6, and we barely scratched the surface. Surely, if you are interested in robotics you should do whatever you have to do to get your hands on one of these arms; it is a must-have learning tool. Even better, it is one that could be put to useful work as in the GE lab mentioned earlier. ■

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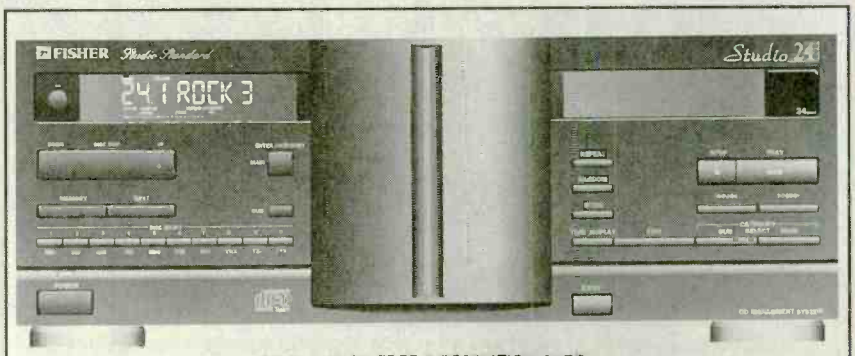
CD Harmony

STUDIO 24 CD MANAGEMENT SYSTEM MODEL DAC-2403. Manufactured by Fisher Audio/Video, 21350 Lassen Street, Chatsworth, CA 91311-2329; Price: $299.95.



It's true confessions time: As teenagers, we (well, at least *some* of us) used to *stack* our LP's, letting them drop and spin on top of each other, so that we could have a couple of hours of uninterrupted music while studying, or partying, or just hanging out. Yes, we knew it was bad for the records, but stopping what we were doing every half hour was just . . . such a drag! (That's one reason that our album collection from the 1960's and 70's is in such bad shape!)

A few years later, we got our first double cassette deck, which let us play tape A followed by tape B. Also, whenever we bought a new tape, we could play it in an endless loop, usually at high volume, much to our parent's dismay.

When CD's became our music medium of choice, we immediately appreciated the extra cuts that could be squeezed on each disc. Furthermore, five- or six-disc changers provided unparalleled convenience and the possibility of real long-time play without the risk of destroying the discs.

It wasn't long, however, before we became disillusioned with those changers. One five- or six-disc carousel changer simply couldn't accommodate our growing collections of discs. Cartridge-type changers allowed us to keep separate collections of discs, which is particularly helpful when two people with diametrically opposed musical tastes share one CD changer, but within those separate cartridges we could never remember which disc was in which spot. Besides, loading and unloading single discs was anything but convenient with a cartridge-style changer.

We recently tested a 100-disc changer (see **Gizmo**, December 1992). While it helped keep our CD clutter to a minimum and allowed us unprecedented programming control, it had two major drawbacks. First, programming was a complex, time-consuming process that had to be redone whenever we wanted to swap discs. Second, and more important, it cost $4000! Although we loved the concept and the product, we could never consider buying it for ourselves.

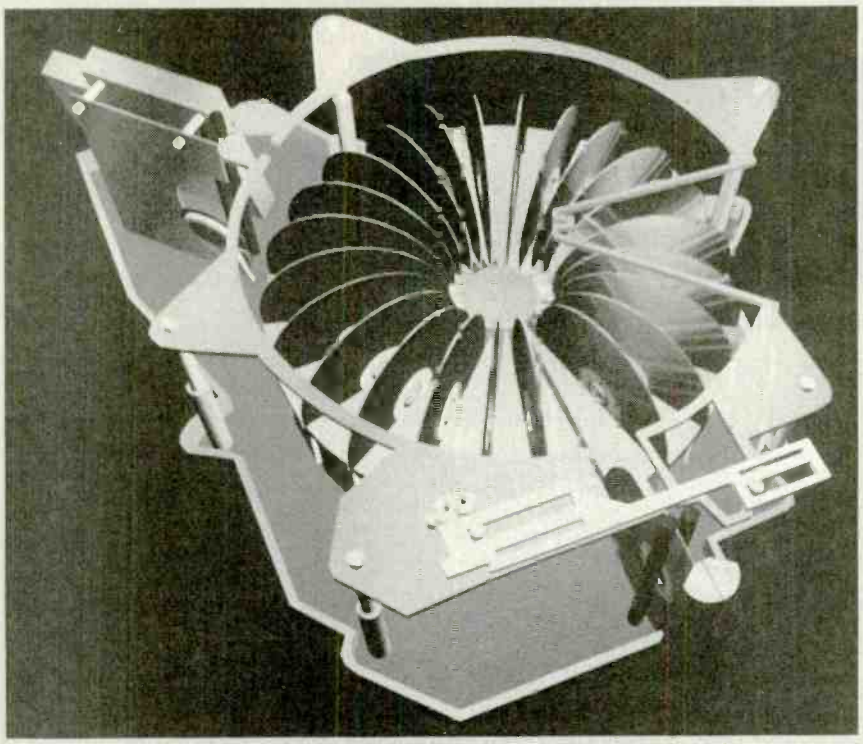
Fisher is another company that recognized the appeal of greater disc capacity, but they also realized that a high price tag could outweigh any mass-market appeal. After studying EIA market research—CD changer sales are on the rise, with carousel-style units claiming 72% of the changer market—and listening to consumer complaints about not being able to identify stored discs even in changers that hold a meager five or six CD's, the company set out to create a changer that was based upon the popular carousel style but enhanced by a larger capacity and the ability to label stored discs—all at a truly affordable price.

The result is the *Studio 24* 24-disc CD-management system, which stores and plays up to 24 CD's, arranged in preset or user-input musical (or other) categories and subcategories. We tested the Studio 24 as a separate component; it is also available as part of a Dolby Pro Logic A/V rack system ($1199), or in mid-sized bookshelf systems ($699–$999).

Studio 24 is taller than your typical CD changer, standing just over seven inches high. That added height is required to accommodate the unit's vertical, bi-directional carousel. Discs are loaded, stored, and played vertically. According to Fisher, vertical loading "eliminates minute disc sagging that occurs in most conventional transports," vertical storage and play back "decrease wear on the discs," and vertical mounting of the laser pickup "minimizes the potential for dust accumulation on the pickup and the CD itself."

Centered on the front panel is a vertical slot into which discs are inserted. To the left of the loading slot is the LCD readout, the power control, the disc-skip button, and the controls used to program disc categories and subcategories, including a row of alphanumeric keys that double as disc-select keys. On the right side, directly opposite the display, is a window through which you can watch the vertical carousel in action. The standard PLAY/PAUSE, STOP, and SKIP/SEARCH buttons are located below the window, along with the buttons used for editing, selecting categories, time display, and loading and ejecting discs.

Studio 24 walks you through the disc-loading process with prompts that appear on the display: "power on," "no disc," "load disc," "enter category," and so on. Anything that doesn't appear on the display can be found in the quick-start brochure or the clearly written user's manual. A press of the LOAD/EJECT button is required to open the slot. When a disc is partially inserted with the label side facing right, the Vertical Auto Load feature automatically retracts it into the carousel.

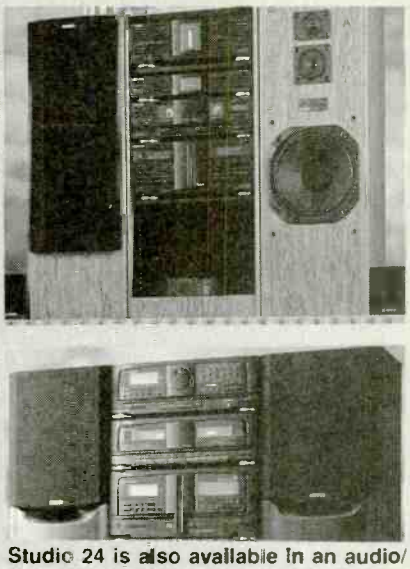


Studio 24's unique carousel vertically stores 24 discs, reducing the accumulation of dust and dirt on the discs and on the pickup.

(We got a kick out of an electronics chain's commercial that ran during local broadcasts of Yankee games last summer and fall. The actor—and director—obviously didn't read any of the Studio 24 instructions. Nor did he look at the icon imprinted on the front panel, which clearly indicates that the discs must be inserted with the label side facing right. He kept inserting the discs backwards!)

Once the disc is inserted, you can assign it a number, category, and subcategory. Studio 24 provides seven preset categories: rock, country & western, rhythm & blues, jazz, easy listening, show tunes, and classical. Each press of the MAIN Enter Category button causes the categories to scroll through the display. Pressing the MEMORY button while a category is being displayed selects that category for that disc. Subcategories are selected in the same manner.

It's also possible to create your own categories and subcategories, each containing up to eight characters. If your entire CD collection is rock, for instance, you might insert the band's name as the category, and the album title as subcategory. If two or more family members use Studio 24, each person might want to use his or her own name as the category, with music type or artist's name as the subcategory. The possibilities are limited only by the 8-character maximum, which leads to some creative abbreviating. We used "WHITELP1" to represent the first disc of the Beatles' White Album, and "BIRDLIVE" for a live recording of Charlie Parker.



Studio 24 is also available in an audio/video rack system featuring Dolby Pro Logic (top), and in a bookshelf system (bottom).

In families with diametrically opposed tastes, the ability to program categories comes in handy. For example, pressing the MAIN category select button until "MOM" appeared in the display, and then the PLAY/PAUSE button, a mother would hear only those discs labeled with her name. After playing all of them, the changer would stop. If Mom felt like listening to only country-and-western tunes, she could further specify the discs by selecting only those with Mom as a category and C&W as the subcategory. All standard CD-player functions work within specific categories and subcategories, including random play.

Labeling is done with a row of ten buttons, each of which represents a number and three letters or symbols. Press the "1" button once for the number one, twice for "A," three times for "B," and four times for "C." It's not the most elegant or efficient method, but you get the hang of it in no time. Once you've entered a customized category—your name, for instance—that label will be added to the presets. Then you can choose it as you would any preset category.

Once all the discs are labeled, you can easily tell which is which by keeping your eye on the display as you repeatedly press the DISC SKIP button. As each disc is selected, its category and subcategory scroll across the display.

Categories and subcategories are stored in nonvolatile memory, so they won't disappear if the power is turned off. In fact, they remain associated with a particular disc number until you erase them, even if you've swapped the disc in that slot. For that reason, it's important to relabel discs as soon as they're inserted, particularly if you're a teenager swapping the latest Nirvana disc for your mother's *James Taylor's Greatest Hits*.

You can get still more selective using Studio 24's programmed-play mode, which allows you to program your favorite tracks. Up to 48 tunes from the 24 discs can be entered in a program, using the MEMORY, DISC SELECT, and FAST FORWARD buttons on either the panel or the remote control.

For dubbing, two edit modes are provided. It's possible to do time-edit recording, in which the tracks on a disc are rearranged to best fit on the two sides of a cassette; or program edit recording, in which you specify the order of the songs and blank spaces are inserted at the end of each side to make them fit. There are no provisions for automatically recording songs from more than one CD onto a tape. Of course, it can be done manually, using the programmed play mode and determining the time allotment on your own.

We put Studio 24 to use in a number of ways. It fortuitously arrived the day before we were to host a barbecue/reunion for some old friends visiting from out of town. Although we didn't have time to do any fancy programming, we loaded it up with

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No Time for Arguments

TV ALLOWANCE MODEL 100 TELEVISION TIME MONITOR. Manufactured by MindMaster, Inc., 7400A Red Road, Suite 21, South Miami, FL 33143. Price: $99.

CIRCLE 51 ON FREE INFORMATION CARD

When we were kids, our television viewing time was severely limited by our parents—no questions asked! The time we did spend in front of the tube was often family time, as we all gathered to enjoy everything from *The Ed Sullivan Show* to *Laugh In*, and from *Bonanza* to *Star Trek*. When not watching TV, we kids didn't need much encouragement to pick up a book, play outdoors, or pursue various hobbies.

Things certainly have changed! Starting with the first generation that was raised on *Sesame Street*, right down to today's insatiable *Barney* fans, television has become an integral part of children's lives, practically from birth. Parents might bemoan that fact but, in truth, they are at least partly to blame. After all, letting the kids watch *The Little Mermaid* or *Teenage Mutant Ninja Turtles* half a dozen times keeps them quiet for hours—and it's sure cheaper than hiring a babysitter. Parents will take any help they can get, particularly when both work! Perhaps that's why children between the ages of 3 and 5 watch an average of *54 hours of television each week*.

Problems arise when those parents discover that their TV-raised kids don't know how to entertain themselves when the TV's turned off. They've become hooked—and often not just to television, but to video-game playing as well. It isn't easy for those same parents who encouraged toddlers to sit quietly through their favorite videotapes to suddenly tell their school-aged kids that they're watching too much television!

Tests administered recently to determine the literacy level of American students revealed that those who watched the least amount of television (less than three hours a night) scored highest. Other studies have shown that watching less television can lead to better reading skills and better grades for children. We're not surprised. After all, television is a passive, almost mindless, activity that encourages short attention spans and discourages creative and physical activities. Few shows help kids develop the reading and writing skills that they need in school. Watching television discourages conversation and leads to family squabbles over which shows to view and how much time could be spent watching.

But what's a parent to do?

Parents use all sorts of ploys to keep kids away from the TV and the Nintendo—everything from threats to bribery. Putting reverse psychology to good use, one set of parents let their kids decide what they would watch. The children were instructed to carefully peruse *TV Guide* at the beginning of each week and circle everything they wanted to watch. The rules were that they could watch only the shows that they'd circled, but they were *required* to watch every circled show when it aired—even if that meant staying home while the rest of the family went out to McDonald's, or missing a spur-of-the-moment trip to the beach or ball game. It wasn't long before those kids became very selective about their viewing!

Unfortunately, that technique probably wouldn't work on real hard-core cases—those who would rather spend a Saturday afternoon watching professional wrestling than boogie-boarding and who would gladly pass up a Big Mac for Super Mario Brothers.

When threats, bribes, and psychology fail, there is a technical solution worth trying. *TV Allowance*, the "television time manager" from *MindMaster, Inc.*, is an add-on device designed specifically to limit the amount of time children spend on TV and video games.

The concept is simple and straightforward. Once the parents (and children, in more democratic households) determine an appropriate amount of viewing time per child (up to four) per week, the parents use their master code to input the time(s). Each child is given his or her own four-digit code that is used to access the TV or video-game machine. As the child watches, or plays a video game, their "TV Account" is debited for each minute of viewed time. When all the time is used up, the television shuts off and will not turn back on in response to that child's code until the following week, when the account automatically rolls over and begins the next week's allowance.

TV Allowance resembles an oversized, wedge-shaped, wired remote control. Its top panel features a four-digit LED display, a row of four red and one green LED's (representing the four children and the parents, respectively), a numeric keypad, and several function keys. The bottom panel features a locked compartment that opens to reveal the battery holder (three "AAA" batteries provide back-up power for memory settings) and an outlet for the television's power cord. If TV Allowance is unplugged, the TV won't work at all. Two keys to the compartment are provided for Mom and Dad.

When TV Allowance is plugged into a wall outlet, and the TV is plugged into TV Allowance, the device controls the power flow to the television. That setup does not interfere with the operation of a VCR, cable box, or remote control. If there is time remaining in a child's account, the TV is allowed to come on after the proper code is entered. It is prevented from working when no time remains.

After installation, several setup steps are required. TV Allowance prompts the users through the set-up process by displaying various messages. The blinking "12:00" that appears when the batteries are installed obviously means you should set the time. When that's done, the display reads "day." TV Allowance is set weekly, with the programming day designated as day 1. Next, the display flashes "PA,"

urging you to choose and input the parental code. That's followed by "C1" through "C4" for the children's codes. "A1" through "A4" are the prompts for programming the weekly time allowance for each child. Each access code must contain four digits; each weekly time allowance cannot exceed 99 hours and 99 minutes.

The front-panel CODE and ALLOW keys can be used at a later date to change a child's code (in case security is breached, and one child discovers a sibling's code) and allowance time, respectively. The FORCE key can be used to change the time remaining in this week's allowance, without changing the basic weekly time allotted to that child. That can come in handy when a teacher assigns a PBS show to be watched as "homework," or, perhaps, as a high-tech method of grounding. To help kids decide if they *really* want to watch a show, they can press the LOOK button, to see how much time remains in their accounts. A save feature allows each child to accumulate unused viewing hours, either to use the following week, or to save up to meet some pre-determined goal.

Several features prohibit kids from gaining parental access to the unit. The master parental access code can only be changed when in the parent mode—which you can't enter without knowing the master code that is currently in effect. To aid forgetful parents who leave the TV Allowance unattended in the parent mode, it automatically exits parent mode after one minute. If both parents are truly absent-minded and manage to forget the parental access code, a new code can be programmed only by unplugging the unit, opening the rear panel using a key, removing the batteries to clear the memory, and then starting the programming process from scratch. (We're not sure what to do if you both forget your code and lose your keys!)

To encourage good habits, it's possible for parents to create "no-viewing" time periods. If, for instance, the kids are expected to do their homework between 4:00 and 6:00 each day, that time period can be blocked using the time-interval lock-out feature. Up to three lock-out periods can be set for various ranges of days. While in parent mode, first the LOOK button and then the FORCE button must be pushed to begin programming lock-out times. TV Allowance then prompts the user to enter the beginning and ending days and times of the lockout period. Parents might also consider locking out late-night viewing by locking out midnight to 6 AM.

Parents, of course, can watch TV anytime they want, by entering the four-digit master access code and then pressing the ENTER key.

If the entire setup sounds rather au-

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Is This the Party to Whom I Am Speaking?

PHONEDEX AUTO-DIALING CARD FILE MODEL CE-8850. Manufactured by Hyton Products, 13905 Artesia Blvd., Cerritos, CA 90701. Price: Between $100 and $150.

It might be a sign that our lives are too busy. Or perhaps it's an early symptom of aging. Whatever the reason, our memories seem to be playing tricks on us lately. We find ourselves calling our cats—and, more embarrassing, our friend's children—by the wrong names. We keep on hand a stack of belated birthday cards because we routinely forget to mail out cards on time (and lately we haven't been doing too well getting the belated ones stamped and into a mailbox!).

The problem is most obvious, however, when we use the phone. We can recall the phone numbers of childhood friends who we haven't called in years, but we have to pull out the phone book every time we order pizza (once a week), reserve a table at our favorite restaurant (twice a month), make an appointment for a haircut (every six weeks), or call Grandma (no where near as often as we should). After several years of one-button speed-dialing our closest friends and relatives, we no longer know by heart even those frequently called numbers, and there isn't a single business call that we can make without consulting our trusty, if somewhat haphazardly arranged, card file. Having ascertained the correct number, if we don't fall prey to dialing dyslexia, we just might "reach the party to whom we are speaking."

Hyton Products' Phonedex Auto-Dialing Card File solves those problems—although it won't do anything to improve your memory—by bringing the good old card file into the information age. The device allows you to see all the information on a business card while the phone number is scanned into the device and dialed automatically. Up to 500 user-programmed phone numbers can be stored in its 64K memory. The Phonedex itself also serves as a speaker phone.

Measuring approximately 11(L) × 6(W) × 2(H), Phonedex resembles a cross between an answering machine and a card file. The top of the device houses a card tray that can hold up to 500 cards. The sloping front panel features a speaker; a microphone; a one-digit LED display; a vertical row of LED's that serve as in-use, programming, tone/hold, and low-battery indicators; and four buttons labeled PROG, DIAL, HOLD/PAUSE and SP-PHONE. A volume-control dial is located on the right side of the unit.

The scan-reader slot runs across the Phonedex between the front panel and the card file. Each of the 500 cards supplied with the auto-dialer has a unique identity as defined by black squares along its bottom edge. Once the Phonedex has been programmed to associate a card with the appropriate phone number, the card needs only to be inserted in the reader slot. Then the Phonedex uses "EncodeSensing" technology to recognize the card and automatically dials the number stored in memory.

Installation is a simple matter. The Phonedex is plugged into an AC outlet and into the modular jack for a single-line phone. A telephone is then plugged into the jack on the back of the Phonedex. Unfortunately, a two-line phone (the lifeline of many a home office!) will not work properly when plugged into the PHonedex. It can, however, be installed to auto-dial a fax machine, and it won't interfere in phone/fax or phone/answering-machine setups.

Programming the phone numbers into memory is not much more difficult than dialing those numbers. A Phonedex card, on which all pertinent information (name, address, etc.) has been recorded, is inserted into the reader slot. After picking up the phone receiver and pressing the front-panel PROG key (at which point the LED labeled PROG lights), the telephone keypad is used to input the phone number. Each digit of the number is displayed in the LED readout as it is input. To complete the process, the phone is hung up and the PROG key pressed once again.

The number can be verified while the card is still in the reader slot by holding down the HOLD/PAUSE button and watching the LED display. The numbers that have just been programmed will appear, one by one. If you discover that you've made a mistake, simply repeat the programming process using the correct phone number.

It takes only a few seconds to program each phone number. The rest of the setup process could take a few minutes or a few hours, depending upon how many numbers you program, and whether you decide to re-write all your cards or to simply attach the old ones to the auto-dialer cards. In fact, the most difficult part of the whole process just might be transferring the information from your old phone book or card file to the new one. But even that isn't too bad. Fortunately, the cards supplied with the Phonedex measure a generous 3 × 5 inches; that's large enough that you can attach a business card or even the 2¼ × 4-inch cards that probably fill the standard card file that you now use.

After the unit is programmed, dialing is a simple two-step process. The correct

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card is pulled from the card file and inserted in the reader slot. Then the DIAL button is pressed. The Phonedex automatically dials the correct number.

There are some cases, however, in which some additional steps might be needed, due to special requirements of your long-distance service or telephone network. The Phonedex provides two ways to handle such cases.

If your phone system requires that you dial a number or string of numbers to access an outside line, or if your long-distance carrier requires additional numbers to process your calls, the Phonedex's PAUSE button can be used to insert a 3.5-second pause in the automatic dialing sequence. For instance, you might program in the number 9, and then a pause before the actual number. Or you might program in your local access code, followed by the two pauses that are required for a computer tone from your long-distance service, and then input your authorization number followed by the phone number. For each card, up to 31 digits can be entered.

