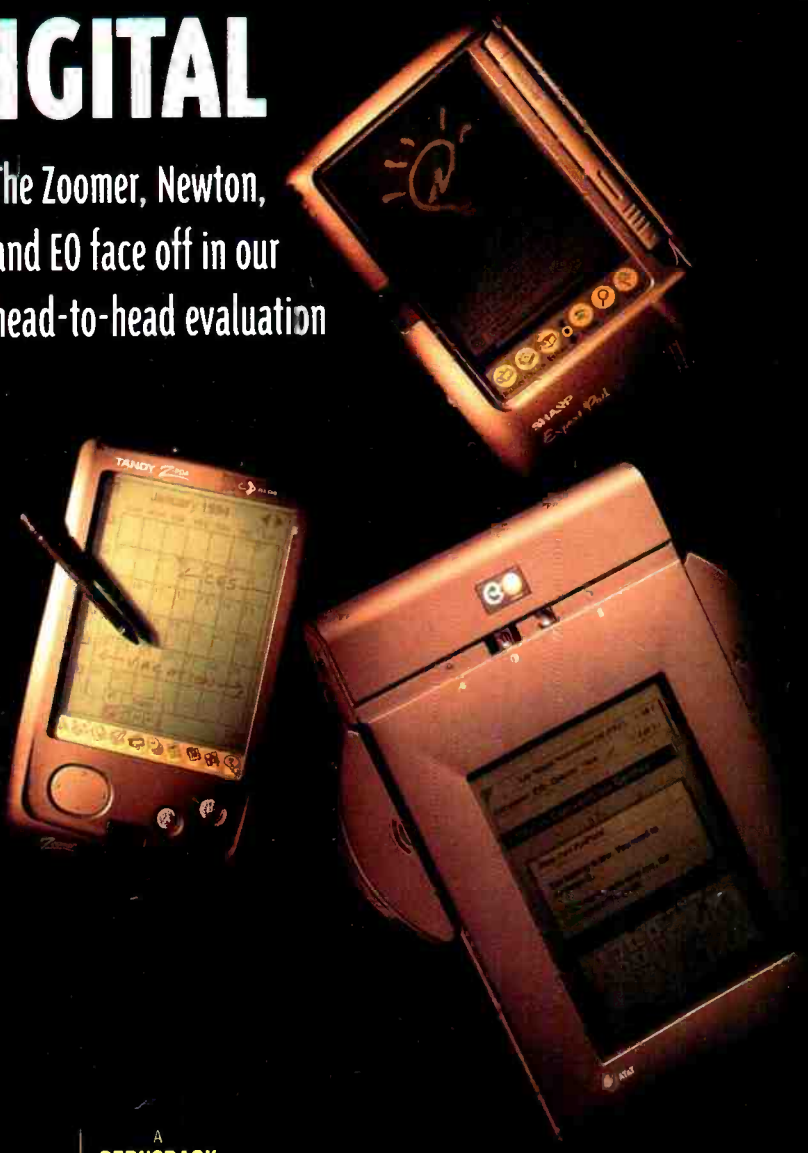
AUTOMOTIVE ELECTRICAL TESTER • PDA'S • BUILD A SHORTWAVE RADIO

March 1994

Popular Electronics®

PERSONAL DIGITAL ASSISTANTS

The Zoomer, Newton, and EO face off in our head-to-head evaluation



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Build an Electrical-System Analyzer for your Car

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Hamming in the Fabulous Fifties

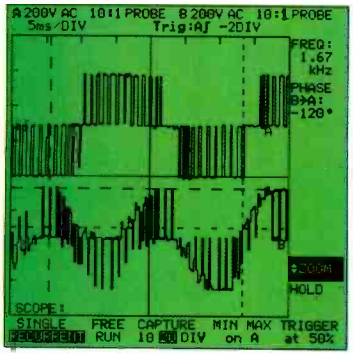
A look back at the great gear and good times from the golden age of amateur radio

A GERNSBACK PUBLICATION

craps, and slots–without the financial risk

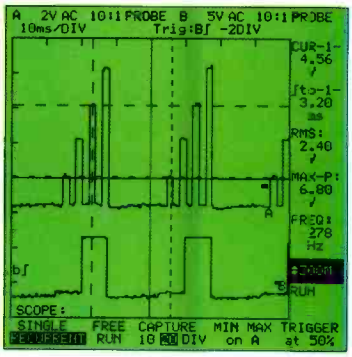
A DAY IN THE LIFE OF SCOPEMETER®

6:42 AM, Motor in #2 shaft overheating.
Dual channel shows incorrect drive signal.

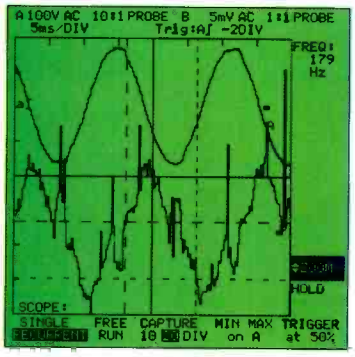


8:23 AM, Security Monitor not working.
3-1/2-digit DMM indicates bad ground.