Some telephone networks require that you wait for an operator's prompt before entering additional numbers. In such cases, the Phonedex allows "chain dialing." If, for instance, after the call goes through you are asked to input an extension, you can program two separate cards, one with the number and the other with the extension. After you've dialed the number using the first card, replace it with the second to auto-dial the extension. In that case, you could keep the two cards paperclipped together in the card file. If your telephone network requires that you first enter your local access code for all calls, then dial the phone number, and then enter your authorization code, you can program your local access code on one card and your authorization number on another. To auto-dial using the Phonedex, you would insert the local-access-code card, followed by the phone-number card, and then the authorization-code card. The access and authorization cards could be stored at the front of the card file for easy access.

Although the Phonedex is primarily an office/home-office tool, we can think of several other scenarios for its use. Older people who might have trouble reading the phone numbers printed on business cards or written in their phone books, and who might also experience difficulty with the small buttons on most telephones, can benefit from the Phonedex in two ways. First, they can write the person's name in large block numbers—or simply affix a photograph to the card. If they use the Phonedex as a speaker phone, they needn't bother with the phone at all.

The device could also come in handy in the event of emergencies: Even very young children could be taught to locate cards with pictures of police, firefighters, doctors, or close family friends, whose numbers could be auto-dialed in the event of an emergency.

We do have a few complaints. A definite drawback for millions of home-office workers is the Phonedex's inability to operate conveniently with a two-line phone. We wouldn't mind so much if it could be used on even one of the two lines. Instead, its installation on line 1 caused line 2 to go completely dead. Another, relatively minor, complaint is that it's necessary to make up separate cards for each of a person's several phone numbers—home, office, pager, car phone, and the like. That's more an inconvenience than a major flaw, however.

We wouldn't consider the Phonedex a necessity for home or office—it's simply not up there with fax and answering machines. It is a handy device, however, and if one of your New Year's Resolutions is to get organized, you could make a good start with the Phonedex. ■

FISHER CD CHANGER

(Continued from page 50)

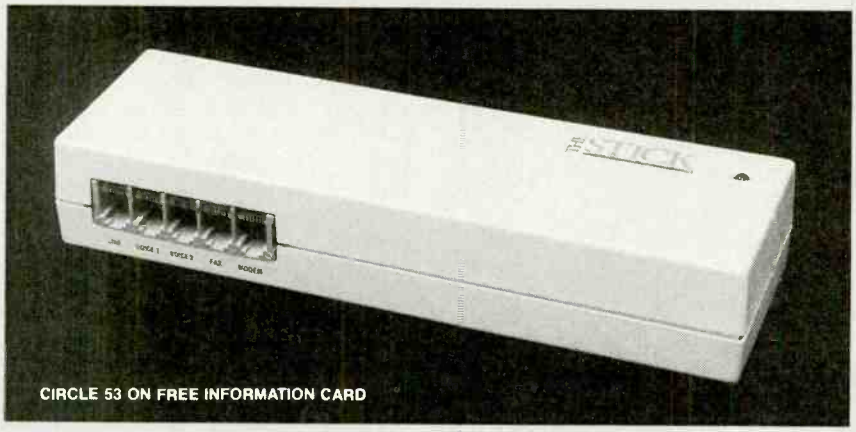
an assortment of discs, heavy on nostalgic ones from the "old days," and simply pressed random play. How nice not to have to fuss with the music for the entire day! The unit itself was a big hit with a few people who had been considering upgrading from a CD player to a CD changer, and with all the kids (who particularly liked being able to see the carousel rotate and the fact that when Studio 24 is turned off, the display says "good bye").

The next day, we were able to sit with the manual and our CD collections and decide which discs rated semi-permanent inclusion (in other words, being loaded and labeled) in the Studio 24's carousel. With twelve discs apiece, there was much less bickering than is usual when we try to load the 6-disc changer in our car before a road trip! The most difficult part was deciding how to label the discs to make programmed playback easiest. We definitely agreed use owner's name as the main category, but differed as to album title or music type for the subtitle. Fortunately, there was no need to settle our difference or work out a compromise—we each labeled our own as we saw fit. After that, we were able to listen as we pleased. (Translation: We never had to be subjected to the other person's musical tastes.) Each of us used various programming methods at different times, depending on our moods.

While we initially disliked the fact that Studio 24 retains disc information even when the disc is removed, we soon found that to be a convenience. If we felt like listening to a CD that wasn't on the program, it was easy to eject a disc and insert a the new one temporarily, without erasing the original disc's categorization.

The only source of conflict occurred when one of us ejected the other's disc to listen to a new one, and forgot to replace the old one—and neglected to mention the swap to its owner. (We quickly learned to leave each other's discs alone.)

Once we learned not to touch each other's discs, Studio 24 went a long way toward promoting harmony in a family with very different tastes in music, where arguments over listening material are a common occurrence. We suspect it could do the same in many other homes. ■



CIRCLE 53 ON FREE INFORMATION CARD

Phone Alone?

THE STICK VOICE/FAX/MODEM CALL PROCESSOR. Manufactured by Multi-Link, Inc., 225 Industry Parkway, Nicholasville, KY 40356. Price: $119.95.

More than 30 million Americans now work at home, and phones, fax machines, and computers make that possible. The telephone line is the vital link from the home office to the outside world.

Many home-office workers opt to install a second telephone line, for several reasons. First, it allows a business call to be identified immediately so that calls can be answered in a professional manner (not by a couldn't-care-less teenager). It also allows a dedicated business answering machine to be used.

But many home offices and small businesses find that a single separate business line is not enough! A fax machine is most useful when it is left on continuously, which requires that it has its own separate line. Yet another line might be needed for accessing on-line services, fetching e-mail, or perhaps uploading information to the main office or downloading data remotely.

Unfortunately, the cost of installing and maintaining separate telephone lines can be prohibitive for small businesses. The monthly charges add up quickly—even when the phone line is used only to receive incoming calls. *Multi-Link, Inc.*, offers a potential solution to people who communicate over telephone lines using more than just a phone. It's a voice/fax/modem call processor called *The Stick*. The Stick screens incoming calls and routes them to the right equipment. The four output jacks on the Stick allow calls to be routed to two pieces of voice equipment, a fax, and a modem.

(We're unsure of how Multi-Link came up with the name for the device. Perhaps it's because of the utilitarian but attractive white plastic case is shaped something like a stick. But more likely it was named to fit an advertising campaign in which consumers are urged to "stick" it to their local phone companies by saving the cost of separate lines.)

The Stick's main job is to screen incoming calls for the tones that are emitted by fax machines. We're not talking about the screechy noises you may have heard if you accidentally dialed a fax from your voice telephone. Autodialing fax machines emit an 1100-Hz tone every few seconds to identify themselves as fax machines to the receiving unit. The Stick also listens for Touch-Tone codes, which can be used to route calls to other devices such as modems.

The Stick can't listen for fax tones unless it first answers the phone. After the Stick answers, it emits ring-back tones so that a voice caller isn't even aware that the call has been answered. If the Stick hears the fax tones, it routes the call to the fax port. If it doesn't, it routes the call to the telephone port

The Stick can be installed in a number of different ways depending on how the home or office is wired; not all features are available in all installation configurations, however. We'll look at some common installation configurations.

The simplest case would be an office with a single telephone wall jack and no extension phones. In that installation, the Stick would be plugged into the wall jack, and the phone, answering machine, fax, and modem would be plugged into the Stick, which means that all incoming calls would be routed through it.

In such an installation, the Stick should be programmed to answer the call on the first ring. Fax calls would be routed to the fax machine almost immediately. On voice calls, the telephone would begin ringing with minimum delay.

Most installations involve extension phones, and that can make the installation-configuration selection a little more difficult. One way to install the Stick is to mount it at the interface jack where the phone line enters the house, and to hook your phone and other equipment to it. The existing telephone wiring that previously plugged into the interface would simply be plugged into the main voice-line port. But how would the fax, modem, and alternate voice equipment be connected?

Unfortunately, that might require snaking wires through walls if the office is located far from where the phone line enters the house. It's not a solution for everyone. Also, not all telephone interface jacks are installed where power is available; the Stick is powered via a wall-mount transformer.

One advantage of installing the Stick before any other phone equipment is that it provides what is called "barge-in protection." A data (fax or modem) call can't be interrupted by an extension going off-hook.

Yet another installation option is to plug the Stick into any single phone outlet. We would be most inclined to install it in our home office. The fax, modem, and office phone would be plugged directly into the stick. But, unlike in the first example, we would not want the Stick to answer on the first ring. If it did, we would never hear the extension phones ring on the office line. Instead, we would want it to answer on, say, the fourth ring. Incoming calls will ring on all office-line phones. If an extension is not picked up, the Stick will answer after its programmed ring and route the call to the appropriate equipment.

What happens if you pick up an extension only to find that you've just intercepted an incoming fax call? You simply transfer the call to the fax port. The Stick allows you to transfer calls to any port by punching in a Touch Tone code. The preprogrammed code for transferring a call to the fax port is *2. So if you answer a fax call on an extension, punching in *2 will send it to the right place.

Modem calls can't be recognized by an answering device, because a calling modem remains silent until it hears an answer tone from the modem it is calling. Remember, however, that Touch Tones can be used to transfer a call to any port. If the calling modem is instructed to dial the right transfer code (*3, for example), it can get to the right piece of equipment.

A number of features can be programmed in the Stick with touch tones. The procedure is relatively simple—as long as you keep the manual on hand. Some programmable features include fax-tone detection (on or off); transfer codes for the voice, fax, and modem ports (for added security); and the number of rings before the Stick answers (0 to 10).

With its plain Jane appearance and lack of any "bells and whistles," the Stick was not the most exciting product we've ever had the pleasure to review. For the most part, it just sits there and does its job, effectively and unobtrusively. ■

The Power of Suggestion

SCANTRAK 18 GOLFBALL FINDER. From Lil' Orbits, Inc., 2850 Vicksburg Land, Minneapolis, MN 55447. Price $89.95.

We here at Gizmo are the first to admit that technology is wonderful. We should know—we see new technology all the time. Because of that, we've become somewhat jaded. But still, occasionally there is a product that is so different and that uses such new technology that even we are impressed. When we received a press release describing the *ScanTrak 18* golf-ball locator from *Lil' Orbits, Inc.*, we were delighted. It described technology that we didn't even know existed.

The first line that attracted our attention was "Using new microchip technology, the ScanTrak 18 finds golf balls in any terrain from weeds to bushes to high grass." We weren't aware of any new microchip technology that had anything to do with golf balls, so we read on. "Within minutes, this tiny hand-held device can detect and point out any balls in the vicinity." How, we wondered, could a device find ordinary golf balls? There had to be a catch, we figured. Maybe this was a way to sell special golf balls.

But as we read on, that guess seemed to be wrong. "The secret is in the unique molecular wavelength given off by every golf ball, of whatever manufacture." So *that's* how they do it!

But hold on a minute! *What* molecular wavelength? We know that spectrometers can be used to identify the makeup of materials by measuring the spectrum emitted when they are burned or electrically excited. That's also the way that scientists determine the elements of which stars are composed.

We were surprised to find out that plain old *golf balls* emitted wavelengths that could be measured. But there in black and white was the promise that "The ScanTrak 18 identifies and homes-in on the signal of the golf ball, just like a short wave radio set—regardless of rocks, trees, or bushes."

When the ScanTrak 18 arrived, we immediately popped in the instructional video, hoping to better understand how it worked. The video provided simple operating instructions, and showed the device hard at work finding golf balls behind bushes, in high grass, and even in a water hazard!

The four-page instruction manual shed more light on the principles behind the fascinating device. The ScanTrak, it said, operates with a new technology called "Positive Molecular Attraction." We couldn't find any reference to the technology in our well stocked reference library. Boy, it *must* be a new technology, we figured.

"The unit contains a ROM (Read Only Memory) card which detects the molecular structure of golf balls and is energized by static electricity which you generate when moving." We didn't see any slot into which a ROM card could be inserted, so we figured that they meant a ROM chip and not a ROM card. Perhaps they were planning on manufacturing different versions of the device—a car-key locator would seem to be a good idea. But we're unsure whether all car keys emit a common wavelength. We were also a little surprised that the device was powered by static electricity. After all, we've destroyed more electronic components than we care to remember with inadvertent discharges of static electricity. Besides, just how much static is generated by walking across a grass field in golf shoes? Maybe it would be a good idea to wear a wool sweater when testing the device out. Come to think of it, ROM chips are pre-programmed *read-only* devices. How can a ROM detect anything, let alone the molecular structure of golf balls?

"Just like a magnetic compass needle which swings of its own accord to the North Pole, the direction-finding antenna on your Locator will swing of its own accord in the direction of a hidden golf ball." We were impressed by the amazing technology that was packed in a device that looked like nothing more than a piece of plastic with a telescoping radio antenna mounted on a free-moving swivel.

"The Locator does not generate or transmit any harmful signals. Your Locator only 'tunes in' to signals generated by golf balls." Well that's a relief!

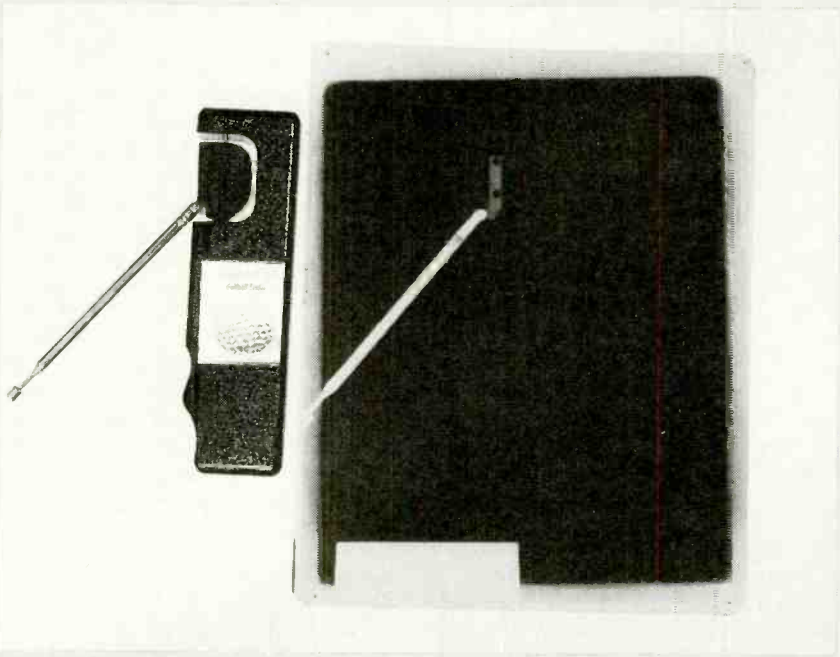
We were so excited about trying the ScanTrak out that we dropped a golf ball on our office floor, took the device in hand, and extended the antenna. The antenna just seemed to swing randomly instead of homing in on the golf ball. We thought it was odd, so we went back to the instruction sheet. Aha! We had made the classic mistake of not reading the instructions! Right there was the note that "the locator works best outdoors away from household appliances, fluorescent lights or computers which emit signals that can confuse your locator." We picked up our golf ball and headed outside.

We extended the antenna again and held the device properly (with our little finger below the unit as shown in the photograph) and began by pointing the ScanTrak 18 to the ground. (That "initializes and clears the Locator of any previous signals." We guessed that there's a mercury switch or something similar in the device.)

We still couldn't seem to get the hang of it. The antenna would seem to swing in random directions. We re-checked the instruction sheet to make sure we were doing things correctly. "It's important that you keep walking! This generates the power which drives the antenna." We tried it again, but still were unsuccessful.

"You must be insulated from the ground. Most golf shoes use composite or rubber soles which insulate you from the ground. If you are wearing leather soles we suggest you insert foam inner liners or plastic sole inserts in your shoes. We also know that molecular activity slows down in freezing weather. So don't expect to find

CIRCLE 54 ON FREE INFORMATION CARD



Here the ScanTrak 18 is pictured beside its x-ray. Using another apparently new technology, any components that are in the device appear to be immune from x-ray detection.

golf balls in the snow unless they're still warm." We were wearing sneakers, so we figured we were well insulated, and it was a hot summer day. We weren't sure what was going wrong. The instructions promised that "When you pass along side your golf ball, the antenna should abruptly swing in the direction of the ball."

"When used correctly, the Locator is so sensitive it will locate balls from a great distance once it locks on to the signal. It may pick up signals from an adjacent green where players are putting in. When the Locator points in a totally different direction, it is picking up a signal from another ball." So *that's* it. We should have known! Our offices are located near a driving range. (Our test ball was, in fact, an escapee from the range that was hit into our parking lot by what we hope is an embarrassed golfer with a nasty slice.) The device must have been sensing all those flying balls and getting confused! Further, we concluded, those balls must have more molecular energy because they're moving so fast.

We tried the ScanTrak 18 in different locations and in different weather conditions but we still couldn't get reliable results with golf balls we could see. We doubted whether we could ever find balls that were truly lost. But that didn't concern us too much—we don't golf.

Then, realizing that our lack of golf experience might be one of our problems, we loaned the ScanTrak 18 to a doctor friend who (surprise, surprise) is an avid golfer. He loved it! He not only found his own golf balls, but he came home with extra balls that other golfers had given up trying to find! He also made a lot of new friends. All golfers, it seemed, were as fascinated by the device as we were. He estimated that he could have sold a couple dozen ScanTrak 18's if he had them with him at the time.

We were impressed by the success reported on the golf course. We still didn't understand how the device worked. And we were dismayed to read that "There are no user repairable parts within the unit. Trying to open the case will damage the unit beyond repair and will void our warranty." We had considered opening the case, but couldn't see any way of doing so. There were no screws holding things together. The plastic case seemed to be solid.

In our effort to learn more, we pulled out our digital multimeter. We measured the impedance between the antenna and the pivot around which it swiveled. (These were the only metal parts to which we had access.) To our surprise, there was an open circuit. So how did the electronics inside the unit control the antenna?

Refusing to give up, we enlisted the help of our doctor friend who had been so successful with the device. We couldn't open the device, but his x-ray equipment could see into it! The results of the x-ray left us more puzzled than ever. It seemed to show that there was nothing in the device except for a metal rod around which the antenna swiveled—nothing at all!

But that couldn't possibly be true, could it? The new technology must also render the circuitry immune from x-rays. After all, people wouldn't spend $89.95 for a piece of plastic, would they? ■

A First Step

PRO MOVIE SPECTRUM VIDEO CAPTURE CARD. From: Media Vision Inc., 3185 Laurelview Court, Fremont, CA 94538. Price: $399.

We remember when the only thing that a computer could display was fuzzy text on a green screen, and the only sounds they made were occasional beeps. Today, of course, most new computers do a great job of producing text and graphics. Photo-quality images can be displayed, and high-fidelity sound has become commonplace.

If you're wondering what's next, the answer is video. Just as the conniving head of security in *Jurassic Park* used video and animation to warn hackers (and his bosses) to keep out of the system, soon everyone will be using video to try to grab your attention on the desktop PC.

We recently added video to our IBM-standard PC with the *Pro Movie Spectrum* from *Media Vision Inc.* The Pro Movie Spectrum is a full-size add-in card for 386- and 486-based computers. It permits video to be digitized and saved on disk so that it can then be played back on the PC and "attached" to other files and applications. For example, an E-mail message could contain a video clip to add emphasis to a memo. Computer-presentations and training could be made more dynamic and effective with video.

The software that controls Pro Movie Spectrum is Microsoft's Video for Windows, which is included with the video capture card. The video can be edited, and the resulting "movie" can be played via the Windows Media Player, an accessory supplied with Windows.

A conversion utility supplied with the video-capture card permits files saved on the PC to be played back on an Apple Macintosh computer, and used in any QuickTime application. For people who hate Microsoft Windows, a DOS video player and recorder are also provided.

The computer system requirements for the Pro Movie Spectrum are modest: a 386SX or better microprocessor, MS-DOS 5.0 or better, four megabytes of RAM, a hard drive with at least twelve megabytes of free space, one full-length slot, Microsoft Windows 3.1 or better, a high density 3½-inch floppy disk drive, and a VGA display. (A super-VGA color monitor with at least 256-color capability is recommended.

Installing the Pro Movie Spectrum requires setting jumpers and switches on the card, installing the card inside the computer's case, and running an installation program, which configures the software to match the hardware jumper and DIP-switch settings. As is standard with most

cards that are installed in a PC, the Interrupt line, base memory address, and I/O port must be set.

We got the system running only after considerable frustration. We have to accept part of the blame, however. The tables of I/O port and memory addressed in the manual that shipped with the product were incorrect. We had failed to note that correct tables were included in a installation guide addendum. (We ignored the "Read First!" plea printed on the addendum's cover.)

After the card is installed and passes a diagnostics test, it's time to connect a video source. The Pro Movie Spectrum accepts NTSC composite video from a VCR, camcorder, or other video device through an RCA-type connector on its rear panel. An S-video input is also provided.

We used Microsoft's Video for Windows for most of our interaction with the Pro Movie Spectrum. (Another software package, Action! from Macromedia, Inc., is also provided. Action!, which runs under Windows, is presentation software that can take advantage of video and moving graphics.)

Video for Windows includes VidCap, a data-capture program; VidEdit, a program for "cut-and-paste" editing of video segments; and BitEdit, a program that allows the bitmap images that a video frame or segment is composed of to be edited for detail or color. The color palettes that define how the colors in an 8-bit color image appear can be controlled by another program called PalEdit.

After we got the hardware installed, video connected, and got a rudimentary working knowledge of Video for Windows, we set to work to capture some video. The computer we used for our test was in the middle of what Media Vision recommends as minimum system requirements for video capture: a 386 DX running at 40 MHz, with 4 megabytes of system RAM, and a super VGA monitor. As a video source, we used the composite video output from a VHS VCR.

One thing that becomes immediately obvious when capturing video sequences is that capture files are huge. The amount of data that must be transferred to disk is enormous. For that reason, our initial attempt at capturing video was almost a total failure. More frames of video were dropped than were written to disk. The resulting video frame rate could be measured in seconds per frame instead of frames per second!

Dropped frames are an indication that the hard disk can't keep up with the data it is being fed. We tried defragmenting our disk, as suggested by the documentation, but it didn't have a noticeable effect. After a little bit of searching, we found the problem—we weren't running SMARTDRV.EXE, the disk-caching utility. (We had REM-ed it out from our AUTOEXEC.BAT file a few months ago, when we used the same computer to review software that was incompatible with SMARTDRV.EXE).

There are a number of parameters that affect the size of the captured video image. First is the size of the image. Two sizes of video can be captured: 80×60 and 160×120. Single frames can be captured at two larger sizes as well: 320×240 and 640×480. If we were to assume that each pixel in a frame required one bit to represent it, a 640×480 image would require sixty-four times more storage space than an 80×60 image.

Color images, of course, require much more than one bit per pixel. VidCap gives the choice of choosing 8-bit color (which uses eight bits per pixel to define 256 possible colors), or 16-bit color (which provides 32,767 colors). A 24-bit setting is also available, but it doesn't display 16 million colors as you might expect. Instead, the color depth is the same as 16-bit color; the 24-bit setting is provided to make the captured files compatible with software that expects to see files in the 24-bit storage format.

Depending on the settings, it's easy to create files that require a megabyte of disk storage per second of video! More conservative settings (smaller image, reduced color depth) can provide a megabyte for every four or five seconds.

Fortunately, images can be compressed digitally in Microsoft's Video for Windows through the VidEdit program. The compression ratios can be impressive. Using the Microsoft Video 1 compression method, we were able to compress an 8.4-megabyte file into one just over half a megabyte! (The resulting compression ratio was about 16:1.) Unfortunately, while it's easy to compress the data, the compression process is somewhat slow—especially on a computer without a math coprocessor. For example, the file we used in our example required about eight minutes to be compressed.

Once we had a number of captured video images and were tired of playing them through Video for Windows, we had to figure out what else to do. So we created some "Watch Me" icons for Windows (to replace some Read Me icons on our system.) And then we wrote a couple of memos in which we were able to emphasize a point in sound and video.

It worked, but what a chore! A spokesperson from Media Vision was right on target with the comment "The market for desktop video won't take off until putting video into documents is quick and easy." The Pro Movie Spectrum was anything but.

However, Media Vision hasn't gotten to the top of the multimedia heap by standing still. Its latest video-capture board addresses the major problems with the Pro Movie Spectrum. It's called the Pro Movie Studio.

The major feature that the Pro Movie Studio offers is real-time compression. Rather than storing all of the captured data to disk and then compressing it manually, the Pro Movie Studio contains on-board compression chips. Data is compressed on the fly, so that only the compressed data needs to be stored. That greatly speeds up the process and, of course, requires less

disk space. Media Vision has dubbed its compression technology "Captain Crunch," and is busy making deals to ensure that it becomes the standard for desktop video compression.

The Pro Movie Spectrum is still available at retail, but it has been superseded by the Pro Movie Studio. If you're interested in getting your feet wet in desktop video, the Pro Movie Spectrum might become a good deal if the street price goes down far enough—and it should considering that the new product promises a significant improvement. If you're looking for easy desktop video, the Pro Movie Spectrum is not for you. It can be, however, a good first step. ■

TV ALLOWANCE

(Continued from page 52)

thoritarian (which we suppose it might, particularly to those parents who have trouble simply saying "no" to their kids!), there are several factors to consider. TV Allowance was invented by the father of pre-teen boys, and refined as the result of feedback from other parents. Its primary purpose is to discourage excess TV watching and Nintendo playing—without the usual nagging, bickering, screaming, and punishments. However, when used properly, the device can actually encourage the development of some positive skills and character traits. For instance, while using TV Allowance, kids can learn to plan ahead, make good use of their time, *budget* their time, evaluate television shows, the value of savings (time, instead of money), and the meaning of personal responsibility.

To help families gain all those side benefits from TV Allowance, a "Parental Guide" is included along with the standard user's manual. The guide suggests calling a family conference to discuss the reasons for using TV Allowance and to determine each child's viewing allowance, perhaps after reading through the weekly TV schedule together.

Once the initial shock wears off, kids begin to realize that they are responsible for how and when they use their allotted time. Many kids quickly figure out how much time they can save by passing over the commercials (close to 12 minutes during one half-hour program!). Particularly during those programs aimed at kids, having them skip commercials is a major bonus for parents who are besieged by requests for the toys advertised on TV.

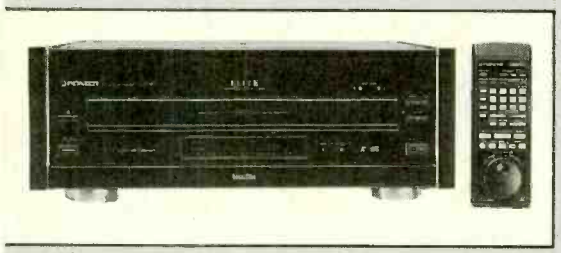
The Parental Guide also touts the benefits of the device's save feature, which can be used as the basis of a rewards program. Children can be encouraged to save up a certain number of hours over a given time period to be eligible for a predetermined award—perhaps a special toy or outing. Saved time also gives a child an advantage in bartering for viewing time with siblings. Sharing can also be encouraged, because siblings often watch the same television programs.

No wonder TV Allowance received the National Parenting Center's Seal of Approval!

We don't have kids, but that doesn't mean there's no bickering about television in our household. And when the football and hockey seasons roll around, we seem to lose track of the hours we waste in front of the TV. Perhaps we've discovered a new use for TV Allowance! ■

ELECTRONICS WISH LIST

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



Pioneer Laserdisc Player

Elite-ist Combi Player

The latest entry in *Pioneer Electronics U.S.A.'s* (2265 East 220th Street, P. O. Box 1720, Long Beach, CA 90801-1720) Elite line of high-perforamnce CD/CDV/LD players, the *CLD-97* is also the first to incorporate the company's proprietary Legato Link conversion technology. Legato Link is said to produce a more natural, less metallic sound by extending the high-frequency analog audio output beyond the conventional 20,000 kHz. Picture quality is improved through digital video-noise reduction, digital timebase correction, and digital color-separation circuitry. The CLD-97 also features Pioneer's proprietary alpha-turn mechanism, which provides quick, automatic dual-side play of laserdiscs. Price: $2500.

CIRCLE 56 ON FREE INFORMATION CARD

Panasonic Cordless Phone/Answering Machine

The Cordless Answer

For those who just can't be tied down—to a corded phone or traditional answering machine, that is—*Panasonic Company* (One Panasonic Way, Secaucus, NJ 07094) offers the *KX-T4330* cordless phone with built-in answering machine. "Sound Charger" technology helps reduce extraneous background noise up to 1000 feet from the base, and 10-channel access allows users to choose the clearest channel from the handset, even in mid-conversation. The phone's retractable rubber antenna measures just over three inches when extended. The phone also features ten-number speed-dial, one-touch redial, a speakerphone function, and a handset battery that can hold a charge for up to two full weeks in standby mode. The answering machine features a digital outgoing message; incoming messages are recorded on microcassette. Calls can be screened, and most answering-machine functions can be accessed, from the handset as well as the base. Price: $179.95.

CIRCLE 57 ON FREE INFORMATION CARD

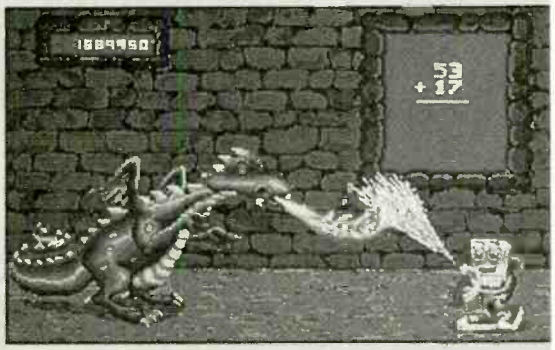
For more information on any product in this section, circle the appropriate number on the Free Information Card.

ELECTRONICS WISH LIST

The Human Calculator

Scott Flansburg, a.k.a. the Human Calculator, has taught his innovative and inspirational mathematics techniques on TV shows and videotapes, and in classrooms across the country. Now his math methods are available from *Compton's NewMedia* in interactive form on CD-ROM and floppy disk. The animated program called *The Human Calculator* contains traditional testing methods and action-filled math games designed to improve grades and transform students of all ages into math whizzes. Flansburg's method involves solving problems from left to right, in the same way that we read, rather than the traditional right-to-left method. It allows students to perform addition, subtraction, multiplication, and division in their heads. Price: $39.95 on CD-ROM, $59.95 on floppy.

CIRCLE 58 ON FREE INFORMATION CARD

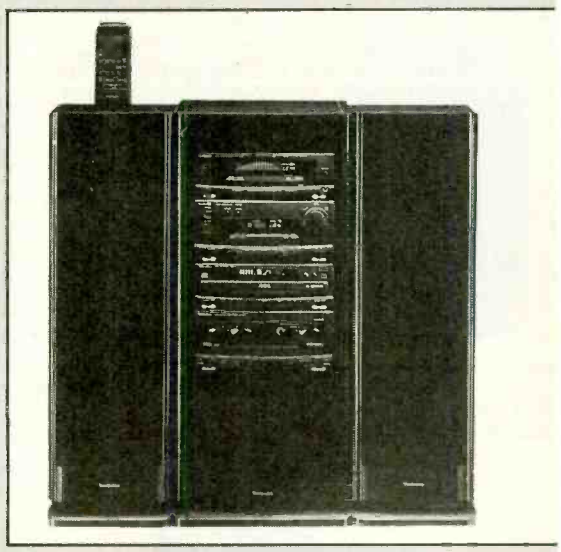


Compton's NewMedia The Human Calculator

Towering Mini

Yesterday's towering audio rack systems simply can't fit in many places where we'd like to hear music today—in bedrooms, dens, dorms, offices, and small apartments, for instance. The *Model SC-CF999* from *Technics* (One Panasonic Way, Secaucus, NJ 07094) is a tower system for the '90's—a mini tower system, that is. Equipped with high-performance speakers, integrated amplifier, three-disc CD changer, quartz-synthesized AM/FM tuner, and a dual-transport cassette deck, the system is roughly half the size of its traditional counterparts. The SC-CF999 offers surround-sound circuitry for home-theater applications; an integrated remote control; a sleep timer that allows the user to fall asleep to one volume level and source and wake to another source at a different volume; and a digital sound field processor with a choice of Live, Hall, or Disco environments. The tower mini system is enclosed in an elegant rack with matte black finish, generous storage space for storing CD's or tapes, and a curved glass door to protect the system. Price: $999.95.

CIRCLE 59 ON FREE INFORMATION CARD



Technics Tower Mini System

Tune in the World

Radio Shack's (700 One Tandy Center, Fort Worth, TX 76102) *Realistic DX-380* world-band radio receiver (catalog number 20-213) can tune in broadcasts on AM, FM, longwave, and 13 international shortwave bands. The receiver features precise digital tuning. The push-button keypad permits direct access to the desired frequency, which can then be fine-tuned using the rotary dial. Up to 45 favorite frequencies can be stored in memory, 18 in the shortwave band and up to nine each on AM, FM, and LW bands. A manual-control lock prevents accidental power shut-off or frequency change. When listening to shortwave, AM, or longwave broadcasts, DX/LOCAL and NARROW/WIDE switches can be used to reduce distortion. The unit's LCD readout displays the time, band, frequency, and signal strength. Especially suited for travelers, the compact, light-weight portable receiver has a dual-time feature that can be set to show local time, the universal time coordinate (UTC), or the local time of a city in another time zone. The DX-380 also serves as a clock radio with built-in alarm/standby buzzer and sleep timer. It runs on four "AA" batteries (or on AC/DC power using optional adaptors); two additional "AA" batteries keep the clock running and protect the stations stored in memory. The receiver includes a folding stand and a headphone jack for private listening in stereo. Price: $179.95.

CIRCLE 60 ON FREE INFORMATION CARD

Realistic World-Band Radio

ELECTRONICS WISH LIST

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

Radio Shack Video Door Phone

Who Rang?

Unless your front door is equipped with a peephole, when the doorbell rings you have no idea who is standing outside the door. You can feel safer answering the door if you've installed the *Safe House Video Door Phone System*, available at Radio Shack (700 One Tandy Center, Fort Worth, TX 76102). The Video Door Phone allows homeowners to see and talk to the person at the door before deciding whether to open it. The black-and-white monitor with handset can be mounted on a wall or placed on a table top anywhere in the home. The surveillance camera is installed outside, positioned near the entryway. When a visitor presses the call button on the camera, a doorbell or chime sounds to alert the homeowner. The person inside can see the visitor's face on the inside monitor, and can talk to the visitor either through the handset or through an intercom. It's also possible to leave the camera and speaker turned on continuously to monitor the sights and sounds at the front entry. Price: $399.95.

CIRCLE 61 ON FREE INFORMATION CARD

Sharp High-Speed Microwave

Quick Cooking

Microwave cooking just got quicker, with Sharp Electronics Corporation's (Sharp Plaza, Mahwah, NJ 07430-2135) introduction of the high-speed *R-3A05*, the industry's first 1050-watt microwave. The oven features a control panel that includes such time- and work-saving settings as CompuCook, which calculates cooking time and power level for automatic cooking of baked potatoes, frozen vegetables, fresh vegetables, rice, ground meat, and fish fillets; CompuDefrost, which determines time and power levels based on weight for efficient defrosting of meat or poultry; Breakfast settings for quick heating of coffee or tea, warming a fresh or frozen roll or muffin, cooking hot cereal, heating a frozen breakfast, or making scrambled eggs. Instant Start keys provide one-touch heating of a single serving of pasta or a casserole, a bag of popcorn, a dinner plate, or a frozen main dish. Price: $299.95.

CIRCLE 62 ON FREE INFORMATION CARD

Sima PowerMax PowerPack

Electronic Reader

The *Digital Book System* from *Franklin Electronic Publishers* (122 Burrs Road, Mt. Holly, NJ 08060) is an electronic library that fits in a shirt pocket. The device weighs less than five ounces and plays (reads) books on plug-in ROM cards, each with a 10-megabyte capacity. (That's the equivalent of ten printed Bibles.) What's more, the Digital Book System plays two ROM cards at once, allowing you to look up something in one while reading the other. A doctor reviewing the *Manual of Adverse Drug Interactions*, for instance, can cross-reference the definition of a medical term in *Stedman's Medical Dictionary*. Upcoming (non-medical) titles cover gardening, cooking, nutrition, education, religion, foreign languages, sports, and business. The Digital Book System comes with two ROM cartridges: a word game, and a dictionary/thesaurus. Price: $200 (additional ROM cartridges, $30–$100).

CIRCLE 63 ON FREE INFORMATION CARD

Power Pack

There's no need to stop recording when your camcorder battery runs out, if you have the *PowerMax PowerPocket* from *Sima Products Corporation* (8707 North Skokie Blvd., Skokie, IL 60077). The PowerPocket is a compact waist pouch or "fanny pack" that houses up to three spare camcorder batteries. Your camcorder plugs into the pouch and, when the "battery low" warning begins to flash in the viewfinder, you simply pause the camcorder, flick the switch on the PowerPacket to the next battery, and resume recording. The PowerPacket will accept all popular 6-volt batteries, including Sony, JVC, Panasonic, Hitachi, and RCA. The pouch is made of heavy-duty nylon with a fully adjustable belt to fit comfortably around the waist or hips. Because the battery is in the bag, the camcorder is lighter to carry. Price: $49.95.

CIRCLE 64 ON FREE INFORMATION CARD

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Build a Relative-Humidity Gauge

Keep an eye on the humidity with this easy-to-build digital instrument.

BY ANTHONY J. CARISTI

Many of people like to keep track of the prevailing weather conditions using indoor and outdoor thermometers, barometers, and humidity gauges. High-quality instruments provide accurate readings, but the common, consumer-type humidity gauges—called hygrometers—leave much to be desired. Even relatively expensive devices that rely on the absorption of moisture by a human hair or some other organic substance cannot respond accurately to very low or very high relative-humidity levels.

Modern solid-state technology has brought advances in relative-humidity measurements by providing various types of capacitive and resistive sensors that respond to varying amounts of moisture in the air. Many of those, however, are non-linear and may not give reliable readings at humidity levels below 10% or more than 90%.

It's All Relative. Relative humidity (RH), a measure of the quantity of moisture contained in the air, is important to our well being and can be a significant factor in forecasting weather conditions. The term "relative" refers to the percentage of water vapor contained in a given volume of air as compared to the maximum amount of moisture that can be accommodated in that volume of air at the same temperature. A condition of 100% RH indicates that the air is saturated with moisture, and that any further increase in moisture content will result in precipitation (rain, snow, or condensation).

Personal comfort is closely related to humidity. In the summer, mild temperatures accompanied by high relative humidity are uncomfortable because the body's natural cooling system (which works by evaporation of perspiration) is slowed. Conversely, the reduction in relative humidity during the winter when indoor air is heated causes one to feel cold unless the temperature is raised to 72 degrees or more.

Adverse reaction to insufficient or excessive relative humidity is not limited to the human body. You may have noticed that wooden drawers and doors tend to expand and stick during the summer, and furniture often shrinks and cracks during the winter. Even electronics, such as VCR's and copying machines, can fall prey to moisture unless the relative humidity is kept within certain limits. In extreme cases, where high humidity is coupled with high temperatures, mildew can form everywhere, causing significant damage.

There are many ways to measure relative humidity. One way is by detecting the rate of water evaporation using an instrument, known as a psychrometer, that uses two thermometers. One thermometer has a continuously moistened cloth covering its bulb, which senses a reduction of temperature through moisture evaporation. That reading is compared to the dry-bulb thermometer, which responds to ambient temperature. A chart is then consulted to determine the relative humidity that corresponds to the two temperature readings. But that method, which can be very accurate, is not convenient to use.

Another method of measuring humidity is the one used in many low-cost, consumer-type, relative-humidity gauges that have been around for many years. Such instruments have been designed to respond to the percentage of relative humidity through the action of a strand of hair; the hair changes length in accordance with the amount of water vapor that it absorbs from the air. It is not surprising that such instruments are not very accurate and any reading of relative humidity may not be meaningful, especially at very low or very high humidity levels. There are also several electronic methods by which relative humidity can be gauged; one of which uses passive components that change capacitance or resistance in accordance with the air's moisture content.

However, the *Digital Relative-Humidity Indicator* described in this article takes advantage of a new development in sensor technology to produce a professional-quality instrument that is simple to build, accurate, and easy to use. The sensor—the IH3602L precision humidity sensor, one of several developed by Hy-Cal Engineering (9650 Telstar Ave., El Monte, CA 91731; Tel. 800-444-4000)—is linear over a range of 0 to 100% RH, and with proper calibration can be used to produce an instrument that is accurate to within ±2%.

Our circuit can measure and display relative humidity with significantly better accuracy and resolution than can be obtained from common, consumer devices, thereby enabling you to determine whether a humidifier or dehumidifier needs to be turned on or off. It can also be used to indicate an improvement in humidity once you have taken corrective action, with the added advantage of being able to give an indication of whether your humidifier, dehumidifier, or air conditioner is doing its job.

How it Works. Figure 1 shows a schematic diagram of the Digital Relative-Humidity Gauge. The heart of the humidity-measurement system is SENS1 (the Hy-Cal IH3602L, an 6-pin CMOS device with only 3-active terminals), whose DC output voltage varies linearly with RH levels from 0 to 100%.

The sensor is fed from a regulated 5-volt source provided by U1, an

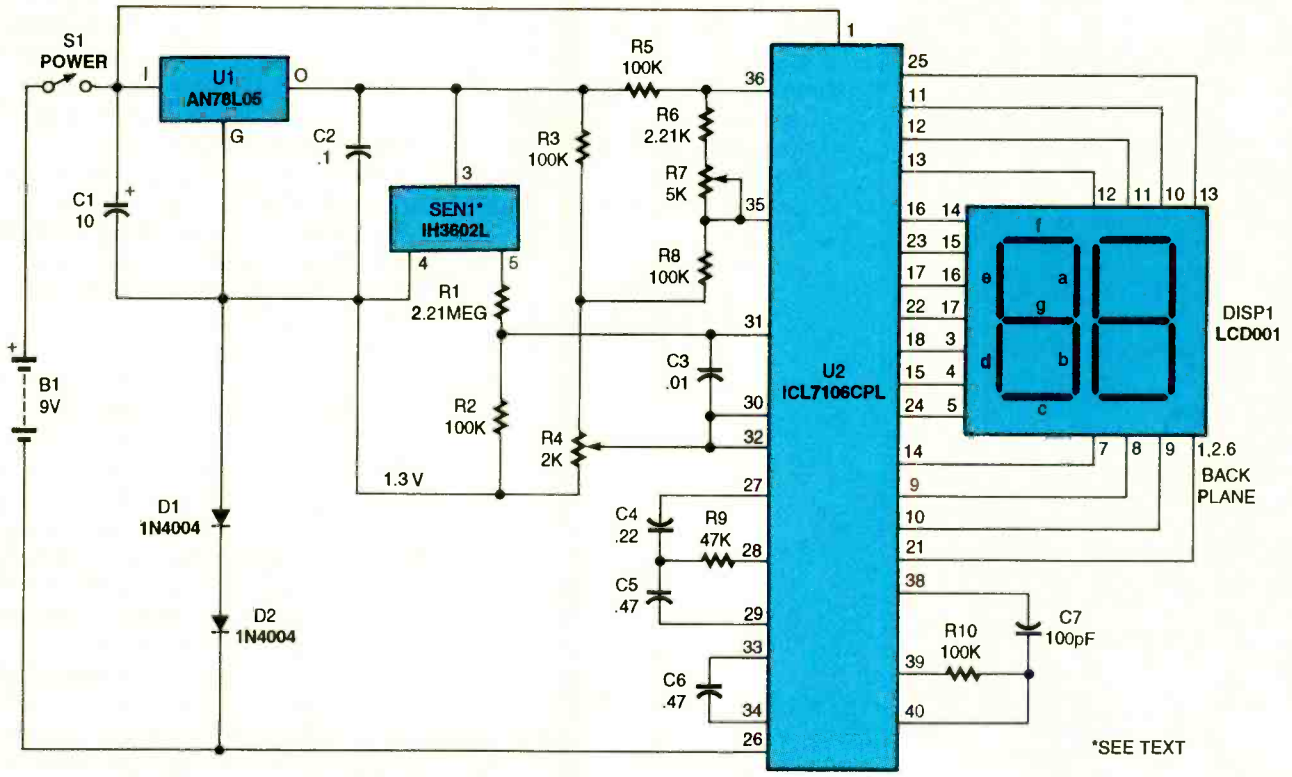


Fig. 1. At the heart of the Digital Relative Humidity Gauge is the Hy-Cal IH3602L, SENS1 (a 6-pin CMOS device with active 3-terminals).