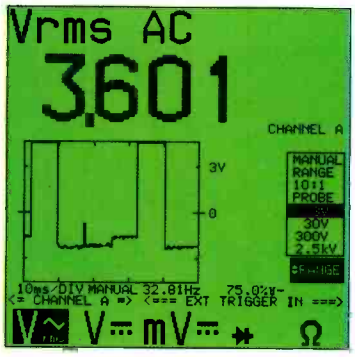
9:25 AM, Conveyor Stepper Control fails.
Cursors help find broken sync connection.



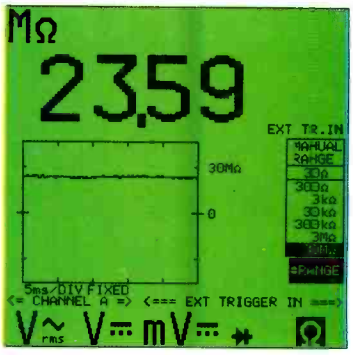
10:57 AM, Intermittent Auditorium lighting.
Waveform shows too much noise.



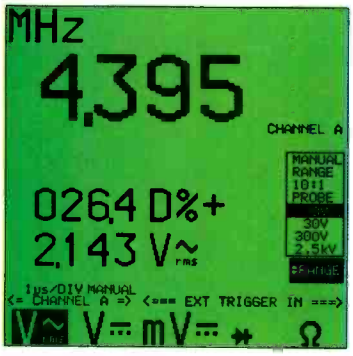
11:17 AM, 5V Control Signal is bad.
Scope display reveals -DC offset.



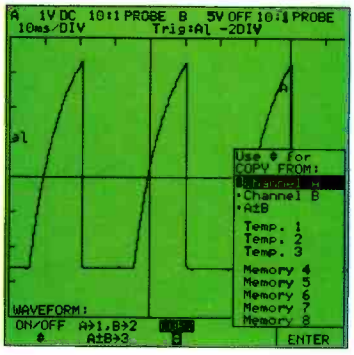
12:58 PM, Air Conditioner overheating.
Resistance shows corroded connection.



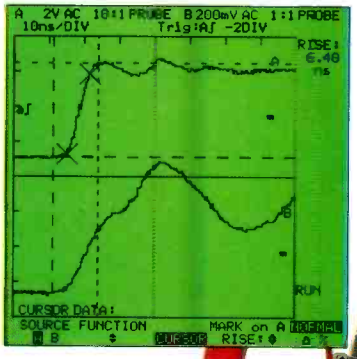
1:22 PM, Copier toning uneven.
Counter finds clock off frequency.



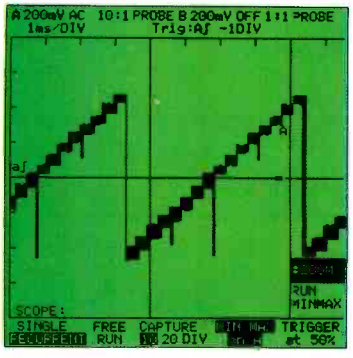
2:14 PM, Testing Power Inverter loads.
Save reference waveform to memory.



3:12 PM, Copier fails, again!
The ns rise time helps find broken shield.



4:05 PM, Salesman presents demo board.
25MS/s finds 40ns glitches.



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FEATURE ARTICLES

PRODUCT REVIEWS

COLUMNS

DEPARTMENTS

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Popular Electronics®

EDITORIAL

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ABC AUDITED

COLORIZING MOVIES—MUCH ADO ABOUT NOTHING

I know, you're already mad at me! How could I possibly defend colorizing old black-and-white movies? Well I can! It's all a matter of personal choice. And if I don't like seeing an old movie in color, all I need to do is use my remote to turn off the color. So why all the excitement?

What I would like you, our reader, to do is to take a favorite monochrome movie that has been colorized and watch it. While you are watching, turn the color on and then off every 15 minutes, or so. Now you're watching segments of the same movie, some in color, some in monochrome. When you're done, drop me a note; a postcard will do. Give me the name of the movie you watched, and tell me if it was better or worse in color. Don't bother protesting the colorization; I don't intend to debate that subject. Just tell me if the movie was better or not better after being colorized.

In a couple of months, I'll let you know how you rated colorization, and list the movies you rated.

If you want to have even more fun, do the same thing with a recent, color movie. Turn the color off and on every 15 minutes and then tell me which version you liked better.

Again, give me the name of the movie as well as your opinion.

I'll be looking for your responses.

Larry Steckler, EHF, CET
Editor-in-Chief and Publisher

LETTERS

SORRY, WRONG NUMBER

In the article, "Build a Relative Humidity Indicator" (**Popular Electronics**, January 1994), the telephone number of Hy-Cal Engineering is mistakenly listed as 800-444-4000. That number is answered by an MCI Information operator. The correct number is 818-444-4000.