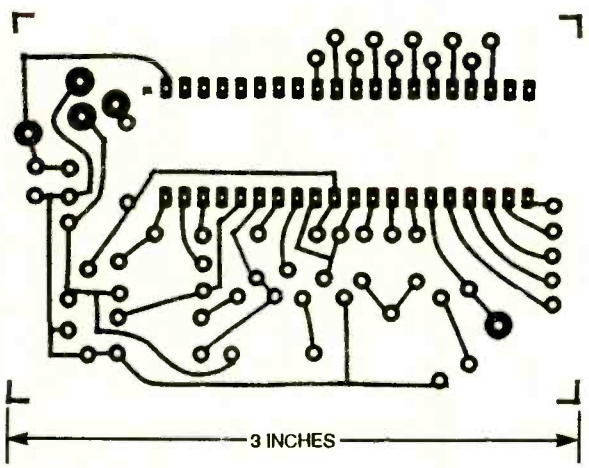


Fig. 2. The Digital Humidity Gauge was assembled on two single-sided, printed-circuit boards; a template for one of them—the sensor board—is shown here full size.

AN78L05 100-mA fixed regulator. The output of the sensor (measured with respect to its negative power input terminal) is ratiometric and varies linearly from 0.8 volts at 0% RH to 3.65 volts at 100% RH when powered by 5-volts. The sensor output is fed through resistors R1 and R2, which form a voltage-divider network that reduces the output voltage of the sensor to a range of about 35 to 158 mV. The change in voltage (28.5 mV/% RH) is used to drive U2 (an ICM7106CPL A/D converter that also contains an on-board oscillator, output latches, 7-segment decoder/drivers, and a back-plane signal generator).

Potentiometer R4 is used to set pin 30 of U2 at 35 millivolts, while the reference voltage of the chip is set to equal the total change in voltage at pin 31, 123 mV (158 mV – 35 mV). Potentiometer R7 permits full-scale calibration of the instrument for variations in humidity sensors by allowing adjustment of the reference voltage of U2.

Although U2 is capable of driving a full 3½-digit LCD readout, in this application only two sets of U2's digit drivers are used (the most-significant and least-significant digits are not used). A full scale reading, 100% RH, occurs when the analog input voltage is equal to the reference voltage. That would normally give a display of 100.0; but, since the most- and least-significant-digits are not used, 100% RH is represented by a two-digit display of 00.

Components D1, D2, and R4 set the analog-ground terminal of U2 at pin 32 to slightly above ground (at 1.3 volts). Pin 31 of U2 (the positive analog differential-input terminal) is connected to the output voltage of the sensor through a voltage divider composed of R1 and R2. Diodes D1 and D2 are also used to generate a fixed voltage of about 1.3 volts, which is necessary to bias the analog input stages of the A/D converter. Pin 30 (the negative analog differential-input) of U2 is connected to the wiper of R4, allowing calibration at 0% RH. Pins 35 and 36 of U2 are the reference-input terminals and are used to set the full-scale range of U2. A full-scale output occurs when the input voltage applied between pins 31 and 30 is equal to twice the reference voltage.

PARTS LIST FOR THE DIGITAL RELATIVE-HUMIDITY GAUGE

SEMICONDUCTORS

U1—AN78L05 5-volt, 100-mA voltage regulator, integrated circuit
U2—ICL7106CPL 3½-digit A/D converter, integrated circuit
DISP1—LCD001 2-digit liquid-crystal display (Digi-Key)
SENS1—IH3602L P/N sensor (Hy-Cal)

RESISTORS

(All fixed resistors are ¼-watt, 5% units, unless otherwise specified.)
R1—2.21-megohm, ¼-watt, 1% metal-film
R2, R3, R5, R8—100,000-ohm, ¼-watt, 1% metal film
R4—2,000-ohm, cermet, PC-mount potentiometer
R6—2,210-ohm, ¼-watt, 1% metal film
R7—5,000-ohm, cermet PC mount potentiometer
R9—47,000-ohm
R10—100,000-ohm

CAPACITORS

C1—10-µF, 25-WVDC, radial-lead electrolytic
C2—0.1-µF, ceramic-disc
C3—0.01-µF, ceramic-disc
C4—0.22-µF, 50-WVDC, metallized-film
C5, C6—0.47-µF, 50-WVDC, metallized-film
C7—100-pF, 50—WVDC, ceramic-disc

ADDITIONAL PARTS AND MATERIALS

B1—9-volt transistor-radio battery
S1—SPST momentary-contact switch
Perfboard materials, enclosure, IC sockets, battery holder and connector, wire, solder, hardware, etc.

Note: The following parts are available from A. Caristi, 69 White Pond Road, Waldwick, NJ 07463: a set of two printed-circuit boards for $18.95; U1 for $2.50; U2 for $17.75; LCD readout for $11.00; kit of 5 metal-film resistors for $3.00; sensor $65.00. Please add $4.00 postage/handling to all orders. New Jersey residents, please add appropriate sales tax.

Construction. The Digital Relative-Humidity Gauge was assembled on two single-sided, printed-circuit boards, referred to as the senor and the display boards. That type of construction allows the boards to be stacked if desired to permit the circuit to be housed in a very small enclosure. Figure 2 is a full-size template of the sensor board, while Fig. 3 is a full-size template of the display board.

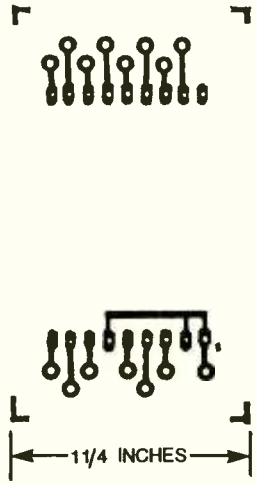


Fig. 3. Use this full-size printed-circuit pattern to etch the display board for your Digital Humidity Gauge.

oriented. It is mandatory that those components be placed in the circuit as shown. Doing otherwise will result in an inoperative circuit and possible component damage.

When assembling the sensor board, do not install SENS1 (the humidity sensor); that part will be installed later, when the circuit is calibrated. Be sure to use a socket for U2. That permits the project to be serviced should it ever become necessary, and is well worth the slight additional cost. A socket for the display is optional; one can be easily fabricated by cutting an 18-pin IC socket lengthwise in half to produce two 9-pin sections.

When handling the display module, be extremely careful not to exert excessive force; that unit is fragile. When inserting the IC and display into the boards be sure to orient them properly (as indicated in their respective parts-placement diagrams).

Note that most of the resistors specified in the parts list are 1% metal-film types. Those resistors are used in the

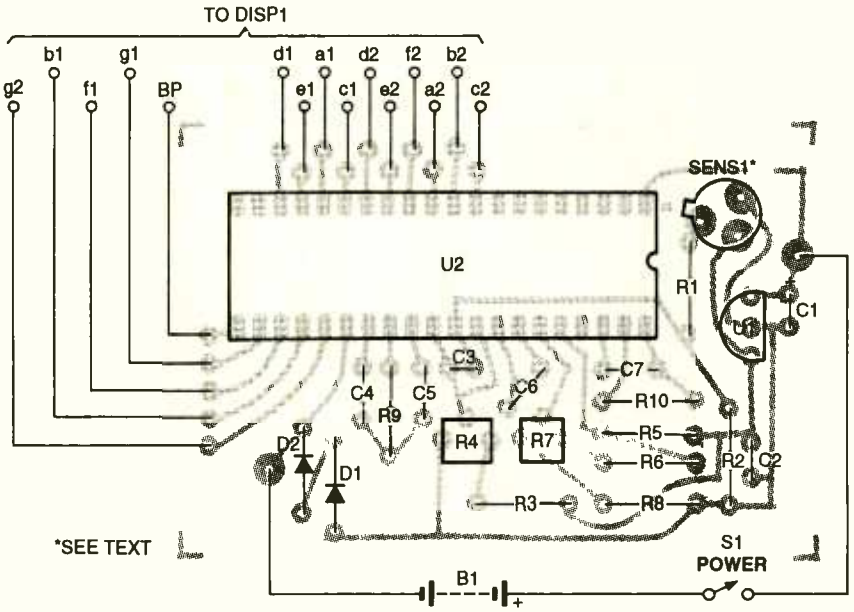


Fig. 4. When assembling the senor board be sure that all of the polarized components are correctly oriented and installed in their proper locations.

If you choose not to etch your own board, a set of boards can be obtained from the source given in the Parts List.

Figures 4 and 5 are the parts-placement diagrams for the sensor and display boards, respectively. When assembling the boards, be sure that all of the polarized components (the display module, IC's, diodes, and electrolytic capacitors) are properly

circuit to ensure temperature stability, as well as ensure that its calibration does not change with temperature variations or from component aging. Ordinary carbon resistors don't have the necessary stability, and should not be used as a substitute for metal-film resistors.

The sensor and display boards are connected to each other via a set of 15 wires; labeled "a" through "g," and

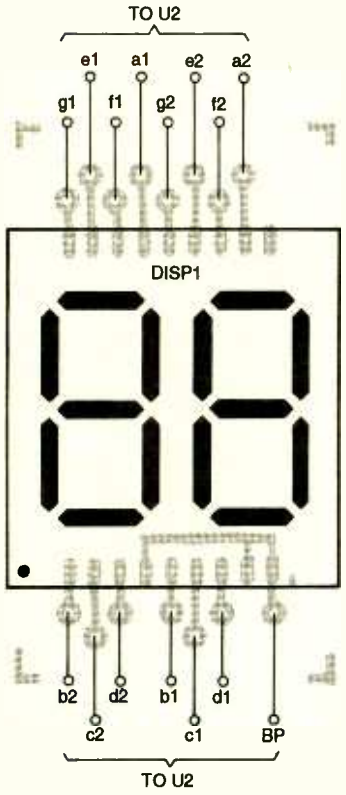


Fig. 5. The display board (as shown by this parts-placement diagram) holds only one component, the LCD readout. Although, from appearances it may seem difficult to assemble this board the wrong way, looks can be very deceiving, so make absolutely sure that the readout is properly oriented on the board.

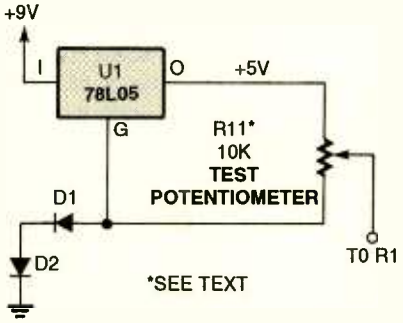


Fig. 6. The Digital Humidity Gauge can be calibrated using two procedures. The first is a two-point method, outlined in this diagram. It requires a potentiometer and digital voltmeter to set R4 and R7. (See the text for more details.)

BP (for back plane) in the parts-placement diagrams. For those connections, use #24 AWG or similar insulated stranded wire. Do not use solid wire; it will break during handling of the boards. Be sure to allow sufficient wire length in accordance with the final position of the assembly in the selected enclosure. The most compact design is to stack the two boards on top of each other and mount the assembly to the front panel of the enclosure, with a rectangular opening into the front panel to allow the display to be viewed.

Connect a 9-volt battery connector to the circuit, and mount a 9-volt battery holder inside the enclosure to secure the battery in place so that it does not rattle around.

There is just one operating control, S1. It is recommended that a momentary "spring-return" switch (either toggle, slide, or pushbutton) be used for S1 so that there is no possibility of accidentally leaving the unit turned on after taking a humidity reading.

When you have finished assembling and wiring the project (with the exception of installing the humidity sensor), examine the circuit very carefully for shorts, especially between adjacent IC terminals, and cold solder joints (which may appear as rough or dull blobs of solder), and correct any deficiencies; it is far easier to fix a problem at this stage than during the checkout procedure when you turn the project on, only to find that the circuit does not work.

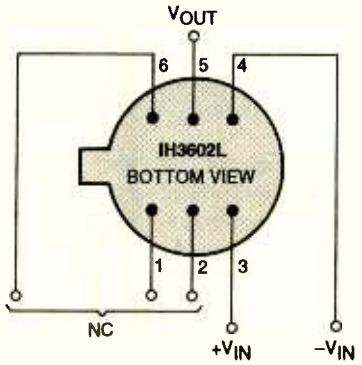


Fig. 7. The Hy-Cal IH3602L sensor, SENS1 (a 6-pin CMOS device with only 3-active terminals), is at the heart of the humidity measurement system. The IH3602L provides a DC output voltage that varies linearly with relative humidity levels from 0 to 100%.

Two-Point Calibration. Either of two procedures can be used to calibrate the circuit: the two-point method (described here) and the one or two-point precision method (to be discussed a little later on). In the two-point method, see Fig. 6, a potentiometer and a digital voltmeter are used to set R4 and R7. It is recommended that the two-point calibration be performed first to verify the proper operation of the circuit. Afterward, the second, more accurate, calibration procedure can be performed if desired (more on that later).

In Fig. 6, a 10k potentiometer (R11) is temporarily substituted for the humidity sensor. That unit is connected in parallel with C2, and the voltage at its wiper is then fed through R1 to the following circuitry as if it were the output of SENS1. By setting the voltage at the wiper of R4 to 0.08 volts and the wiper R7 to 3.65 volts, the digital display will show the correct reading.

Connect a fresh 9-volt battery (or a well-filtered 9- to 15-volt DC wall adapter) to the circuit. Turn S1 on and measure the output of U1 across C2. The reading should be 4.75 to 5.25 volts. If the voltage falls within that range, record the actual value on a piece of paper. If you do not obtain the correct voltage, disconnect power and troubleshoot the circuit to locate and correct the fault.

Check the orientation of C1, U1, U2, D1, and D2. Examine the circuit board carefully for any possible shorts, especially between closely spaced copper conductors. Check the output voltage and polarity of the power source to be sure it is delivering at least 8 volts to the regulator. If everything looks good, try a new regulator. When the fault has been corrected, record the actual output voltage of the regulator and proceed with the checkout.

With power applied to the circuit, the display should show a two-digit number that varies as R11 is adjusted. If either or both of the digits have incorrectly illuminated or extinguished segments, the problem lies with one or more of the 14 segment connections between U2 and the display.

Refer to the schematic diagram to determine which wire connections between U2 and DISP1 are at fault. Use an ohmmeter to verify any suspect connections which can be either shorted or open circuits, or miswiring. If the display is totally blank, the problem most likely lies with the backplane signal that runs between U2 pin 21 and DISP1 pins 1, 2, and 6. Refer to Figs. 4 and 5 to verify that U2 and the display module are properly oriented and correctly wired together.

If an oscilloscope is available, pin

21 of U2 can be checked for the presence of the back-plane signal. A 60-Hz squarewave of about 6 volts peak-to-peak is a normal indication. If that signal absent and the component orientation and wire connections are correct, try a new U2.

At this point, with the display reading properly, the calibration can be performed. First calculate the nominal output voltage of the sensor, for 0% and 100% RH, by using the following two expressions:

$$V_L = (0.8)(V)/5$$
$$V_H = (3.65)(V)/5$$

where V_L is the nominal output of the sensor at 0% RH, V_H is the nominal output of the sensor at 100% RH, and V is the regulated supply voltage as measured and recorded earlier.

Set R7 to mid-position. Connect the negative lead of the digital voltmeter to the anode of D1, and the positive lead to the wiper of R11. Adjust R11 so that the DVM reading is equal to the V_L value calculated above. Adjust R4 so that the display reads 00. Note: The A/D converter is capable of displaying negative numbers even though no polarity sign is used in this circuit. As a result, the display will vary from both sides of 00 as R4 is adjusted.

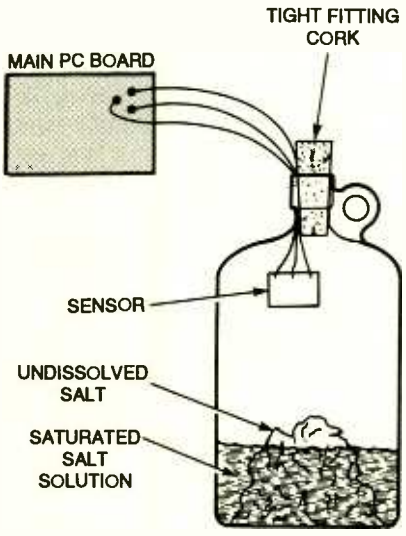


Fig. 8. The second calibration method uses the first procedure, coupled with the one outline in this illustration. (See the text for full details.)

Set R11 so that the DVM reads V_H as calculated earlier. Adjust R7 so that the display reads 00 (representing 100% RH). Perform those steps several times to ensure that neither R4 nor R7 need further adjustment.

TABLE 1—RH OF VARIOUS SATURATED SALT SOLUTIONS

Salts	Percent RH
Lithium Bromide	6.4
Lithium Chloride	11.3
Potassium Acetate	22.7
Magnesium Chloride	32.8
Potassium Carbonate	43.2
Magnesium Nitrate	53.2
Potassium Iodide	69.1
Sodium Chloride	75.3
Ammonium Sulphate	81.1
Potassium Chloride	84.3
Potassium Nitrate	93.8

TABLE 2—CORRECTION FACTOR FOR VARIATIONS IN AMBIENT TEMPERATURE

Ambient Temperature In Degrees F	Uncorrected Relative Humidity Reading						
	20%	30%	40%	50%	60%	70%	100%
25	−1.2	−1.7	−2.3	−2.8	−3.4	−4.0	−5.7
35	−1.0	−1.4	−1.8	−2.3	−2.8	−3.2	−4.6
45	−0.8	−1.0	−1.4	−1.7	−2.1	−2.4	−3.5
55	−0.5	−0.7	−0.9	−1.2	−1.4	−1.6	−2.3
65	−0.3	−0.4	−0.5	−0.6	−0.7	−0.8	−1.2
75	0	0	0	0	0	0	0
85	0.2	0.3	0.5	0.6	0.7	0.9	1.2
95	0.4	0.7	1.0	1.2	1.5	1.7	2.5
105	0.7	1.1	1.5	1.9	2.2	2.6	3.7

That completes the initial calibration of the instrument. If you do not elect to perform the more precise circuit calibration described below, remove the test potentiometer and place the sensor into the circuit (as shown in the parts-placement diagram, Fig. 4).

One or Two-Point Precision Calibration. The known property of a saturated salt solution having a specified RH level in the enclosed air space above the liquid level provides the means for a simple but accurate calibration of the instrument. In this method, a sealed bottle containing a mixture of a specified salt and water produces a known level of relative humidity in the air above the liquid at a given temperature.

To calibrate the unit, the sensor is placed in the air space of a sealed container that holds the saturated salt solution. When equilibrium is reached (when the liquid and water vapor in the bottle are at the same temperature), the appropriate potentiometer (R4 or R7) adjustments are made as described below.

The most accurate method is a two-point calibration performed by selecting two solutions, one near the low end of the scale and the other near the high end; select the appropriate solutions using the information in Table 1. However, an easier one-solution method can be used if desired. To perform the one-solution calibration, adjust R4 first for 0% RH (as discussed earlier), and then use a saturated solution of sodium chloride (common table salt and water) and adjust R7 for a display of 75% RH.

To calibrate the circuit, the humidity sensor must be temporarily connected to the sensor board via a three flexible wires. To aid in the hook up of the sensor, a pinout diagram of the sensor is shown in Fig. 7. Note (as mentioned earlier) although the unit is a 6-pin device, it has only 3 active terminals.

Refer to Fig 8. The solutions are prepared by mixing a sufficient quantity of the selected salt with water, so that the excess undissolved crystals that remain are saturated with water and at a level slightly above the liquid level. It is very important that the bottle be absolutely air tight. The temperature of the solution and the room should be as close to 75°F (24°C) as possible, and remain constant, to ensure accuracy.

Place the sensor in the air space above the liquid. **Caution:** At no time should any liquid or salt be allowed to touch the sensor. Doing so could damage it. Allow a minimum of ½ hour for stabilization; 1 to 2 hours is better. That time delay is required to allow the air space within the bottle to reach its final level of relative humidity.

Adjust the appropriate potentiometer until the display shows the value specified in Table 1, rounded to the nearest integer, for the selected salt solution. For example, if sodium chlo-

(Continued on page 94)

ANTIQUE RADIO

By Marc Ellis

Crystal Set Lore

During the course of a year, it's not unusual for me to receive several letters from readers who are interested in building crystal sets. Some are from grandfathers wanting to show the youngsters in their families what radio was like "in the old days." Others come from younger folks interested in experiencing for themselves the traditional entry-level activity for radio enthusiasts of the 1920's and 1930's.

Quaker Oats Company's early 1920's Christmas ad for the "Quick Oats" crystal set.

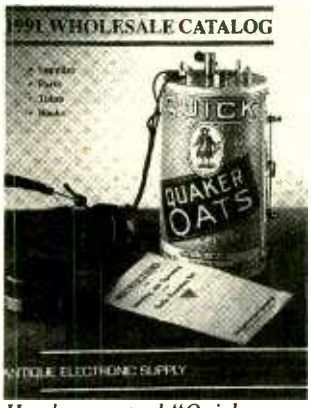
I finally figured it was time to plan a crystal-set project for this column—but not just any project. I wanted one that reflected the construction techniques of the early 1920's, when radio broadcasting was in its infancy and radio receiving was an adventure that could be embarked upon by any kid with persistence, a talent for scrounging materials, and just a couple of bucks in hard cash.

According to legend, such a young experimenter would begin scrounging in the kitchen, where he hung around until mom was ready to relinquish an empty Quaker Oats container. That sturdy cardboard cylinder was just the right diameter to serve as a form for the all-important tuning coil. It was available for the asking in almost every American household, and I wish I had a penny for every foot of double-cotton-covered wire that was wrapped around one during the early days of the radio craze!

CHECKING THE QUAKER OATS ARCHIVES

I'd heard somewhere that the Quaker Oats Company, having become aware of this very popular secondary use for its packaging, once published some crystal-set-making instructions as an advertising ploy. Thinking that those instructions would make a very good basis for a modern crystal-set reconstruction, I contacted the Quaker Oats Archivist to see what she could find out.

No such instructions turned up, but what I found out was just as interesting. Back in the early 1920's, Quaker Oats manufactured a self-contained crystal set, using a "Quick Oats" can-



Here's an actual "Quick Oats" set, complete with the original instruction book, as pictured on the cover of the 1991 Antique Electronic Supply catalog.

ister not only as a coil form but also as a chassis for the crystal detector, binding posts, and tuning mechanism. The archivist sent me a copy of a full-page newspaper ad from a Chicago newspaper of the period (which I'm running with this column) offering such a set as a Christmas promotion.

That particular offer was local only. Anyone desiring a set had to present himself at the downtown offices of the Quaker Oats Company, bringing along a dollar and proof-of-purchase seals from two Quaker Oats containers. Five bucks would buy the complete outfit, including not only the radio but a set of 2400-ohm phones, 100 feet of stranded antenna wire, a couple of insulators, and a 50-foot insulated lead-in wire. Not a bad deal, even considering the more valuable currency of the time!

As soon as I looked at the ad, I realized that I'd seen the set before. Eventually, I figured out where: An excellent photo of the radio,

complete with the original instruction book, appears on the cover of the 1991 *Antique Electronic Supply* catalog. I'm reproducing it here with the kind permission of that organization. You'll notice that the tuning coil is not visible, being located *under* the Quaker Oats label so as not to obscure the artwork.

Although I'd certainly uncovered an interesting bit of crystal-set lore, I was no closer to finding a good construction project for this column. However, since Quaker Oats still sells its product in those neat cylindrical containers, I was determined that whatever project I published would use one of them as a coil form.

TUNING THE SIGNAL

I eventually found what I wanted in *How to Build Your Radio Receiver*, a 1924 handbook for experimenters published by Popular Radio, Inc. It's a set that was designed for home construction by the Bureau of Standards of the U.S. Department of Commerce. We'll get into the details of that radio next month, but I'd like to devote the remainder of this column to a brief discussion of crystal-set theory.

The construction article for the Bureau of Standards receiver didn't include a schematic diagram, just mechanical drawings. That wasn't uncommon for the era, when the mechanical details of a radio were often more complicated than the electrical ones. However, the diagram I'm presenting with this column, taken from a 1922 publication, is virtually identical to that of the set we'll be building. Notice that it includes both schematic and pictorial representations of the parts layout.

First, let's take a look at the tuning circuit; see Fig. 1. It consists only of a coil with two sets of taps. The variable capacitor, shown by broken lines in two possible positions on the schematic, is optional and wasn't used in the Bureau of Standards set. When wound in accordance with the specifications given for that set, the coil will tune to the broadcast band with no capacitance other than that inherent in its mechanical construction.

One might think that an external capacitor might be necessary to make fine-tuning adjustments, but on this set such adjustments were made by manipulating the two tap switches. One of those selects the number of coil turns in groups of six; the other, in groups of two. The "six" switch was used to set the receiver near the wavelength desired; fine adjustments could then be made with the "two" switch.

Instead of tap switches, some crystal-set designs (including the Quaker Oats Christmas radio) used a sliding contact that moved across the surface of the coil, selecting one turn at a time and making it possible to achieve even finer adjustments. However, such an arrangement was a little harder for the home constructor to put together.

A tuning capacitor, if used, might certainly improve the selectivity of the Bureau of Standards set and also extend its tuning range. In the position indicated by C1, the capacitor would enable the radio to tune to lower frequencies than those possible with just the bare coil; in the position indicated by C2, higher frequencies would be available. However, at least for starters, we'll build the set as designed.

DETECTING THE SIGNAL

An amplitude-modulated (AM) signal such as the crystal set is designed to receive consists of an audio component (the voice and/or music being transmitted) superimposed on a radio-frequency signal known as the *carrier*. The amplitude, or strength, of the carrier varies in accordance with the pattern of the audio signal impressed upon it. In the graphic representation shown in Fig. 2(a), the carrier is represented by the alternating current repeatedly varying between plus and minus values. The audio signal is represented by the more gentle variations impressed on the carrier.

The carrier enables the signal to travel through the space between the radio transmitter and your receiver at the speed of light. However, once at the receiver, it must be removed because its presence makes it impossible to hear the audio. Looking at (a) again, notice that every positive point in the signal is balanced by an equal and opposite negative point. The result is signal cancellation and silence in the headphones.

If you look at the crystal radio schematic, however, you'll see that no signal can pass through the headphones without passing through the crystal detector. The characteristics of the crystal are such that it acts as a one-way valve. The net effect is represented in Fig. 2(b), where the negative parts of the signal have been completely cut off with only the positive parts reaching the headphones. However, the rapid variations of the radio carrier can still be seen within the envelope of the audio signal.

Now notice the fixed capacitor shown connected in parallel with the headphones. A capacitor is an energy storage device that becomes charged when the voltage across it rises, then discharges back into the circuit as the voltage falls again. The net result is that the radio carrier variations are smoothed out (filtered) and effectively disappear, as shown in Fig. 2(c), leaving only the audio signal—which is now audible in the phones.

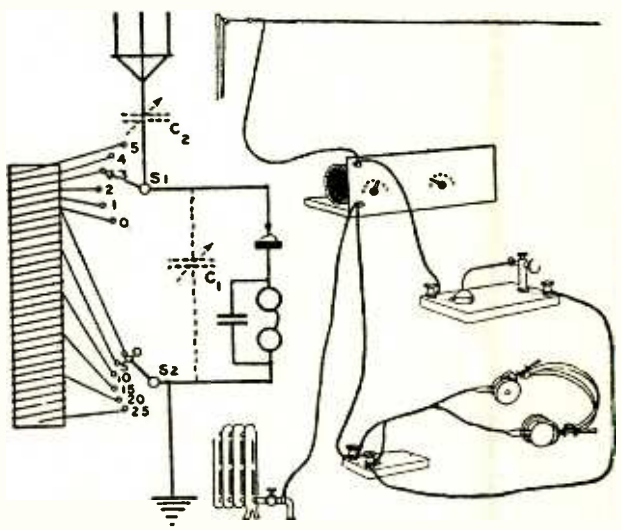


Fig. 1. Here are the schematic and pictorial diagrams of the Bureau of Standards crystal set. It is very similar to the one that we'll be building next month.

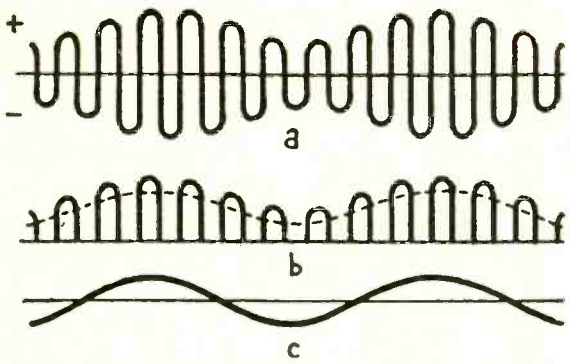


Fig. 2. Here we show (a) a radio carrier (a); (b) the carrier after passing through the crystal detector; and (c) subsequent filtering by a headphone capacitor.

The fact that the variations of the audio signal are not also smoothed out and canceled has to do with the size of the capacitor. It's large enough to handle the rapid changes in the radio signal, but too small to handle the much slower ones in the audio.

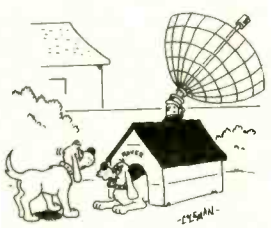
MECHANICS OF THE CRYSTAL DETECTOR

Now that you know how a crystal detector works, it's a little easier to explain what it is. Those of you with some electronic background have recognized that in likening the action of a crystal detector to that of a one-way valve, we've really identified it as a crystal *diode*. In fact, this device really was the first solid-state diode to be commonly used in electronic circuits. But where its more modern counterparts were based on germanium and silicon compounds, the crystal detector used in the 1920's and 1930's employed a mineral called *galena*., otherwise known as lead ore.

A small chunk of this mineral, embedded in a cylindrical metal holder, is held in a metal cup, mounted on a base made of insulating material. Also mounted on the base is a rod held in a ball-and-socket type universal joint so that it can be pivoted in any direction. At one end of the rod is an insulated handle and at the other is a spring loaded phosphor-bronze contact wire familiarly known as the "cat's whisker." The metal cup and rod are wired to electrical connectors on the base so that the detector can be hooked up to the rest of the receiver circuit.

In order to make the detector work, the cat's whisker is placed in contact with the galena ore. But the sensitivity of the detector, and therefore the strength of the received signal, varies greatly depending on exactly *where* the cat's whisker is placed. Operating a crystal radio involves a constant search for the ever-changing "sweet spot," the point where reception is maximized.

See you next month, when we'll unveil the Bureau of Standards crystal-set project, complete with Quaker Oats coil! Until then, write to me c/o *Antique Radio*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■



"It's a cat-scanner."

COMPUTER BITS

By Jeff Holtzman

Shred Your Manuals!

Everyone hates documentation. I have here an ad for video-training tapes. The ad boldly proclaims, "Shred Your Manual! Master Your Software . . . effortlessly!" What is the problem? Why are companies that spend literally millions of dollars producing highly complex software simply unable to document their products in a satisfactory manner?

This ad boldly proclaims, "Shred Your Manual! Master Your Software . . . effortlessly!"

I'll tell you why, and the answer may surprise you. It's not because software engineers (who are seldom responsible for documentation anyway) are poor writers. Nor is it because technical writers (who usually are responsible for it) are technically inept (although many certainly are). It's because what's really required is a non-existent job category called "Document Engineer." The duties of this professional are "Document Engineering."

What is document engineering? Let's focus on the engineering part of the term. The American Heritage Dictionary, 3rd Ed., 1992 defines engineering as "The application of scientific and mathematical principles to practical ends such as the design, manufacture, and operation of efficient and economical structures, machines, processes, and systems."

For purposes of this discussion, we can reduce that definition to "The application of scientific and mathematical principles to the design of efficient and economical structures." Systems might be a better word than structures, but that's a subject for another discussion.

SCIENTIFIC, EFFICIENT STRUCTURES

Now let's look at the existing state-of-the-practice with respect to that definition. There are exceptions, but 1) The vast bulk of existing computer documentation could hardly be said to be based on any principles whatsoever, much less scientific or mathematical ones; 2) The vast bulk of existing documentation is neither efficient nor economical; and 3) The vast bulk of existing documentation has no concept of structure. Or if it does, it is of an outmoded, linear format based on rhetorical structures and techniques designed literally thousands of years before the advent of the computer.

Computer software is complex, and is unlikely to become less so. The purpose of user-interface design (or what I call user interaction design, discussed last month) is to make the complexity manageable. The purpose of documentation is to, well, document that complexity. The problem is that those producing the documentation often do not understand the complexity, not in a holistic, systematic, structural way.

They typically understand the "how" of many small activities, but not how they fit together to form the overall structure, nor do they understand the ways in which they interact. The situation is analogous to that in medicine, where countless specialists understand particular subsystems of the human body in more or less detail, but no one systematically understands either the overall arrangement of parts that form a whole or the myriad forms of interaction among the parts.

Returning to computer documentation, without understanding how the parts of something fit together, how can anyone be expected to describe that thing, especially something as ethereal as computer software? This is the crux of the problem.

THE SOLUTION

My solution is this hypothetical field of endeavor called document engineering. Practicing document engineers would have a lot more qualifications than they do now. Indeed, there is no national accreditation agency for technical writers, and there are precious few academic programs

that approach that discipline with any rigor.

If it were left to me, no one would be allowed to write a computer manual without training in the following: computer science (data structures, algorithms, languages, database design), psychology (theories of cognition and learning theory), education (learning practice, instructional design), graphics (screen design and page layout), and English (etymology and rhetorical structure). I also assume competence in the basics (punctuation, grammar, usage, composition).

That curriculum almost certainly exceeds what may be accomplished within the span of a 4-year degree that also encompasses traditional studies in science, social science, and the humanities. So be it. Thus, the minimum qualification for a degree in document engineering would be a two-year Master of Science; a Ph.D. would be preferable.

ANOTHER PROBLEM

Assume for a moment that the world were suddenly populated with adequate numbers of document engineers. Would our problems with computer documentation suddenly evaporate? No. The problem is broader than simply documentation. A supply of fully qualified document engineers is a necessary part of the equation. But it is not sufficient.

The other major missing ingredient, as you might expect, is user-interface (interaction) design. That is a consistently neglected part of product design, not just computer software. It combines elements of both art and science. Engineers that are good at implementing algorithms, electronics circuits, or mechanical or architectural designs are not necessarily good at user-interaction design. Indeed, they often are not, because they appear to lack the empathetic capability of getting inside their user's head and understanding the world from that point of view.

For example, look at Word Perfect. It is far and away the best selling word processor for the PC. But it has far and away the most abstruse command structure of any program of its type. No one likes that command structure; people invest considerable time and effort in learning it and then become religiously attached to it. No one seems to be able to explain why particular features are implemented in particular ways; indeed, there may not be a why, other than the whim of the programmer. In the case of that type of unsystematic design, no documentation will ever be successful.

Thus, instead of a usable interface (interaction model), Word Perfect Corporation has substituted an enormous telephone-support organization. If the interface were improved to the point that it were truly usable, the company could undoubtedly reduce support cost significantly.

The printed documentation provides little help. It's not bad; but without changing the program, the documentation by itself will never suffice. The only solution is better user-interaction design.

The days of using paper documentation to substitute for poor program design are over. A new breed of professional is required to help bridge the gaps between product design and documentation. Only then will we lose the urge to shed the manual. ■

CIRCUIT CIRCUS

By Charles D. Rakes

555 Astable Roundup

During this visit, we're going to share with you a few 555 oscillator/timer circuits. It's my guess that the 555 is second only to the 741 op-amp in popularity and circuit applications. Of course, I could be wrong and the reverse could be true. Either way, our subject for this month is 555 oscillators.

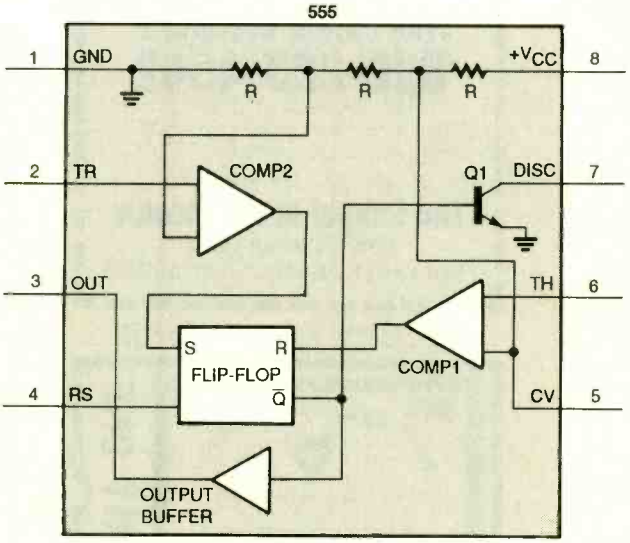


Fig. 1. The 555 oscillator/timer is composed of two comparators, an RS flip-flop, an output buffer, a discharge transistor, and two reference voltages as shown by this functional block/pinout diagram.

We'll start out with a quick look at the IC's architecture to help you to understand how that IC works and the external components function in our circuits. Figure 1 is a functional block/pinout diagram of the 555, which is composed of two comparators, an RS flip-flop, an output buffer, and a discharge transistor.

The chip's trigger (at pin 2) and the threshold (at pin 6) levels are internally set for one-third and two-thirds of the supply voltage by a resistor string. The control input (at pin 5) allows those levels to be varied. Feeding a negative pulse to the trigger input causes the 555's internal flip-flop to "set," sending its output at pin 3 high. The chip can be configured for monostable, bistable, or astable operation.

ASTABLE MULTIVIBRATOR

Figure 2 shows one a variation of the basic 555-astable configuration. When power is first applied to the circuit, capacitor C1 (the timing capacitor) is initially discharged. That causes the output of the 555 at pin 3 to be high. Capacitor C1 then begins to charge through the R1/D1 parallel combination until it reaches ⅔ of the supply voltage (or the upper threshold level).

At that point, pin 3 goes low, and the discharge transistor turns on, draining the charge on C1 to ground via R1. There is no discharge path through D1 since it is now reverse biased, so C1 takes longer to discharge than to charge. When the charge on C1 has been drained to about ⅓ of the supply voltage, the discharge transistor turns off, and the cycle starts over again.

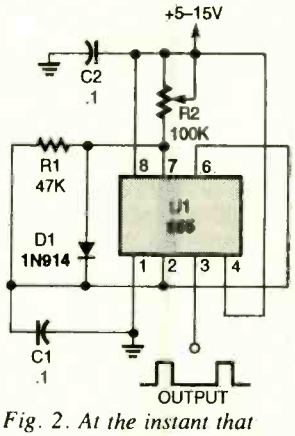


Fig. 2. At the instant that power is applied to the 555 astable, timing capacitor C1 is initially discharged, causing the output of the chip output at pin 3 to be high. Once C1 has charged to about ⅔ of the supply voltage, its output goes low, and the discharge transistor turns on, draining the charge on C1.

PARTS LIST FOR THE ASTABLE MULTIVIBRATOR

U1—555 oscillator/timer, integrated circuit
D1—1N914 general-purpose silicon diode
R1—47,000-ohm, ¼-watt, 5% resistor
R2—100,000-ohm potentiometer
C1, C2—0.1-μF, ceramic-disc, capacitor.
Perfboard materials, 5–15-volt power source, wire, solder, hardware, etc.

MODIFIED ASTABLE

The circuit in Fig. 3 shows another method of obtaining a variable positive pulse-width output; the circuit also allows you to set the output to a symmetrical waveform. In that circuit, pin 7—the discharge terminal, which in the previous circuit was used to control the timing capacitor's discharge rate—is not used. Instead, the 555's output at pin 3 is tied back to C1 through a 100k potentiometer, which is used to set the

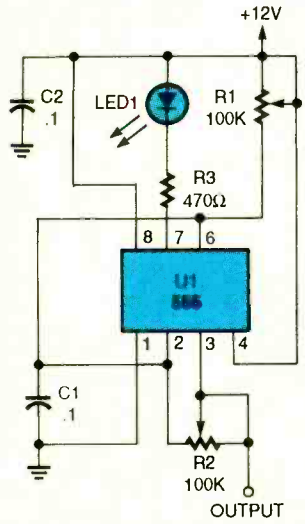


Fig. 3. This modified astable (a variation of the previous circuit) shows another way of producing a positive variable-pulsewidth output. The circuit also allows you to set the output to a symmetrical waveform.

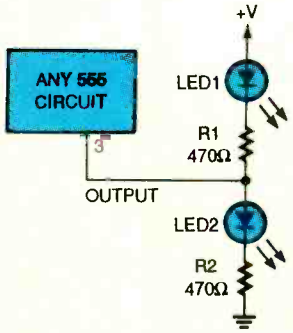


Fig. 4. A pair of LED's connected as shown here can be used with just about any low-frequency 555 oscillator to give high/low output indications. When the output goes high LED2 turns on, and when the output goes low LED1 turns on.

circuit's discharge period.

The oscillator's frequency and output pulse width can be altered by varying the potentiometers R1 and R2. Since the discharge transistor isn't necessary in this circuit, it can be used as an isolated output by connecting a load resistor between pin 7 and the positive supply. I would suggest using a 470-ohm or larger valued resistor for the external load.

In low-frequency applications, an LED and a 470-ohm resistor can be connected to pin 7 as shown, allowing the circuit's frequency to be monitored by way of the flashing.

ADD-ON LED CIRCUIT

A pair of LED's, connected as shown in Fig. 4, can be added to just about any low-frequency 555 oscillator circuit to give a dual and opposite flashing output. When the 555 output goes high, LED2 turns on and when the output goes low, LED1 turns on.

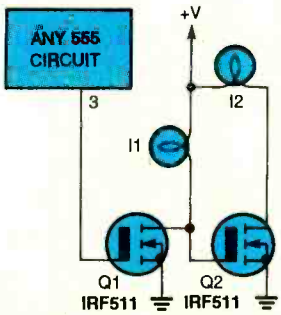


Fig. 5. This dual-flasher circuit is much like the previous flasher circuit except that hexFET's have been included in the circuit, enabling it to control a pair of higher-current incandescent lamps.

HIGH-POWER FLASHER ADD-ON

A high-power version of the dual flasher circuit is shown in Fig. 5; in that circuit, two hexFET's (Q1 and Q2) are used to supply current to a pair of incandescent lamps. When pin 3 of the 555 goes high, Q1 turns on, lighting I1. With Q1 turned on, the voltage at the gate of Q2 is near ground, holding it off. When the voltage a pin 3 goes low, Q1 turns off and supplies a positive gate voltage to Q2, turning it on and causing I2 to light.

The IRF511 hexFET can handle pulsed drain currents up to 8 amps, but the average current should be limited to 3 amps or less. Also keep in mind that the initial current drawn by incandescent lamps is several times their normal operating current. To control higher wattage lamps, hexFET's with higher current ratings can be used.

DC-TO-DC CONVERTER

Our next circuit (see Fig.