Other than that, the article was very good. Keep up the good work.

P.B.
Kalamazoo, MI

RELOCATED SUPPLIERS

*The company referred to as "KA7QJY Components" in the article "Where to Find Electronics Parts" (***Popular Electronics**, *November 1993) has moved and changed its name. The company is now known as Dan's Small Parts and Kits. It is located at 1935 South 3rd West #1, Missoula, MT 59801. The phone/fax number is 406-543-2872.—Editor*

Oak Ridge Engineering, mentioned in "Where to Find Electronics Parts," has moved. The new address is 477 Ann Street, Pigott, AR 72454. The new phone number is 501-598-3459.

LINDEL CLARK, OWNER
Oak Ridge Engineering
Pigott, AR

MISSING TRADEMARK

Thanks for the review of our company's Robix Robot-Construction Set (**Popular Electronics**, January 1994). I hope you readers enjoyed it.

I'd like to correct one omission. "Robix" is indeed a trademark of Advanced Design, Inc.

EVAN ROSEN, PRESIDENT
Advanced Design, Inc.
Tuscon, AZ

WE ASKED—YOU ANSWERED

In response to your request ("What's Next?," **Popular Electronics**, December 1993) for input on your good magazine's content for the upcoming year, I would like to make a couple of comments.

First, I'd like to say that I do enjoy the content of your magazine. I am an Electrical Engineer both by training and practice. I'm also an electronic and computer hobbyist. Your level of electronics coverage is more than adequate for my appreciation—I get enough of the theoretical stuff at work.

I do thoroughly enjoy the articles on simple basic transistor and IC application "whatever's" (oscillators, amplifiers, etc.). I see so many projects that use micro's that it is relaxing to review some very fundamental control ideas. It also makes one realize that in some applications, a bunch of transistors can do the same job. It might not be as precise, but then sometimes we tend to be too exacting.

I would enjoy seeing more articles on linear devices interfacing with some type of transducer (temperature, humidity, acceleration, etc.). It would also be nice to see items on magnetic compasses using a fluxgate magnometer, and on the use of transistors instead of IC's as basic integrators and differentiators. Then there is the subject of home automation: What sort of bus structure is going to be used, and how do we interconnect to it?

Also in the wings, is low-power RF to be used as a control feature? Note the computer industry and the extent to which it is being promoted for printer and peer-to-peer communications. The cost of RF communication devices is decreasing rather rapidly, more so than the apparent cost of using fiber-optic and/or copper lines in the home.

I also like the articles and/or reviews of new electronic devices that are being introduced to the market, and items that are on the forefront of their respective areas, be it stereos, computers, photography, blenders, or robotics. The short reviews keep one informed that a lot of progress is being made to make us live better and enjoy what we have that much more.

It would also be nice to have more articles on adding new functions to our cars. And then there are remote-controlled electric lawn mowers . . . I could keep going, but I think you get the idea that what you are doing is what you should be doing. Just continue to do it and keep up with the times.

R.B.
Cortland, OH

I'd like to commend you on a very fine magazine. I've read **Popular Electronics** for many years.

As an electronics hobbyist, I really appreciate the construction articles, and the articles that deal with the new and upcoming electronic "gizmo's." I feel as if the magazine is just about right in the balance of articles.

Even though I am not personally interested in every area covered, the areas you do cover are about right for electronic hobbyists and professionals (of course, this is only my "2-volts worth"). Since you did ask, however, I would like to see more construction articles in the computer/digital area.

Please keep up the good work.

R.R.
Bedford, IN

RECALCULATING ELECTRIC CAR COSTS

After reading the letter titled "Electric Car Costs" (**Popular Electronics**, December, 1993), I think that R.D.C. must have spend most of his time at the ballpark and not in mathematics class. His attempt to prove that operating battery-powered electric vehicles (BPEV's) will cost more than operating internal-combustion engine vehicles (ICEV's) is seriously flawed with basic arithmetic errors. Those errors, when corrected, paint a completely different picture.

First, in the BPEV calculations, R.D.C. failed to convert 547.5 billion *pounds* of coal per year to *tons* before multiplying by $52 per ton to get the annual cost of coal. The correct annual cost, using R.D.C.'s assumptions, would be $14.235 billion. How he arrived at $28.47 billion is a mystery.

Second, gasoline weighs six pounds per gallon. All airline pilots (such as myself) rely on this number to calculate critical weight and balance of an aircraft prior to every flight. Why R.D.C. is concerned about the weight of gasoline is another mystery.

Third, the annual cost of gasoline (73 billion gallons per year multiplied by $1.23 per gallon at the pump) would be $89.75 billion. How R.D.C. arrived at $12.82 billion is yet another mystery.

Using the corrected numbers, ICEV's are 6.3 times more expensive than BPEV's. If you add the hidden cost of the various oil subsidies paid to oil companies (estimated to be $3 per gallon) you add another $219 billion to the annual ICEV fuel costs. The 6.3 factor now becomes a whopping 21.7.