PARTS LIST FOR THE MODIFIED ASTABLE

U1—555 oscillator/timer, integrated circuit
LED1—Light-emitting diode (any color)
R1, R2—100,000-ohm potentiometer
R3—470 ohm, ¼-watt, 5% resistor
C1, C2—0.1-µF, ceramic-disc capacitor
Perfboard materials, 12-volt power source, wire, solder, hardware, etc.

PARTS LIST FOR THE ADD-ON LED CIRCUIT

LED1, LED2—Light-emitting diode, any color
R1, R2—470-ohm ¼-watt, 5% resistor
Perfboard materials, wire, solder, hardware, etc.

PARTS LIST FOR THE HIGH-POWER FLASHER ADD-ON

Q1, Q2—IRF511 hexFET
I1, I2—See text
Perfboard materials, power source, wire, solder, hardware, etc.

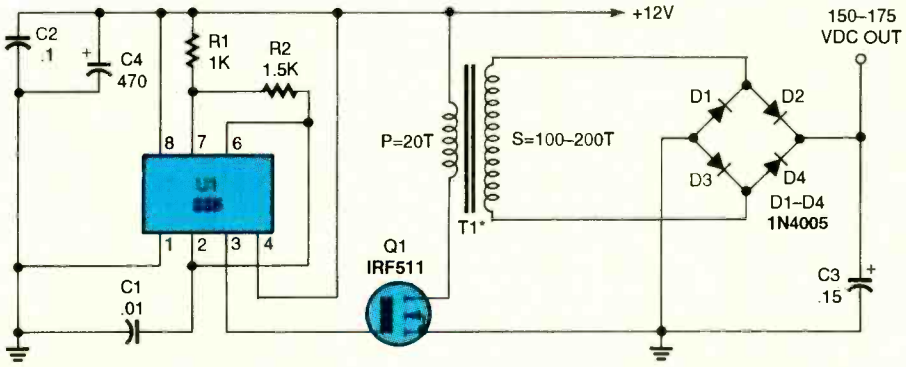


Fig. 6. In this DC-to-DC converter, the 555 is used to produce a rising and collapsing field in T1's primary, generating a higher voltage in T1's secondary winding. That voltage is then fullwave, bridge rectified by D1–D4, and filtered by C3.

PARTS LIST FOR THE DC-TO-DC CONVERTER

SEMICONDUCTORS
U1—555 oscillator/timer, integrated circuit
Q1—IRF511 hexFET
D1–D4—1N4005, 1-amp, 600-PIV, silicon rectifier diode

RESISTORS
(All resistors are ¼-watt, 5% units.)
R1—1000-ohm, ¼-watt, 5% resistor
R2—1500-ohm, ¼-watt, 5% resistor

CAPACITORS
C1—0.01-µF, ceramic-disc capacitor
C2—0.1-µF, ceramic-disc capacitor
C3—0.15-µF, 600-WVDC, Mylar capacitor
C4—470-µF, 16-WVDC, electrolytic capacitor

ADDITIONAL PARTS AND MATERIALS
T1—See text
Perfboard materials, 12-volt power source, wire, solder, hardware, etc.

6) places the 555 in a high voltage DC-to-DC converter. In that circuit, the 555 is connected as a standard astable circuit that oscillates at about 25 kHz. The output of the oscillator is fed to the gate of an IRF511 hexFET, causing it to turn off and on in time with the output of the 555. That off/on action chops the 12-volt DC supply voltage, producing a 25-kHz rising and collapsing field in T1's primary. That rising and collapsing field causes a higher voltage to be induced in T1's secondary winding, which is then applied to a fullwave, bridge rectifier consisting of four 1N4005 600-PIV 1-amp diodes. The rectified secondary output is then filtered by C3, to provide a 150- to 175-volt output.

The transformer is a home-made unit wound on a nylon bobbin that's provided with the EA-77-375 E core from Amidon Associates, Inc. (2216 East Gladwick St., Dominguez Hill, CA 90220; Tel. 213-783-5770). With a 10-to-1 turns ratio (200-turn secondary to 20-turn primary), the 12-volt input produces between 150 and 175 volts in the secondary of T1.

The primary winding is wound solenoid fashion on the bobbin with 20 turns of #26 copper enamel-coated wire. The primary winding is then covered with a layer of plastic tape. The secondary winding can then be wound with the same size wire as the primary for windings up to 200 turns. If a higher output voltage is desired, the secondary can be wound with #28 or #30 copper enamel-coated wire. The circuit can supply about 5 watts to an external load.

DUAL TONE GENERATOR

The final circuit this go-around is a dual-tone audio-signal generator that will keep the kids busy for hours—hopefully outdoors. Use your imagination and build the circuit into a musical like instrument and become the kid's neighborhood hero. In the tone generator (see Fig. 7), two 555 oscillator/timers are configured similarly as audio oscillators, with each oscillator feeding a separate speaker.

A dual 100k potentiometer is used to tune the two oscillators simultaneously. The oscillators' frequency range is controlled by a dual-transistor switch, which selects the timing capacitor for both oscillators. Although our circuit only

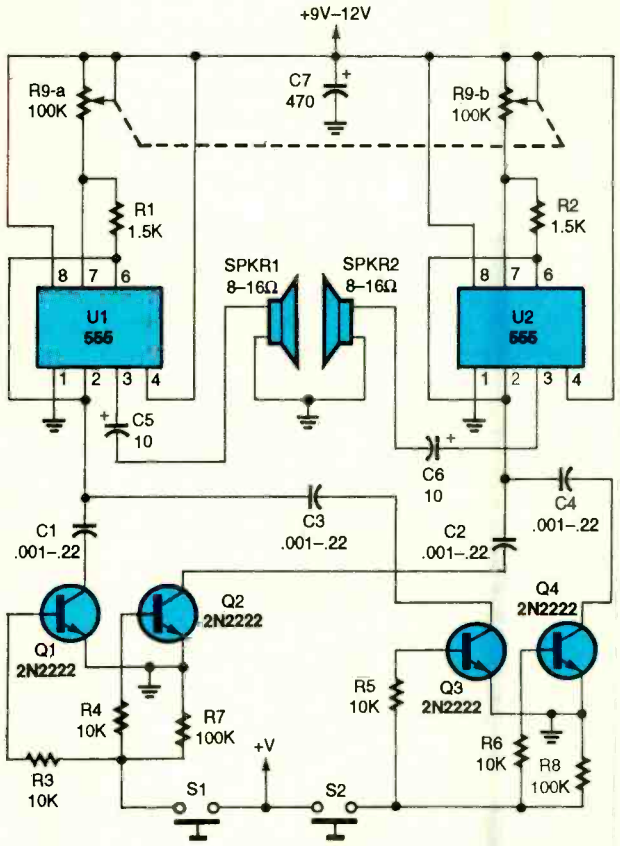


Fig. 7. The dual tone generator is little more than two 555 oscillator/timers feeding a separate speaker.

PARTS LIST FOR THE DUAL-TONE GENERATOR

SEMICONDUCTORS
U1, U2—555 oscillator/timer, integrated circuit
Q1–Q4—2N2222 general-purpose NPN silicon transistor

RESISTORS
(All fixed resistors are ¼-watt, 5% units.)
R1, R2—1500-ohm
R3–R6—10,000-ohm
R7, R8—100,000-ohm
R9—100,000-ohm dual potentiometer

CAPACITORS
C1–C4—0.001 to 0.22-µF, ceramic-disc
C5, C6—10-µF, 16-WVDC, electrolytic
C7—470-µF, 16-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS
S1, S2—Normally open push button switch
SPKR1, SPKR2—8- or 16-ohm speaker
Perfboard materials, 9–12-volt power source, wire, solder, hardware, etc.

shows two range-switching circuits, any number can be added by simply duplicating the two-transistor switching circuit.

An eerie sound effect can be generated by selecting the two range capacitors, C1 and C2, so that both oscillators are tracking at about the same frequency. Or you can select the range capacitors so that one of the oscillators operates an octave above or below the other. The tone combinations are endless, so be creative.

As you look over each of our 555 circuits it's much easiest envision the circuit's operation by referring to Fig. 1. Actually anytime you can see inside an IC when designing a circuit or in troubleshooting, you'll be miles ahead of the pack.

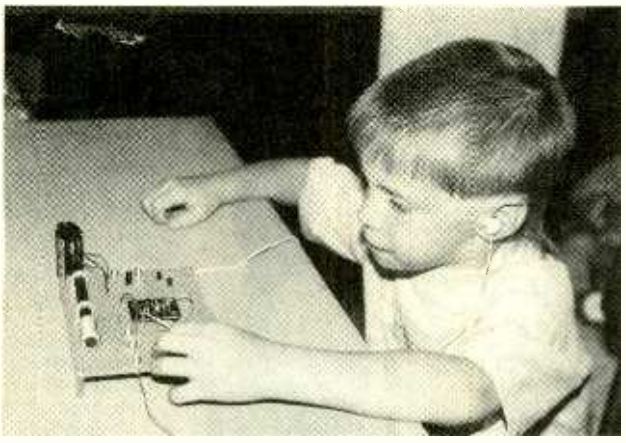
Well, it's that time again. See you next month. ■

DX LISTENING

By Don Jensen

E.C.S.S.

Exalted carrier selectable sideband is a tuning trick not widely known to most SWL's, but experienced DX enthusiasts rely on it to bring in intelligible signals in crowded and noisy band conditions. English shortwave whiz Gordon Bennett, writing in the World DX Club's "Contact" bulletin, calls exalted carrier, selectable sideband, or E.C.S.S., "a marvelously simple and very effective DX'ing technique." Never mind what it all means—although Bennett notes that it involves (in its simplest form) "non-synchronous heterodyne detection." Let's focus, instead, on how you can use the technique.



The magic of shortwave listening is evident to 4-year old Ian Ingles, who tunes in stations on this simple, breadboarded receiver built by his father.

First of all, I should note that you must have a shortwave receiver that's capable of tuning single-sideband signals. It should have a control marked LSB (lower sideband) and USB (upper sideband). If your receiver doesn't, and some of the less costly portables don't, sorry, E.C.S.S. isn't for you.

Assume that you are tuning an SW signal on 6,150 kHz, when another station fires up on an adjacent frequency. It isn't a powerhouse signal, but it's bad enough to spoil reception on 6,150 kHz. Some receivers have a narrow-wide bandwidth option. You try the narrow setting, but still the interference is bothersome. What do you do? I'll let Bennett explain:

"Switch to LSB. You'll then hear a 'howl,' which is, in fact, a heterodyne or beat-frequency note. Fine tune your receiver until this note decreases in pitch and effectively disappears—'zero beat!' The signal now sounds normal again to all intents. With any luck, you'll now find that the previous interference is minimal, or may even have disappeared completely. If not, try the USB setting instead, making sure that you've still got 'zero beat;' that is, the heterodyne howl is fine-tuned out. Now, hopefully, the interference is minimized."

E.C.S.S. isn't always the solution. Sometimes the interference is just too strong or it's on the tuned station's identical frequency. But, as Bennett notes, "In general, though, the technique works very well and some of us have been using it for many years. I'm really astonished," he concludes, "as to how little use in general is made of this powerful DX'ing technique."

DX'ING DOWN UNDER

Looking for Australia, New Zealand, the Pacific islands? Radio Australia is on the air, in English and eight other Asian and Pacific languages, around the clock. Its shortwave transmitters are located at Carnarvon, Western Australia; Darwin, Northern Territory; Brandon, Queensland; and Shepparton, Victoria. Try 17,795 or 21,740 kHz at 220 to 0600 UTC or 9,580 and 11,800 kHz from 0800 to 1600 UTC.

Radio New Zealand International focuses on events in that southern-hemisphere country and on the island nations of the Pacific. While some of its programs are produced especially for international listeners, much of the schedule is simply relayed from the New Zealand home-service broadcasts. Listen in on 15,120 kHz from 0230 to 0700 UTC, and on 9,700 kHz from 0700 until 1200 UTC.

In the good news and bad news department, one Pacific-island SW outlet, *Radio Vanuatu*, is reported to be back on the air on both 3,945 and 7,260 kHz at various times between about 0700 and 1000 UTC. But *Radio Cook Islands'* shortwave transmitter, which was destroyed in a 1992 fire at the station, probably will not return to the air, at least not in the foreseeable future.

KEEPING IT SIMPLE

In several *DX Listening* columns last fall, readers told about the fun they have SWL'ing with unsophisticated and, even, home-built radio receivers. That seems to have touched a nerve with a number of others who also have written with comments about this sort of shortwave listening.

Here, for instance, is what Peter Ingles of Palmerton, PA, says: "My 4-year-old son, Ian enjoys tuning in stations on the three-transistor regenerative receiver that I recently put together. How much more interesting this is to him than turning a dial on a plastic cabinet. He shares my fascination with the actual electronics involved in capturing radio waves and turning them into sound.

"I get more enjoyment out of this simple circuit than the more advanced receivers I've owned. The magic of shortwave listening is never more evident than when you listen to a foreign broadcast from thousands of miles away on a simple receiver like this one."

Thanks for the testimonial, Pete.

But Jack Costello of St. Augustine, FL, is looking for something more sophisticated in the way of a receiver. "I'm looking for an inexpensive way to get started listening to SW stations, but I don't have a lot to spend. On the other hand, I want a receiver that offers more features than do the cheap multi-band portables I've seen in discount stores. What about used communications receivers. I'd be happy with an oldie, but goodie?"

For many SWL's in your situation, Jack, a good used older model shortwave receiver, indeed, is an excellent choice. But where do you find them? How do you know what to buy and how much to pay? For answers to questions like those, I recommend a useful little book by Fred Osterman called "Buying a Used Shortwave Receiver."

Fred tells you where to look for used SW receivers and what you're likely to come across. He offers ratings on the different models and a price guideline. That 20-page book is available for $3.95, plus $1 postage, from Universal Radio Inc. (6830 Americana Parkway, Reynoldsburg, OH 43068).

*Credits: Brian Alexander, PA; Jerry Berg, MA; Richard Cuff, PA; Harold Frodge, MI; Dwight Keen, MO; Fred Kohlbrenner, PA; Marie Lamb, NY; Ed Newbury, NE; Tony Orr, VA; North American SW Association, 45 Wildflower Road, Levittown PA 19057; World DX Club, c/o 2216 Burkey Drive, Wyomissing, PA.

UTILITY STATIONS

Greg Pruitt, Alpharetta, GA, offers the frequencies of some stations he has heard:

"In Alaska, there's Barrow DEW (Distant Early Warning) radar station on 2,866 and 5,631 kHz. The NOAA Hurricane-Hunter aircraft use 3,407, 5,562, 6,673, 8,876 10,015, 13,354, 17,901 and 21,937 kHz."

Thanks, Greg. Those are two-way, usually, communications transmissions, not the program-broadcasting SW services we usually cover in this column. There are many such stations operating on shortwave, military, maritime, and other bands. In SWL parlance, they are usually referred to as utility stations.

Greg also has a question. "What's the frequency for Somalia?" Needless to say, the broadcasting situation in Somalia at this time continues to be highly unstable. I can't promise that this is still accurate, but the last word I have is that *Radio Mogadishu* transmits on either 6,722 or 6,822 kHz at around 0445 UTC. United Nations-sponsored *Radio Manta* is said to use 9,540 kHz at around 1100 UTC, but is deliberately interfered with by a clandestine *Codka Shacabka Somaaliyeed*, or Voice of the Somali Masses.

Programming surely would be in local languages, not English, and those stations probably would not be easily heard in North America.

DOWN THE DIAL

Here's what others are hearing on shortwave lately. As usual, all times are in UTC, or Universal Coordinated Time, which is equivalent to EST plus 5 hours, CST + 6, MST + 7 and PST + 8.

BOTSWANA—7,415 kHz. The *Voice of America's* relay in southern Africa uses this frequency from 1900 to 2200 UTC, and again from 0430 UTC.

BULGARIA—11,720 kHz. *Radio Bulgaria* is a tough catch during its 0000 and 0300 UTC transmissions due to interference and under modulation. But it is better at 2145 to 2230 UTC.

CROATIA—5,920 kHz. *Hrvatska Radio Zagreb* has been noted from 0145 until after 0330 UTC in Croatian, with popular music programming.

LITHUANIA—11,750 kHz. *Radio Vilnius* is heard in English weekdays at 2300 UTC, but the weekend programs at this time are in Lithuanian.

KUWAIT—13,620 kHz. *Radio Kuwait's* English programming, with commentary, news, features, and music, has been noted on this frequency from around 2030 UTC.

SURINAM—4,990 kHz. *Radio Apintie* is not regularly heard, but it has been logged with pop music and Dutch announcements by several east-coast U.S. DX'ers at around 0115 UTC.

TAHITI—15,168 kHz. *RFO* in Papeete broadcasts in French and Tahitian languages with both island melodies and U.S. popular music, and has been heard from about 0250 UTC. ■

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ALL MAJOR BRANDS

COD

By Joseph J. Carr, K4IPV

Operating in the Low Bands

The 75/80-meter, "kilowatt alley," and the 160-meter bands (those below 4,000 kHz) are full of extremely strong signals that can overload receiver front-ends and show up as poor-selectivity problems. The 160-meter band also suffers from its proximity to the AM-broadcast band. At one time, the AM BCB was 540 to 1600 kHz, but recently the upper end of the AM BCB was extended to 1,700 kHz . . . making it even more likely to interfere with 160-meter, ham-band receivers.

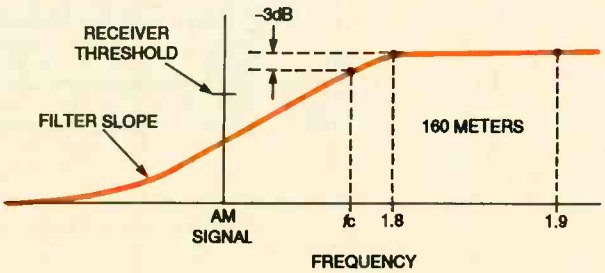


Fig. 1. An "ideal" high-pass filter would cut-off abruptly at the band edge, with no energy coming in at out-of-band frequencies. Unfortunately, receiver front-ends rarely contain high-quality high-pass filters; thus, their response curves exhibit some degree of sloping.

Further many otherwise fine modern ham/SWL receivers do not use tuned front-ends, but instead used LC band-pass filters for each band. The quality of such filters can vary widely, and while poor selectivity might not even be noticed on some bands, on busy bands (such as 75/80 meters), it becomes immediately apparent what sloppy filters will do to a receiver's performance!

Lets turn our attention to a typical 160-meter band-pass filter. As you can see from Fig. 1, its band-pass resembles that of a high-pass filter. Of course, an "ideal" high-pass filter would cut off abruptly at the band edge, with no energy coming in at out-of-band frequencies. The real situation is illustrated in Fig. 1. The filter will be relatively flat above the cut-off frequency (f_c), although real filters always have some ripple in the passband.

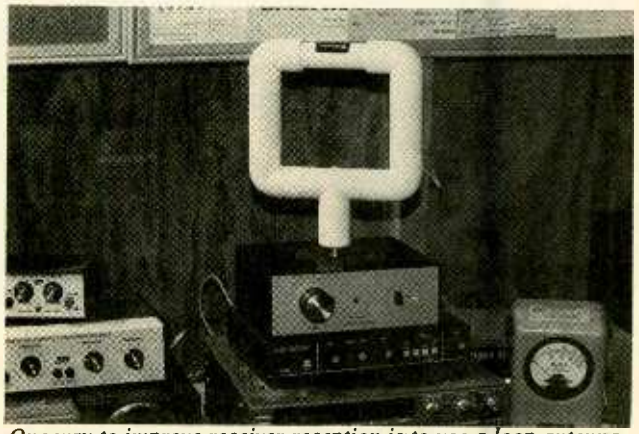
Below the cut-off frequency, the response doesn't drop off suddenly, but rather the drop-off has a certain slope. The quality of the filter (illustrated by the sharpness of the drop-off or slope) is a measure of how well the filter does its job; no filter is perfect, and the slope is a principal determinant. The LC filters in receiver front-ends are often a bit sloppy as filters go, especially those installed in some lower-price receivers.

If you are tuned to 160-meters (see Fig. 1) and there is a strong AM broadcast signal close enough to the high end of the band, and the signal is above the receiver's threshold of detection, it will interfere with the operation of the receiver. Receiver interference may or may not be audible, depending on the situation. In some cases, the interference desensitizes the receiver. For some strange reason in those cases you simply can't hear anything but the strongest in-band signals. In most cases, however, at least some audible interference will accompany weak signal levels.

ONE SOLUTION

There are three solutions to that type of problem. You can use either a sharp cut-off high-pass filter or wave-trap in front of the receiver. Either circuit will severely attenuate out-of-band signals, while adding only some attenuation to in-band signals.

High-pass filters are especially useful if the offending AM station is a couple hundred kilohertz away from the top end of the band. The wavetrap, on the other hand, is a resonant filter that is tuned to the offending signal frequency and is designed to reject that signal. A parallel-resonant LC circuit placed in series with the antenna line or a series-resonant LC



One way to improve receiver reception is to use a loop antenna, such as the square-loop unit from Palomar Engineers.

filter across the antenna line is the way to go.

Suitable filter designs have been published in this column in the past. Or, if you wish to design your own, consult any recent copy of *The ARRL Handbook for Radio Amateurs*. The book gives simple design procedures that turn complex filter arithmetic (and a lot of guessing) into a process that is within the grasp of anyone who can divide two numbers using a handheld calculator.

ANOTHER SOLUTION

Another solution is to buy or build a preselector (see "Receiver Preamplifiers That You Can Build" in the June 1993 issue) for your receiver. Several manufacturers offer ready-built preselectors. Check the MFJ Enterprises (P.O. Box 494, Mississippi State, MS, 39762; Tel. 800-647-1800) catalog; they sell several models, as does Palomar Engineers (P.O. Box 462222, Escondido, CA 92046; Tel. 619-747-3343).

The preselector provides additional front-end selectivity at the frequency of interest, and also rejects the AM-BCB or the other ham-band signals in kilowatt alley. While it cannot do much for nearby, adjacent-channel interference, it works wonders for a guy down the band . . . unless he's on the next block (my situation, unfortunately).

Another solution (one that is related to using a preselector) is to use an antenna tuner. I maintain that HF hams ought to use antenna tuners in any event, especially those tuners that suppress harmonics (some "line flatteners" are actually tunable high-pass filters). Again, several sources of such equipment (including MFJ) offer suitable models.

SOLUTION THREE

The third solution is to use a loop antenna. Palomar Engineers makes loop antennas and base preamplifiers. The antennas are used to null out the offending station, while either not attenuating the desired station or only attenuating it somewhat. Judicious positioning of the loop nulls can provide a tremendous improvement to the signal-to-noise ratio, which vastly improves reception.

People who want to build their own loop antennas might want to take a look at the loops chapter of my book, *Joe Carr's Receiving Antenna Handbook* (High-Text Publications, 125 N. Acacia Avenue, Suite #110, Solana Beach, CA 92075; phone orders from Independent Publishers Group, at 800-888-4741). The chapter on loops has been called "the best available..." by one reviewer.

Note that the solutions presented in this column require the use of a second antenna; *i.e.*, one for reception only. That idea is an old one, and one whose time has returned. Some modern transceivers even sport a second coaxial connector for a receive-only antenna. When the controls are set properly, the receiver-antenna jack is connected to the receiver circuitry (otherwise, the same antenna is used for both transmit and receive). The patterns of the two antennas need not match, and indeed it might be in the lack of a match that the greatest improvement is found.

You can use the main lobe of the transmitting antenna to squirt signal in the desired direction, while the null of the receiver antenna is used to squash unwanted signals. The use of antenna patterns for interference control even works on the higher bands, even though loops are only occasionally used above 40 meters. The directional-beam antenna can often be positioned to null unwanted co-channel and adjacent-channel signals, while placing the main lobe in the direction of interest. Even if the direction of interest doesn't exactly coincide with the main lobe when the null is in the interfering direction, the signal levels at the receiver site will be sufficient for a 5-by-9 QSO.

Palomar Engineers also sells a rod-loop antenna that can go a long way toward improving reception.

Some receivers are equipped with front-end attenuators that can be switched in or out of the circuit at will. One model I saw had −6- and −12-dB attenuators, which when used together will also produce −20 dB of attenuation. They can sometimes be used to reduce the effects of off-channel interference (although their main use is in attenuating the desired signal when it is bone-crushingly strong).

If the undesired signal pushes the receiver into non-linearity, or desensitization, then attenuating the incoming signals is sometimes enough to back the RF amplifiers out of the saturated condition. You will lose some of the strength of the desired signal, but without the attenuator it would be unreceivable due to the receiver being cut-off (sigh). I think that the stories of how well attenuators work in this respect are a little overstated by their advocates, but that they work in some cases is undeniable.

SID OBSERVERS

Last month, I mentioned solar observers who use radio to spot sudden ionospheric disturbances (SID's) by noting their effect on HF or VLF reception. That is a topic of interest to me . . . so much so that I've modified the most popular VLF SID-receiver design and developed a printed-circuit board for it. I would be interested in hearing from people who are engaged in that or related activities. Contact me at P.O. Box 1099, Falls Church, VA, 22041. ■

"I'm trying to tell Herb that he won our 'Communicator of the Year' award, but I can't raise him."

SCANNER SCENE

By Marc Saxon

High-Level Handles

Radio Shack's new Realistic PRO-37 handheld scanner has much to be said for it, including a 200-channel memory formatted in ten 20-channel storage banks, plus an extra ten "monitor" channels. Its frequency coverage is substantial, and includes the 30–54 MHz, 137–174 MHz, 380–512 MHz, and the 860–960-MHz bands (with the two cellular bands blocked. There is also coverage of the 108–137-MHz VHF aeronautics band.

The PRO-37 from Radio Shack offers 200-channel memory and extra-quick "Hyperscanning."

Features? You bet! We particularly liked "Hyperscan," which lets you scan at a fast rate of 25 channels-per-second and search at 50 channels-per-second. If you want to examine the channels more slowly, you can temporarily override the Hyperscan feature and scan or search at a leisurely 8 channels per second.

The scanner's circuit was designed with 10.7 MHz and 455 kHz IF frequencies, and it has both a crystal and a ceramic filter to heighten its selectivity. Selectivity is rated at ±10 kHz (−6 dB), ±20 kHz (−50 dB). Sensitivity is rated at 1.0 μV on all bands except VHF aeronautics and 800 MHz, where it is 2.0 μV. The unit operates on six "AA" batteries or from an AC or DC adapter. It has a built-in memory backup.

You can find the PRO-37 at any of Radio Shacks 7000 retail stores.

THE EAGLE HAS LANDED

The latest update on monitoring the loftier levels of government: President Clinton's Secret Service code name is presently "Eagle," while Hillary Rodham Clinton's is "Evergreen." "Sawhorse" is Vice President Al Gore, while "Skylark" is the code name for Tipper Gore. "Finley" turns out to be Les Aspin, while "Foxtail" is none other than Warren Christopher. First Brother Roger Clinton is code named "Headache."

In actuality, the Secret Service is permitted to refer to "the President," instead of using his code name.

According to the current (8th) edition of *Top Secret Registry of U.S. Government Radio Frequencies*, some good bets for monitoring those communications include 164.65, 165.2125, 165.375, and 165.7875. Dozens of additional frequencies used for those communications are also provided in the book.

FROM THE READERS

Max Lopez of North Hollywood, California, noted that we suggested monitoring for distant stations in the 30–50-MHz "low band." He wrote to say that he has logged numerous stations and to ask if we can tell him the location of a station that he heard early one evening on 43.54 MHz. The station was sending data transmissions, but had an automatic CW identification that gave its call sign as KPD992.

That call sign belongs to Telecom Systems, Inc., which is authorized to use it on 43.54 MHz from numerous sites, primarily in Oregon. Based upon the frequency and the type of signals he described, Max evidently heard radio paging transmissions.

A reader from Texas, who requested anonymity, reported having spent several months in Russia. We weren't given the reason for the visit, but we were given two interesting frequencies used in Russia: 132.60 MHz is used by the Russian Air Force, while 460.01 MHz is used by the Russian Army.

Frank, from Baltimore, Maryland, has monitored military helicopters working with local police while looking for marijuana farms on 122.75 MHz. Police surveillance in Baltimore has been monitored on 453.25 and 460.925 MHz. Baltimore-area Postal Inspectors were monitored on 410.00, 410.025, and 414.975 MHz.

AN ATTRACTIVE SOLUTION

We continually hear from readers who complain that, for whatever reason, they can't place a scanner antenna on their roof. Maybe there's no easy roof access, or there are building restrictions against rooftop antennas. Yet the built-in telescoping whip that came with their desktop scanner doesn't seem to be doing the job.

One approach that often improves reception is to use an all-band, magnetic-mount scanner antenna such as those intended for mobile use (Radio Shack catalog no. 20-012 or its equivalent). Straightaway, this is more of an antenna than the puny telescoping whips that usually come with desktop scanners. The magnetic mount then can be placed at a location of your choice, such as the top of a refrigerator, radiator, duct, or metal locker or cabinet. At that point, the object to which the antenna is affixed becomes a part of your antenna system, further increasing the effectiveness of the antenna. Be sure to keep the antenna vertical and mounted with the magnetic-base end at the bottom.

Going further, if you have a window-mounted air conditioner, consider reaching out and mounting the antenna atop the metal case of the unit. That will give you an outside antenna, and will certainly improve reception if you are in a steel-frame structure, such as a high-rise apartment house or office building.

Another signal-improvement aid would be a preamplifier, a received-signal booster that will strengthen incoming signals by as much as a whopping 20 dB. There are several on the market. We have long used the popular GRE SuperAmplifier scanner preamp to increase the performance of our rooftop antenna, and have had excellent results between 100 and 1000 MHz.

CLUB ADDRESSES

For those who suggest that we periodically list some worthwhile scanner newsletters and organizations, here are three fine choices (listed in alphabetic order):

- *North-East Scanning News*, P.O. Box 62, Gibbstown, NJ 08027;
- *Radio Communications Monitoring Association*, P.O. Box 542, Silverado, CA 92672; and
- *Radio Monitors Newsletter of Maryland*, P.O. Box 394, Hampstead, MD 21074.

Check directly with each one to request their prevailing rates. Please enclose a self-addressed, stamped envelope, as a courtesy, for their reply.

HAPPY NEW YEAR

Here's wishing you a happy 1994, and the hope that you will monitor everything you want to hear on your scanner this year! Let us know what you're hearing, and pass along your questions, comments, frequencies, and anything concerning scanners to *Scanner Scene*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■

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POWER SUPPLY

(Continued from page 17)

volt AC outlet at 50 or 60 hertz. The unit consumes a healthy 400 watts. But despite that brawn, the 1686 still has a small footprint. It measures 5½-inches tall, 5⅞-inches wide, and 12-inches front-to-back. That ought to tuck away nicely on your workbench. The unit *is* heavy, though, weighing in at slightly over 12 pounds.

On The Surface. As you might have imagined, a switch on the front panel turns the unit on and off, and a pilot light above the switch lets you know when the supply is on. Another light indicates an overload condition. A voltage-control knob lets you adjust the output voltage as indicated on the front-panel voltmeter.

The main output is provided by two banana-type screw terminals, and this is where the real current comes from. The unit also has two other tie-point outputs that can provide a maximum of 2 amps apiece. Of course all three outputs are always at the same voltage, and all three combined cannot provide more than 12 amps continuous.

The maximum current output is based on the output-voltage setting. At 3 volts, the unit can output a maximum of 3 amps. At 5 volts, the maximum is 5 amps—that's an awful lot of logic circuits! The maximum output current increases with the voltage setting up to the continuous rating of 12 amps at 13.8 volts. The unit can supply slightly more current, though not for extended periods of time.

Conclusion. The B+K Precision Model 1686 power supply comes with an instruction manual and a spare fuse. The instruction manual includes information on how to calibrate the unit, so it will always be inexpensive and easy to maintain. More importantly, it's got the power! We wish we had one of these power supplies years ago, because it would have come in handy several times since then. If you think you might feel the same way, contact the company directly at the address that was given earlier or circle No. 119 on the Free Information card, which can be found on page 127. ■

HUMIDITY GAUGE

(Continued from page 66)

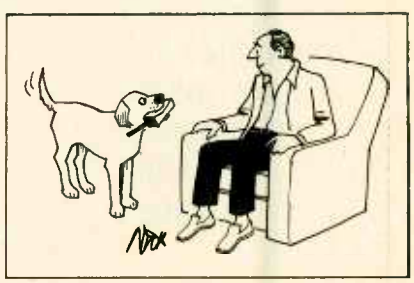
ride (table salt) is chosen for the solution, the calibration is performed by adjusting R7 for a reading of 75% RH.

If a two-point calibration is desired, choose a salt from Table 1 that represents a low value of relative humidity. Then repeat the above procedure, this time adjusting R4 to reflect the correct reading. That completes the calibration procedure.

Once the circuit has been calibrated, remove the temporary wires from the board and install SENS1. Be sure to observe correct orientation. Note: the humidity sensor is somewhat light sensitive, therefore it must be shielded from light while in use. That is automatically taken care of if an enclosure is used to house the instrument. A small opening can be mace in the housing to allow the instrument to respond faster to changing humidity levels.

Use. Relative-humidity measurements can be made at any time by applying power to the circuit. A reading will be produced in less than a second. The use of a spring-loaded power switch for battery operated units ensures long battery life. Should the battery become exhausted, the display reading will become erratic. For the best results, it is recommended that a fresh alkaline battery be installed once a year.

The Digital Relative-Humidity Gauge is designed primarily for indoor use where the temperature is relatively constant, and assumes an ambient temperature of 75°F. However, it can also be used outdoors, and at lower and higher temperatures. For variations in ambient operating temperatures, refer to Table 2; that table gives correction factors that can be added to the relative-humidity reading. ■



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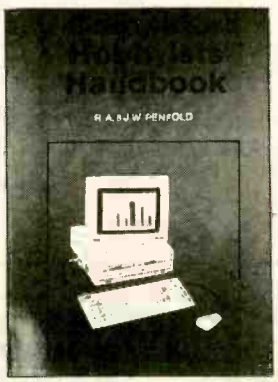

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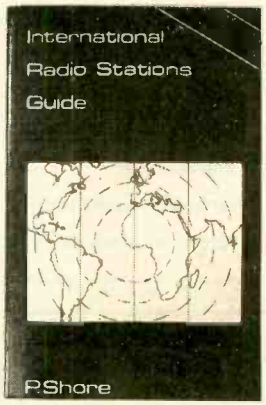

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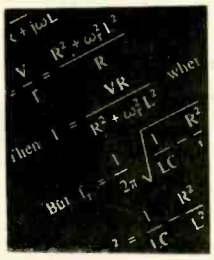

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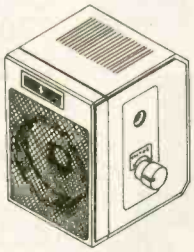

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66	0.033	DRB-66
65	0.035	DRB-65
63	0.037	DRB-63
61	0.039	DRB-61
59	0.041	DRB-59
58	0.043	DRB-58
57	0.045	DRB-57
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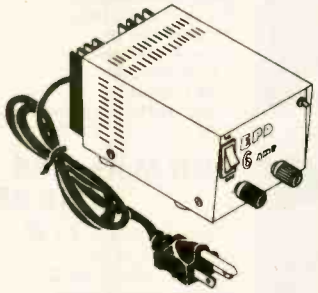
13.8 Vdc @ 6 amps POWER SUPPLY



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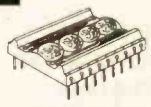
4 Digit Alphanumeric Intelligent Display

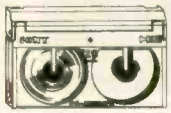


Siemens # DL-2416T. End-stackable, four digit display module with built-in CMOS memory decoder/driver. High contrast, 0.160"high magnified red characters. Direct access to each digit independently and asynchronously. ASCII format. 5 volt logic, TTL compatible. Module size: 1" X 0.8" X 0.25" Includes specs and instructions.

CAT# DL-2416T **$4.95** each

(USED) "HI-8" VIDEO CASSETTE

8 mm Video Camcorder Users!



We have a new supply of these popular T-120 (120 minute) Hi-8 video cassettes. These are top quality, metal oxide cassettes that were used for a short time, then bulk-erased. Each cassette has its own plastic storage box. New, they would sell for considerably more than we're asking.

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AC Load: 300 ma., 20-280 Vac
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The DC input can be any voltage as long as the current is maintained between 5 and 25ma. Use a dropping resistor to do this. LARGE QUANTITIES AVAILABLE.

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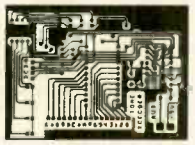

Prototypers, developers and hobbyists can now make PC boards direct from CAD, PCB layout systems or magazines using a photocopier, or laser printer. Techniks Inc's new "Press-n-Peel" copy paper allows you to photocopy PC artwork and iron it onto copper-clad board. It can then be chemically etched in the usual fashion. The process is so easy and fast you won't believe it.

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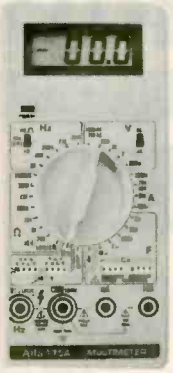

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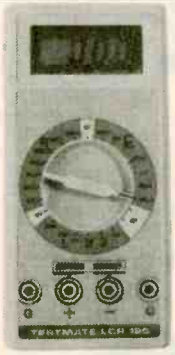

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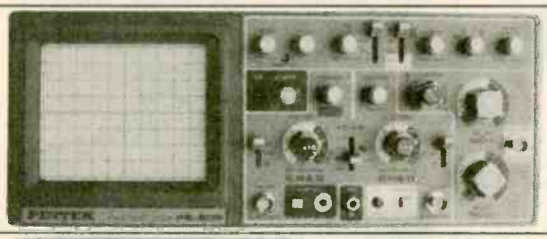

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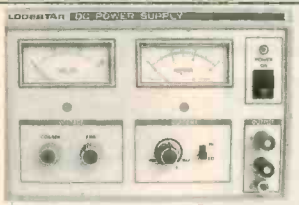

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Output Impedance: 600 ohm

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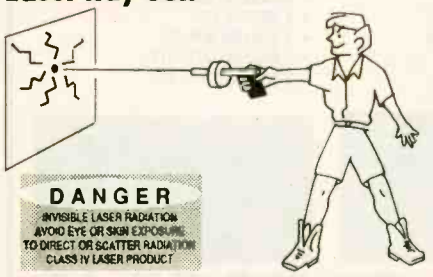

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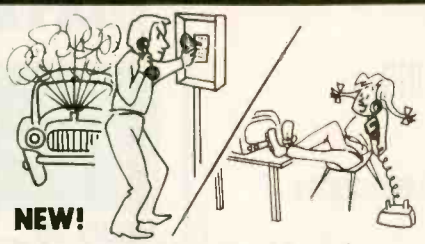

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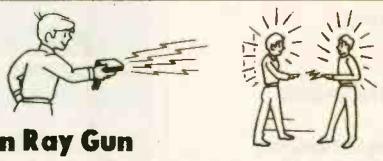

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Projects charged ions that induce shocks in people and objects without any connection! Great science project as well as a high tech party prank. IOG3 Plans $8.00
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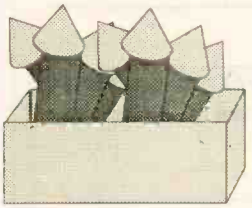

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JERROLD	1-3	4 or more
NEW TRIVBI COMBO (FTB)	130.00	125.00
NEW TRIVBI PAN	75.00	60.00
NEW SB-3 COMBO	115.00	110.00
NEW SB-3 PAN	60.00	55.00
DPV-7212	CALL	MIKE
DPB8-7212	CALL	MIKE
CAMOUFLAGE TRIMODE	85.00	79.00
NEW FTB-2	75.00	60.00
NEW SB-2	60.00	55.00
HAMLIN	1-3	4 or more
NEW HAMLIN COMBO(CH 2 OR 3)	110.00	105.00
NEW HAMLIN MLD-1200	50.00	45.00
MLD-1200-2	50.00	45.00

Price effective 1/1/93 (Subject to change without notice)

PIONEER	1-3	4 or more
*NEW SA-PIO-COMBO	155.00	150.00
NEW SA-PIO-PAN W/SWITCH	80.00	75.00
NEW ORIG. BA-6100 PAN	CALL	MIKE
SCIENTIFIC ATLANTA	1-3	4 or more
*NEW SA-3 COMBO (SA-3B)	130.00	125.00
NEW SA-3 PAN	75.00	60.00
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8580:	250.00	CALL
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NEW OAK N-12 COMBO(Vari Sync)	130.00	125.00
NEW OAK N-12 PAN(Vari Sync)	75.00	60.00
M-35-8	50.00	45.00
PANASONIC-VIEWSTAR	20 LOT	100 LOT
	75.00	CALL
ZENITH: Z-TAK	220.00	CALL
NOTCH FILTERS	16.00	12.00

* All Combos come with new Panasonic or Viewstar converter.

(Parental lockout units: No extra charge.)

Volume control units available

MOST ORDERS SHIPPED SAME DAY!

QTY.	ITEM	PRICE EA.	TOTAL PRICE

SUB TOTAL

SHIPPING Add $4.00 per unit

$4.50 PER COD TAG/CREDIT CARDS Add 5%

TOTAL

(WAIVER) - MUST BE SIGNED FOR OUR RECORD

☐ Yes, I am paying for full service. This is only to be used as a second unit.

DECLARATION OF AUTHORIZED USE - I, the undersigned, do hereby declare, under penalties of perjury, that all products purchased, now and in the future, will only be used on cable TV systems with proper authorization from local officials or cable company officials in accordance with all applicable federal and state laws. FEDERAL AND VARIOUS STATE LAWS PROVIDE FOR SUBSTANTIAL CRIMINAL AND CIVIL PENALTIES FOR UNAUTHORIZED USE.

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CASHIER'S CHECK ☐ MONEY ORDER ☐

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SIGNATURE

X_____

It is not the intent of MOVIE VIEW to defraud any television operator and we will not assist any company or individual in doing the same.

Card #_____ Exp. Date_____

Name_____

Address_____

City_____ State_____ Zip_____

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If for any reason you are not satisfied with any item purchased, you may return it within 30 days of delivery for a full refund.

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MODEL 30 ..... $79.00

- PLUGS INTO PC BUSS
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- 8 CHANNEL-8 BIT A/D IN
- 12 BIT COUNTER
- UP TO 14K SMP/SEC

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- RS-232 INTERFACE
- 8 DIGITAL I/O
- 8 ANALOG INPUTS
- 2 ANALOG OUTPUTS
- 2 COUNTERS-24 BIT

MODEL 70 ..... $239

- RS-232 INTERFACE
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- UP TO 60 SMP/SEC

MODEL 150-02 .. $179

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In a SMALLER package

- 1 MHz - 2.8GHz Frequency Range
- Direct Count Range From 1MHz to 250MHz with 1Hz/Sec high resolution display.
- Prescaled Range from 10MHz to 2.8GHz for virtually all two way communications
- Select up to 6 Gate/Measurement Periods
- 10MHz Industry Standard Time Base
- Ultra Compact – true pocket size
- Maximized sensitivity for picking up radio transmissions from the greatest distance
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The New Model 3300 MiniCounter breaks the LED counter tradition. From our first Model FC50 (1976) to our latest Model 2300, we have always had quality LED counters. But LEDs are power hungry, failure prone and unreadable in sun light. So the LED counter has now gone the way of the LED wristwatch—replaced by LCD. The LCD advantages include lower power, better reliability, smaller package, more information displayed and better viewing characteristics.

ACTUAL SIZE!
(Actual Size Hand!)

Introductory Price
$129.00
MADE IN THE USA

Model M1 & 3000A Hottest on the Market with:
Digital Filtering for the fastest method to reduce false counts–no loss of sensitivity & **Digital Auto Capture** that auto holds and stores – working even near strong RF fields!