As for pollution, 100 million ICEV's would emit about 869 tons (360 grams per mile) of carbon dioxide versus 580 tons (240 grams per mile) for BPEV's, providing even more justification for making the transition to electric vehicles as soon as possible.

To carry this thinking further, development of fuel-cell electric vehicles (FCEV's), using hydrogen as a fuel, should be considered. The hydrogen could be produced from solar-powered photovoltaic cells and could eliminate the use of fossil fuels completely. FCEV technology could provide a renewable energy source that could be stored and distributed like gasoline. It would result in zero pollution and provide a solution to short- and long-distance transportation.

D.E.M.
Gilbert, AZ ■

Turn a Faulty VCR Into a Profit

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"...gives all the necessary information for learning the art of troubleshooting popular brands."
—Electronics For You

MAINTAINING AND REPAIRING VCRs will help you master maintenance and repair procedures, including how to:

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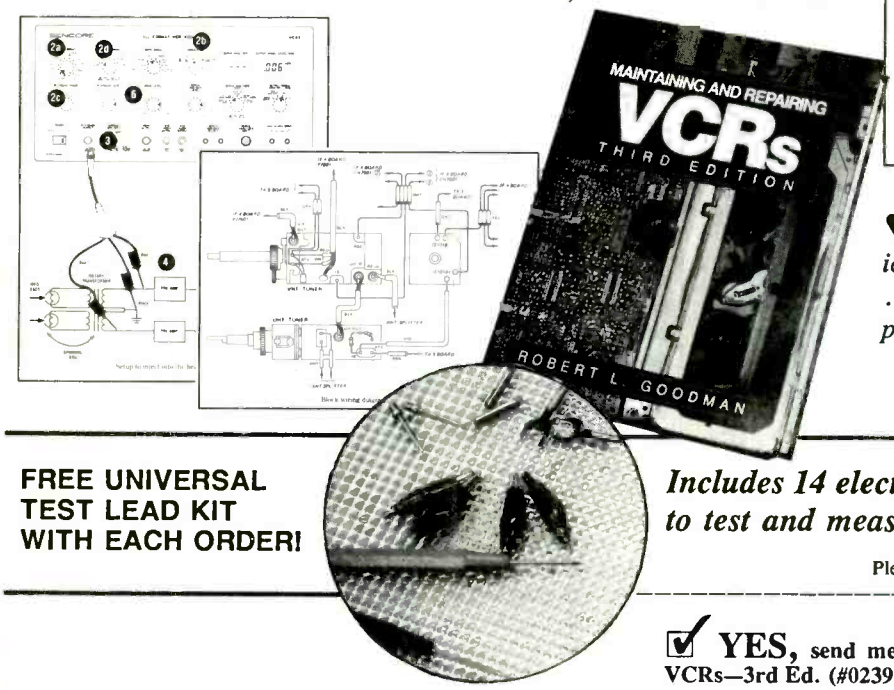
- Repair and replace dirty switch contacts
- Troubleshoot electronic or mechanical servo malfunctions
- Identify and correct video head sticking and friction
- Turn a snowy, weak picture into a crisp, strong picture
- Adjust an improperly running tape path
- And much more.



"...fully explains the mechanical systems and electronic circuitry ...also details servicing data on all popular brands of VCRs."
—VIDEO Magazine

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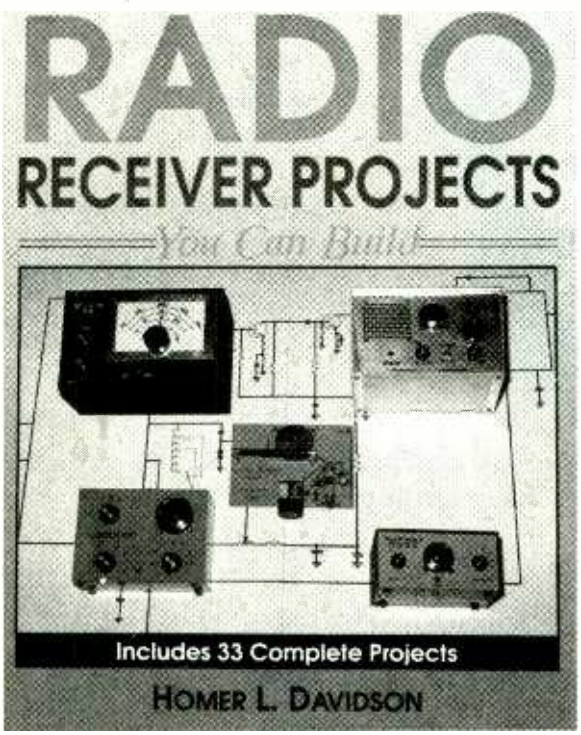
ELECTRONICS LIBRARY

Radio Receiver Projects You Can Build

by Homer L. Davidson

The 33 projects in this book are sure to appeal to radio buffs, students, and hobbyists who enjoy working with electronics. No experience is necessary to build all types of inexpensive, useful radio receivers from scratch, following the common-sense, hands-on directions offered in the book. More than 200 helpful circuit diagrams and photographs accompany the plain-English text.



Some of the projects include a simple crystal radio, an integrated AM radio, an antique-tube regenerative radio, a two-tube regenerative battery-powered radio, an integrated tube radio, a one-tube shortwave radio, a toroidal-coil shortwave radio, a solar-powered radio, and a direct-conversion shortwave receiver that uses the TDA7000 IC chip.

The book also covers PC-board, chassis, and cabinet construction. Sources for parts and components are included.

Radio Receiver Projects You Can Build costs $18.95 and is published by Tab Books Inc., Blue Ridge Summit, PA 17294-0850; Tel. 800-233-1128.

CIRCLE 98 ON FREE INFORMATION CARD

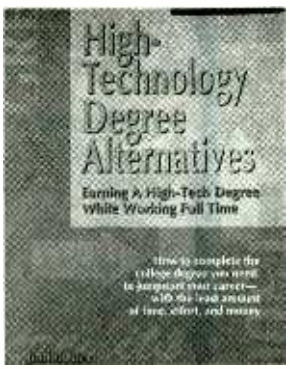
HIGH-TECHNOLOGY DEGREE ALTERNATIVES: Earning a High-Tech Degree While Working Full Time

by Joel Butler

If there's one thing that's certain in today's economy it's that everything changes. Advanced education can help you cope with the changing job market, and advance your career in a positive direction. Whether you have no credits or are only a semester short of graduation, this book shows you how to get a college degree without leaving your full-time job.

There are more than 50 accredited undergraduate and graduate programs across the country that offer non-traditional methods of obtaining a college degree in technical fields such as engineering, computer science, information systems, electronics, and technology-oriented management. Many of those offer "external" degree programs that you can complete no matter where you live, without ever entering a traditional classroom.

This book reveals time- and money-saving techniques that can get your college education on track. It offers three steps to help you discover which high-tech degree will help you move up the ladder in your chosen field, and how to select the right school. Cost-cutting pointers in-



clude earning college credit for work and military experience, turning what you know into college credits, sure-fire credit transfers, and using exams to build credits and cut your degree completion time. The book also covers how to personalize a degree program to fit your goals, schedule, and budget by creating your own college courses and individualized majors, and by taking independent-study courses by mail.

High-Technology Degree Alternatives costs $21.95 and is published by Professional Publications, Inc., 1250 Fifth Avenue, Belmont, CA 94002; Tel. 800-426-1178.

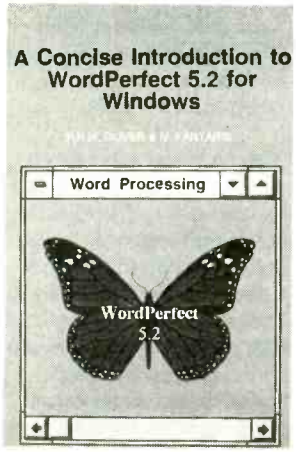
CIRCLE 85 ON FREE INFORMATION CARD

A CONCISE INTRODUCTION TO WORDPERFECT 5.2 FOR WINDOWS

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

The routines described in this book will help you get the most out of WordPerfect 5.2 for Windows. Written with busy beginners in mind, the book assumes no prior knowledge of WordPerfect and has an underlying structure based on the philosophy "what you need to know first appears first."

The book outlines the hard-



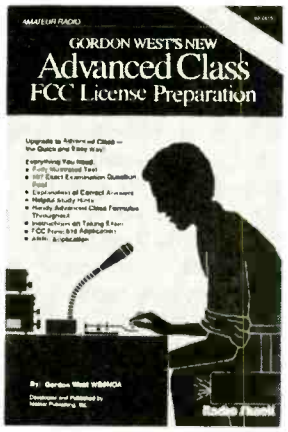
ware requirements for WordPerfect 5.2 for Windows, and walks you through a standard installation on a PC. It familiarizes you with the basics of WordPerfect and the Windows environment, and explains how to benefit from the built-in Help system and the different operating modes and screen views. The book covers how to enter, edit, and enhance text; how to work with formatting codes, button icons, the ruler, tabs, graphic boxes, and styles; and how to use advanced features such as document checking, columns, outlining, tables, file and data management, transfers, and creating and running simple recorded Macros. A brief introduction to the Macro Programming Language is included. The book also shows how to come to terms with the program's ability to use two sets of printer drivers, and still produce good-looking printed output.

A Concise Introduction to WordPerfect 5.2 for Windows (order No. BP339) 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

GORDON WEST'S NEW ADVANCED CLASS FCC LICENSE PREPARATION

by Gordon West, WB6NOA



By taking the step to the next-to-highest amateur-operator/primary-station license—the Advanced Class—you can enjoy increased privileges on worldwide bands and can become a part of the VE system for conducting amateur license examinations. This book makes it easier to take that step, by providing everything you need to learn about, prepare for, and pass the exam. It contains the exact 507 FCC Element 4A questions with their multiple-choice answers, that are valid until July 1, 1995. Fifty of those questions will appear on each exam given. The correct answer each of the questions is identified, and an explanation as to why that answer is correct is provided. The fully-illustrated text also includes study pointers and instructions for successfully taking the exam, along with charts, diagrams, and formulas for an easy-to-understand approach to learning.