- **3000A-Multifunction HandiCounter®**
  - 15 gate times selectable • 7 hrs. Batt. life
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Both offer:
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- 16 Segment Signal Strength Bargraph
- 3 Data Storage Registers
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3000A .....$329.
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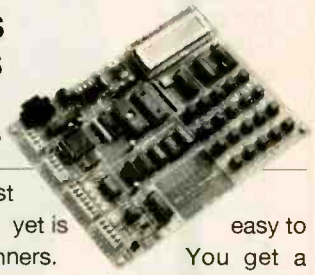
Learn COMPUTERS MICROPROCESSORS AND PROGRAMMING with the AES-10 trainer



This microboard has the most advanced features available, yet is easy to use and understand by beginners. You get a learning system that is also a fully functioning embedded industrial controller with 20 key input - 2 line liquid crystal display - Intel 8052 PLCC microprocessor - 64K bytes of memory - digital and analog inputs and outputs - built in logic probe - battery or 9v converter powered - and two RS232 ports. The AES - 10 operates as a stand-alone system, or connect it to your PC for high-level-language programming. Learn by doing. Machine language-Assembly language-Full Basic. Clear texts give details about how the microcontroller/computer works. Shown in easy to follow style; hex and binary numbers, digital and analog electronics, and the three levels of programming. Fully built.

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.47	35	.12 ea.
1.0	35	.18 ea.
2.2	35	.17 ea.
3.3	20	.17 ea.
4.7	35	.24 ea.
6.8	35	.38 ea.
10	16	.28 ea.
10	25	.35 ea.
10	35	.45 ea.
15	16	.25 ea.
22	10	.20 ea.
22	16	.32 ea.
22	25	.45 ea.
33	16	.30 ea.
47	10	.38 ea.
68	6.3	.50 ea.
82	6.3	.50 ea.
100	6.3/10	.75 ea.
150	6.3	1.50 ea.

Minimum 10 Pieces Per Type

Nichicon - Snap-In Lytic

220MFD 160VDC
(22x30mm)**$.60ea**
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All Colors - All Sizes

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Contains
Half - Single - Dual Digit Units
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25 pc. asst **$9.95**

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(Variable Transformer)

Input: 120VAC/60Hz
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Dial Plate Not Included
$19.95 each

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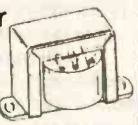
Power X'fmer



General Purpose
American Mfgr.
Primary: 115V 60Hz
Secondary:
#1 5VAC @ 4.0 Amp
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3-1/2" Mounting Centers
2-1/2" H x 3" L x 1" W
Special $5.75ea

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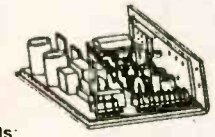
230 Watt Cherokee Switching Power Supply



Outputs:
+5V @ 8 Amp, +12V @ 2 Amp
-12V @ 1.5 Amp, 25.5V @ 3Amp
+18V @ .2 Amp, -18V @ .2 Amp
Size: L 9.5" x W 4.5" x H 1.75"
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486 SUPER COOLER FAN SYSTEM

Snap on mount — no tools required!
Spring loaded heat sink —
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Powerful 5500 RPM 12 VDC Fan
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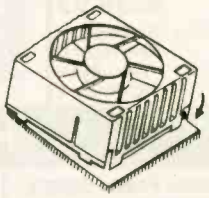

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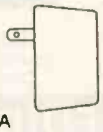
PLUG-IN WALL TRANSFORMERS



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* Table Top Model/2 Secondaries

LED's

Standard Jumbo 5MM or 3MM

Red	$.06 ea.	20 piece
Yellow	$.07 ea.	minimum
Green	$.07 ea.	per item

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Kester 60/40
Rosin Core Solder
1 lb. Rolls
$5.99 each

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24 VDC	4.7"	$3.75	$35.00
12 VDC	3.5"	$4.25	$40.00
24 VDC	3.5"	$3.75	$32.00
12 VDC	2.25"	$4.25	$40.00
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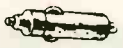
Standard 12V Auto Lighter Adapters

18/2 Cable
4' Long
Stripped/Tinned

$1.20 each 10 Lot/$1.00 each

With 4 Amp Fuse
No Case



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PVC, Made In USA
$.75 per roll

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3.579545	MHz
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Assembled $75
Kit $49.95

2 to 15V @ 1A,
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(or 4 to 30V @ 1A)
and 5V @ 3A
Made in USA by Elenco
All the desired features for doing experiments.
Features short circuit protection, all supplies.

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$28.95
Provides sine, triangle, square wave from 1Hz to 1MHz
Kit $26.95 AM or FM capability

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Finest in the industry
10 rock steady patterns
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RF Freq 100K-450MHz AM Modulation of 1KHz Variable RF output
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Robotic Arm Kit

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Learn to Build and Program Computers with this kit

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Ideal School Project
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Measures Frequency, Period, Totalizer
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.5ppm Accuracy

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A complete mini-lab for building, testing, prototyping analog and digital circuits
Elenco's Digital/Analog Trainer is specially designed for school projects, with 5 built-in power supplies. Includes a function generator with continously variable, sine, triangular, square wave forms. All power supplies are regulated and protected against shorts.

$159.95 Assembled $129.95 Kit

Power Supplies
- Variable Power Supply
- +1.25 to 20VDC @ .5 Amp (+1.25 to 15VDC @ 1 Amp)
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- -12VDC @ 1 Amp
- +5VDC @ 1 Amp
- 30VAC Center tapped @ 15VAC at 1 Amp

Analog - Section
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- Frequency adjustable in five ranges from 1 to 100KHz
- Fine frequency adjust
- Amplitude adjust
- DC offset
- Modulation FM-AM

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- Two no bounce logic switches
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- 2 breadboards, each contain: 840 tie points (total 1,680)

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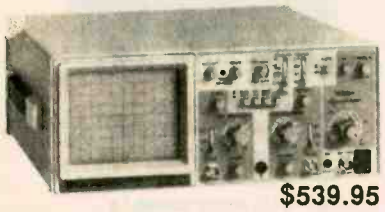

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20MHz $389 **Model 2125**
2 Channel **Delayed Sweep**

40MHz DUAL-TRACE

Model 1541B

- 1mV/div sensitivity
- Video sync separators
- Z axis input
- Single sweep
- V mode-displays two signals unrelated in frequency.

$695.95

60MHz DUAL-TRACE

Model 2160

- 1mV/div sensitivity
- Sweep to 5 ns/div
- Dual time base
- Signal delay line
- V mode-displays two signals unrelated in frequency
- Component tester

$949.95

100MHz THREE-TRACE

Model 2190

- 1mV/division sensitivity
- Sweeps to 2ns/division
- Dual time base
- Calibrated delay time multiplier
- Signal delay line
- 19kV accelerating voltage

$1,395.95

20MHz ANALOG WITH DIGITAL STORAGE

Model 2522A

- 20MHz analog bandwidth
- 20MS/s sampling rate
- 2k memory per channel
- 20MHz equivalent time sampling
- Pre-trigger capture

$875

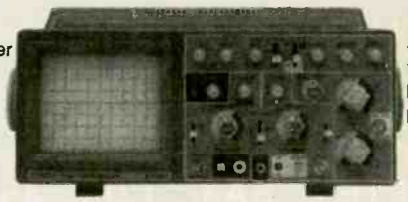
AFFORDABLE - ELENCO OSCILLOSCOPES

2 YEAR WARRANTY

S-1360 Delayed Sweep $775

- Automatic Beam Finder
- Built-in Component Tester
- 1mV Sensitivity
- Dual Time Base
- Illuminated Internal Gradicule
- TV Sync

60MHz Dual Trace



S-1365 Cursor Readout $849

- Voltage, Time, + Frequency differences displayed on CRT thru the use of cursors.
- 1mV Sensitivity
- TV Sync

S-1345 Delayed Sweep $575

- Automatic Beam Finder
- Built-in Component Tester
- 1mV Sensitivity
- Dual Time Base
- Illuminated Internal Gradicule
- TV Sync

40MHz Dual Trace

S-1340 $495

- High luminance 6" CRT
- 1mV Sensitivity
- 12KV Acceleration Voltage
- 9ns Rise Time
- X-Y Operation
- TV Sync

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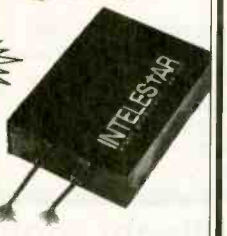

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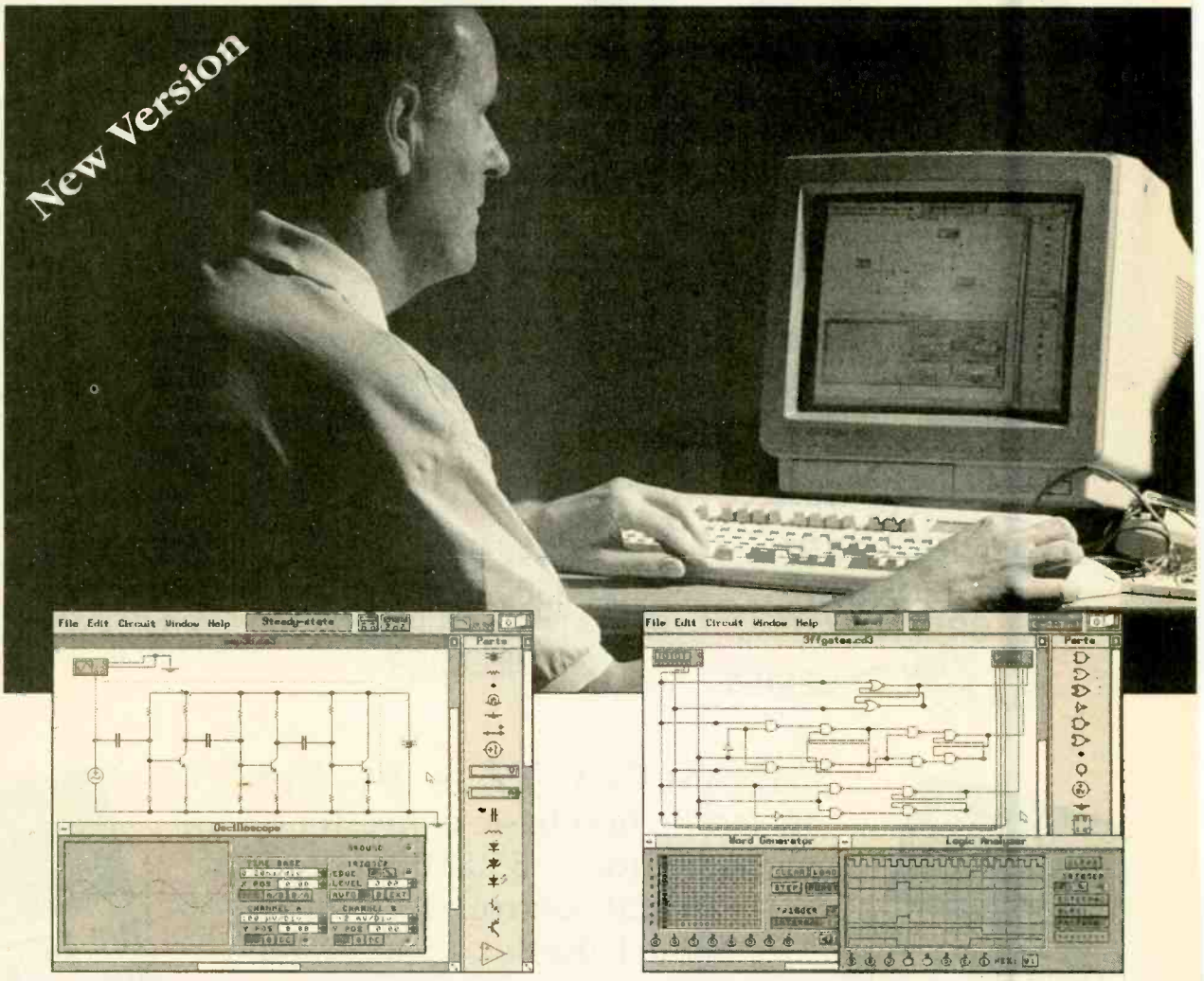

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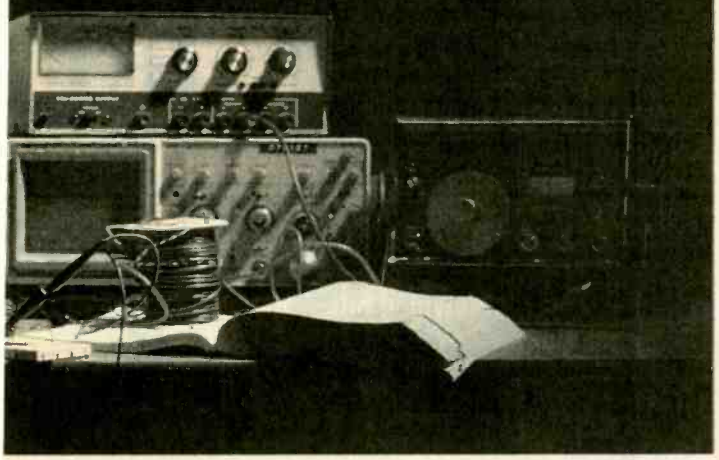

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1991	—	49	—	50	51	52	53	54	55	56	57	58
1992	59	60	61	62	63	64	65	66	67	68	69	70
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Popular Electronics
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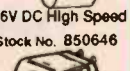

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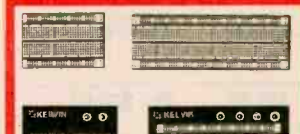

Stock No.	Post	Contacts	YOUR COST
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680097	0	840	$ 5.95
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680100	4	2390	$22.95

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260078	2 COLOR RED/GREEN	$.32 ea	$.29 ea

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We cannot bill for classified ads. Payment in full must accompany your order. We do permit repeat ad or multiple ads in the same issue, but in all cases, full payment must accompany your order.

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The first two words of each ad are set in bold caps at no extra charge. No special positioning, centering, dots, extra space, etc. can be accommodated.

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Our classified ad rate is $1.00per word. Minimum charge is $15.00 per ad per insertion (15 words). Any words that you want set in bold or caps are 20¢ each extra. Bold caps are 40¢ each extra. Indicate bold words by underlining. Words normally written in all caps and accepted abbreviations are not charged as all-caps words. State abbreviations must be Post Office 2-letter abbreviations. A phone number is one word.

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Ads received by our closing date will run in the next issue. For example, ads received by November 15 will appear in the march, 1994 issue that is on sale January 18. The PE Market Center is published monthly. No cancellations permitted after the closing date. No copy changes can be made after we have typeset your ad. NO REFUNDS, advertising credit only. No phone orders.

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Send your ads with payment to:
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CATEGORIES

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160 — Business Opportunities
190 — Cable TV
210 — CB-Scanners
240 — Components
270 — Computer Equipment Wanted
300 — Computer Hardware
330 — Computer Software
360 — Education
390 — FAX
420 — Ham Gear For Sale
450 — Ham Gear Wanted
480 — Miscellaneous Electronics For Sale
510 — Miscellaneous Electronics Wanted
540 — Music & Accessories
570 — Plans-Kits-Schematics
600 — Publications
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660 — Satellite Equipment
690 — Security
710 — Telephone
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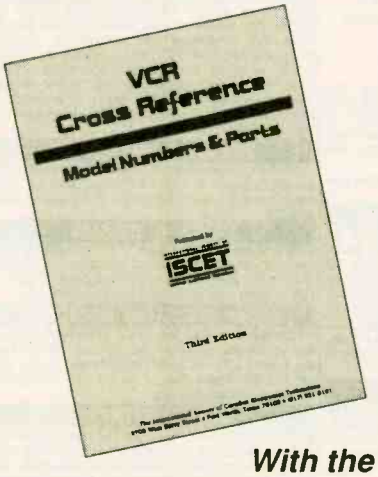

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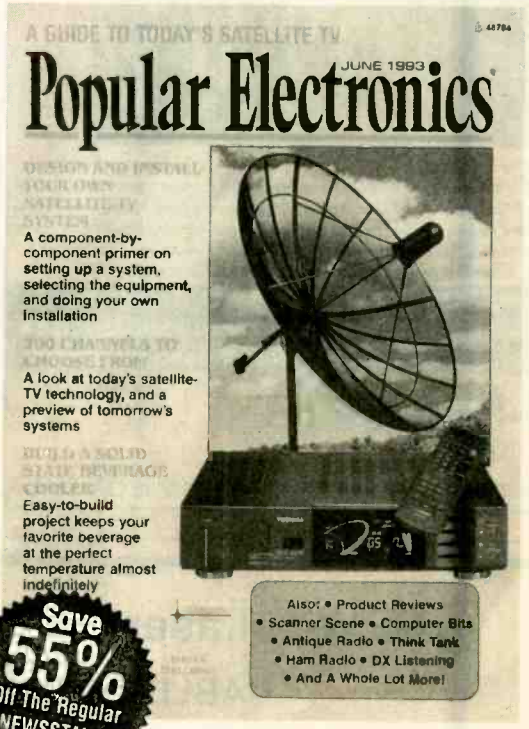

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Non-CFC Cleaners/Degreasers, UV Cured Compounds, Swabs, Wipes, Brushes, Wick, Cleanroom Supplies, and Static Control Products.

They sell through distributors. They belong to the E.I.A. They belong on your vendor list.

Leadership in electronics is not just a matter of designing products better and manufacturing them better, but also of marketing them better. And the sponsors of this message understand that better service to customers *requires* effectively involving distributors as part of their marketing teams.

Distributor involvement means lower prices, quicker deliveries, better service over-all. The Buyer wins. . .the Seller wins.

Distributors help achieve marketing leadership. So does the manufacturer's involvement in the Components Group of the Electronic Industries Association. EIA fosters better industry relations, coherent industry standards, and the sharing of ideas, which helps one another *and* serves customers better.

In choosing your component supplier, look for the marks of leadership —

- availability through distribution
- membership in the E.I.A.

ELECTRONIC INDUSTRIES ASSOCIATION
EIA
EST. 1924

Electronic Industries Association/Components Group
2001 Pennsylvania Avenue, N.W. 11th Floor
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Committed to the competitiveness of the American electronics producer

Countersurveillance

Never before has so much professional information on the art of detecting and eliminating electronic snooping devices—and how to defend against experienced information thieves—been placed in one VHS video. If you are a Fortune 500 CEO, an executive in any hi-tech industry, or a novice seeking entry into an honorable, rewarding field of work in countersurveillance, you must view this video presentation again and again.

Wake up! You may be the victim of stolen words—precious ideas that would have made you very wealthy! Yes, professionals, even rank amateurs, may be listening to your most private conversations.

Wake up! If you are not the victim, then you are surrounded by countless victims who need your help if you know how to discover telephone taps, locate bugs, or "sweep" a room clean.

There is a thriving professional service steeped in high-tech techniques that you can become a part of! But first, you must know and understand Countersurveilance Technology. Your very first insight into this highly rewarding field is made possible by a video VHS presentation that you cannot view on broadcast television, satellite, or cable. It presents an informative program prepared by professionals in the field who know their industry, its techniques, kinks and loopholes. Men who can tell you more in 45 minutes in a straightforward, exclusive talk than was ever attempted before.

Foiling Information Thieves

Discover the targets professional snoopers seek out! The prey are stock brokers, arbitrage firms, manufacturers, high-tech companies, any competitive industry, or even small businnesses in the same community. The valuable information they filch may be marketing strategies, customer lists, product formulas, manufacturing techniques, even advertising plans. Information thieves eavesdrop on court decisions, bidding information, financial data. The list is unlimited in the mind of man—especially if he is a thief!

You know that the Russians secretly installed countless microphones in the concrete work of the American Embassy building in Moscow. They converted

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what was to be an embassy and private residence into the most sophisticated recording studio the world had ever known. The building had to be torn down in order to remove all the bugs.

Stolen Information

The open taps from where the information pours out may be from FAX's, computer communications, telephone calls, and everyday business meetings and lunchtime encounters. Businessmen need counselling on how to eliminate this information drain. Basic telephone use coupled with the user's understanding that someone may be listening or recording vital data and information greatly reduces the opportunity for others to purloin meaningful information.

CLAGGK INC. PE
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Please rush my copy of the Countersurveillance Techniques Video VHS Cassette for a total cost of $53.95 each (which includes $4.00 postage and handling)

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The professional discussions seen on the TV screen in your home reveals how to detect and disable wiretaps, midget radio-frequency transmitters, and other bugs, plus when to use disinformation to confuse the unwanted listener, and the technique of voice scrambling telephone communications. In fact, do you know how to look for a bug, where to look for a bug, and what to do when you find it?

Bugs of a very small size are easy to build and they can be placed quickly in a matter of seconds, in any object or room. Today you may have used a telephone handset that was bugged. It probably contained three bugs. One was a phony bug to fool you into believing you found a bug and secured the telephone. The second bug placates the investigator when he finds the real thing! And the third bug is found only by the professional, who continued to search just in case there were more bugs.

The professional is not without his tools. Special equipment has been designed so that the professional can sweep a room so that he can detect voice-activated (VOX) and remote-activated bugs. Some of this equipment can be operated by novices, others require a trained countersurveillance professional.

The professionals viewed on your television screen reveal information on the latest technological advances like laser-beam snoopers that are installed hundreds of feet away from the room they snoop on. The professionals disclose that computers yield information too easily.

This advertisement was not written by a countersurveillance professional, but by a beginner whose only experience came from viewing the video tape in the privacy of his home. After you review the video carefully and understand its contents, you have taken the first important step in either acquiring professional help with your surveillance problems, or you may very well consider a career as a countersurveillance professional.

The Dollars You Save

To obtain the information contained in the video VHS cassette, you would attend a professional seminar costing $350-750 and possibly pay hundreds of dollars more if you had to travel to a distant city to attend. Now, for only $49.95 (plus $4.00 P&H) you can view ***Countersurveillance Techniques*** at home and take refresher views often. To obtain your copy, complete the coupon or call.