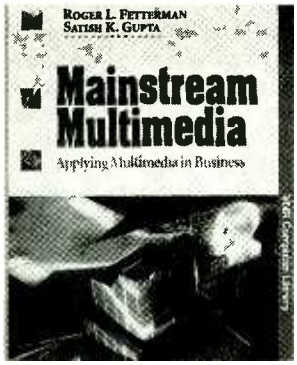
Gordon West's New Advanced Class FCC License Preparation is published by Master Publishing Inc. and is available for $9.90 at Radio Shack (Cat. no. 62-2415).

CIRCLE 86 ON FREE INFORMATION CARD

MAINSTREAM MULTIMEDIA: Applying Multimedia in Business

by Roger L. Fetterman and Satish K. Gupta

As multimedia computing based on desktop platforms begins to



gain acceptance in the business world, this book describes how, when, where, and why multimedia capabilities can and should be used in different business environments. It can help business managers make informed decisions about multimedia applications.

The book explores the transformation of personal computers from "compute-intensive" to "communications-intensive" device, and explains how advances in desktop platforms, operating systems, authoring systems and applications software can provide seamless integration of audio, images, and video with text, graphics, and animation.

Taking a structured-analysis approach, the book shows how to match multimedia computing and networking solutions to application requirements to ensure success. The technology infrastructure is revealed in discussions of the components needed to implement desktop applications and multimedia-capable networks, with separate sections covering computing platforms, operating systems, storage devices, compression technologies, and networking solutions. Methods for analyzing costs and value are also provided.

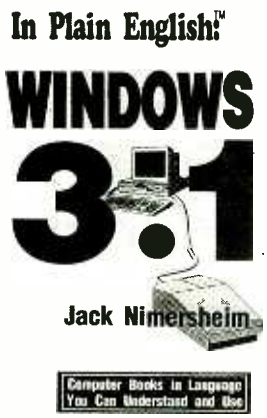
Mainstream Multimedia is published by Van Nostrand Reinhold, 115 Fifth Avenue, New York, NY 10003.

CIRCLE 87 ON FREE INFORMATION CARD

IN PLAIN ENGLISH: WINDOWS 3.1

by Jack Nimersheim

Windows 3.1 is a graphic interface designed to simplify using an IBM PC or compatible computer, but at first glance it can seem anything but simple to new users. Because most of today's most powerful and useful programs operate in the Windows environment, it's worth learning to use the program. With a minimal amount of "computerese," this book helps you have fun while mastering Windows, instead of getting lost in a frustrating technical puzzle. It doesn't get bogged down explaining absolutely everything there is to know about Windows—the Windows manual does that. Instead, this book provides a full explanation of everything you need to know to effectively use Windows on an everyday basis.



The book begins with a look at Windows basics and a step-by-step installation guide. It goes on to explain how to use Windows' standard mode and the enhanced 386 mode; select icons; open and change windows; use the control panel, work with different fonts; personalize your Windows desktop; use the Program Manager and the File Manager; manipulate data; work with directories and files; modify program groups; and deal with memory. Plenty of screen shots accompany the text, and each chapter includes a glossary of new terms that have been introduced in its pages.

In Plain English: Windows 3.1 costs $9.95 and is published by WorldComm, Division of Creativity, Inc., 65 Macedonia Road, Alexander, NC 28701; Tel. 704-252-9515.

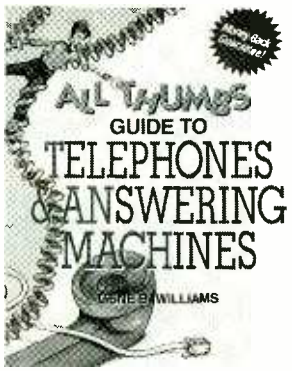
CIRCLE 88 ON FREE INFORMATION CARD

ALL THUMBS GUIDE TO TELEPHONES & ANSWERING MACHINES

by Gene B. Williams

No experience (or repair shop) is necessary to keep your telephone gear running smoothly. You can save money by doing the job yourself, by following the clear, step-by-step instructions in this book. It explains how to safely and easily troubleshoot, test, and repair problems with virtually every type of telephone, including cordless phones, and answering machines.

The book explains how to install wiring inside and outside your house; take apart, repair, and put back together telephones and answering machines; disassemble, install, and modify telephone jacks; and clean the heads in your answering machine. Also included are pointers on performing tests with a volt-ohmmeter, and instructions for building a simple signal generator to test the wires inside walls.



Written for complete novices, the book explains the basics of safety and describes the tools necessary and shows how to use them. The text is heavily illustrated with detailed drawings. Finally, a money-back guarantee is offered if you find yourself unable to follow the book's instructions.

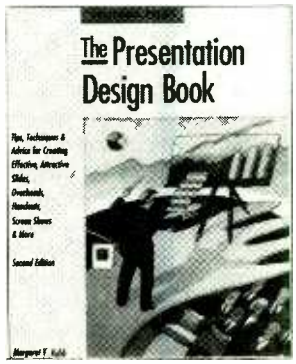
All Thumbs Guide to Telephones & Answering Machines costs $9.95 and is published by Tab Books Inc., Blue Ridge Summit, PA 17294-0850; Tel. 800-233-1128.

CIRCLE 98 ON FREE INFORMATION CARD

THE PRESENTATION DESIGN BOOK: Second Edition

by Margaret Y. Rabb

You can spend a fortune on desktop-publishing hardware and software and still turn out boring presentations, if you don't know how to use those tools creatively and effectively. The bottom line is communication, and this book shows you how to get your message across to your audience with polished computer graphics and screen shows that lend power and appeal to presentations.

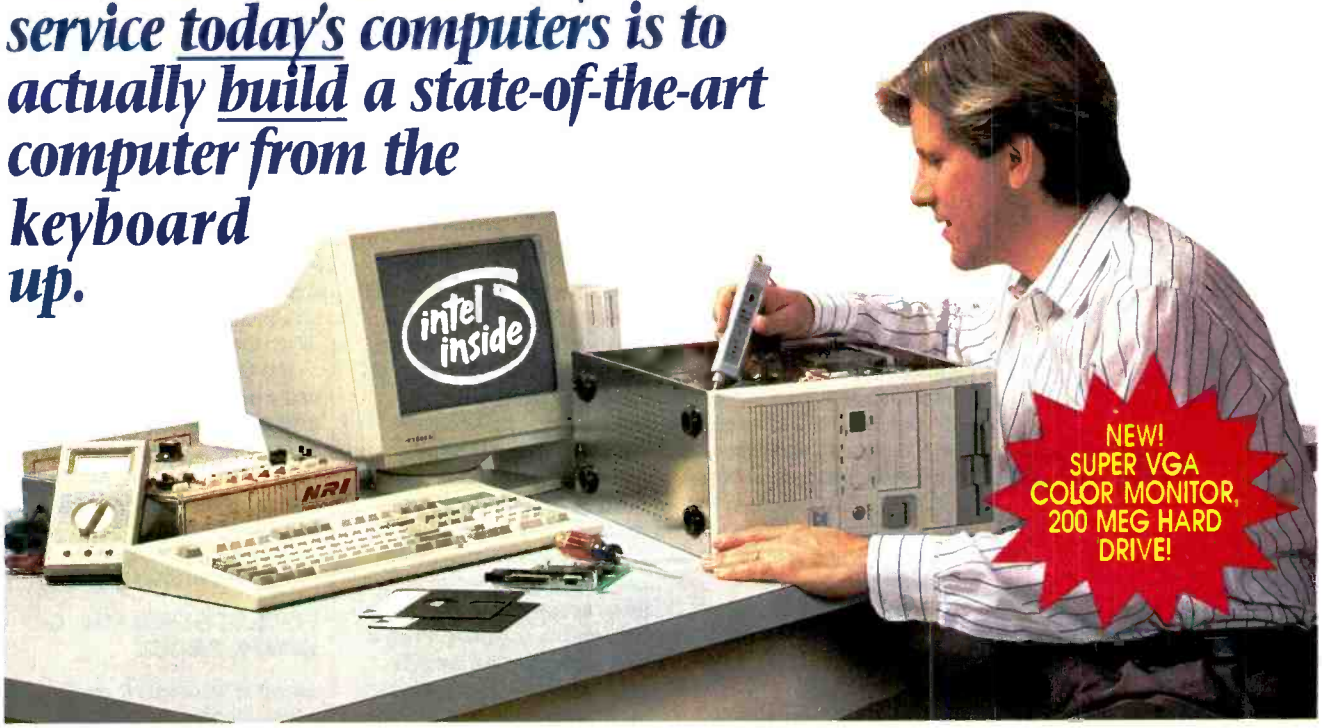


The book provides sound advice, insightful how-to examples, and easy-to-follow guidelines for designing persuasive slides, overheads, and handouts. The updated second edition adds material on using sound, video, animation, and interactivity in presentations, without sacrificing clarity or impact. A four-color section explores the use of color to create depth and set the tone. The book shows how to analyze the audience and environment to determine to optimal presentation media; understand the subtle effects of typeface on audience perceptions; create the best layout and design; integrate various multimedia elements into a cohesive, balanced presentation; and determine hardware and software requirements for multimedia presentations.

The Presentation Design Book: Second Edition costs $24.95 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

NRI knows: The best way to learn to service today's computers is to actually build a state-of-the-art computer from the keyboard up.



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The Department of Labor forecasts over 220,000 jobs for computer service technicians by the year 2005 — a full 38% increase over today's level. With NRI's easy, effective training, you can cash in on this wide-open opportunity and become a high-paid computer service technician.

NRI is the best way to prepare for a profitable new career, even a business of your own. A leader in at-home training for 80 years, NRI knows how to help you break into this high-demand field — regardless of your background in electronics! That's because you start with the basis, moving on step-by-step to master advanced computer concepts — all the while reinforcing theory with hands-on training that ensures success.

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NRI's highly acclaimed learn-by-doing approach gives you a complete understanding of the intricate electronics behind the 1 meg RAM, 32-bit CPU computer included in your course. You perform hands-on electronics experiments with your NRI Discovery Lab and digital multimeter, then build and test the powerful 486sx/25 MHz computer you train with and keep. You install the floppy drive and, to give you maximum storage capacity, the 200 meg hard disk drive. And you go on to interface the Super VGA color monitor now included in your course. You even learn to recognize and service virtually any computer problem with the extraordinary R.A.C.E.R. plug-in card and QuickTech diagnostic software.

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NEW PRODUCTS

Hi8 VCR

For playing back and editing Hi8 and standard 8mm videotapes, *Sony's EV-C100* Hi8 player/recorder delivers crystal-clear images and hi-fi stereo. The deck's Hi8 recording system captures more than 400 horizontal lines of resolution (versus 250 lines for VHS), to reveal image details without jitter or noise, even in still, slow-motion, or frame-by-frame modes. The EV-C100 also provides up to two hours recording in SP (best-picture) mode.

The AFM sound-recording feature provides hi-fi stereo audio with wide dynamic range and minimum distortion. Sony's "Voice Boost" system minimizes background noises by boosting the frequency of the human voice.

For editing, the EV-C100's offers a dual-mode shuttle dial, which lets the user operate slow-motion and picture search in both forward and reverse. Other features include frame-by-frame advance/reverse buttons, a flying erase head, 2-times fast play, a Control L (LANC) editing interface, one-touch synchronized editing, and an edit switch to maintain maximum picture quality during editing.

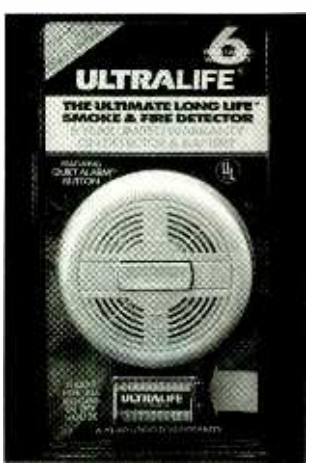
The EV-C100 Hi8 VCR has a suggested retail price of $650. For more information, contact Sony, 1 Sony Drive, Park Ridge, NJ 07656.

CIRCLE 101 ON FREE INFORMATION CARD

LONG-LIFE SMOKE DETECTOR

Safety studies have shown that between 30% and 50% of all installed smoke detectors are not doing their job because of missing or dead batteries. *Ultralife Batteries* addresses that problem in its *Ultralife Smoke Detector*, which is powered by a unique 9-volt lithium battery that lasts up to four times longer than an alkaline battery and up to ten times longer than a carbon-zinc battery. The company offers a six-year limited warranty for both the battery and the detector. The detector senses fires in their earliest stages, responding with a powerful 85-dB horn.

To let the homeowner know when the battery finally does die, a "low-battery" chirp will sound for 30 days. When the battery is working properly, a red operating light flashes at 45-second intervals to indicate that the unit is receiving power. In addition, the smoke detector has a battery-test button.



The main cause for missing batteries is false alarms: Consumers remove the batteries when the smoke alarm goes off due to fireplace, cigarette, or cooking fumes, and then forget to replace them. The Ultralife detector has a "quiet-alarm" button that can be used to quickly silence those nuisance alarms, without removing the batteries. The unit re-arms itself in ten minutes. In addition, the detector cover will not close unless a battery is in place within the unit.

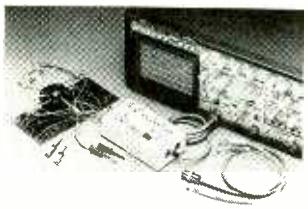
The Ultralife Smoke Detector has a suggested retail price of $19.95. For further information, contact Ultralife Batteries, Inc., 1350 Route 88 South, P. O. Box 622, Newark, NY 14513; Tel. 800-332-5000.

CIRCLE 102 ON FREE INFORMATION CARD

POCKET-SIZED LOGIC-SCOPE PROBE

Aimed at technicians, engineers, students, or hobbyists, for use in the lab or as a cost-effective enhancement to field-service equipment, the *MX9100* logic-scope probe converts an ordinary analog oscilloscope into a logic-analysis instrument suitable for examining and analyzing single-shot and repetitive digital phenomena. The portable 8-channel unit can be used independently or can be daisy-chained to provide 16- or 24-channel reading capability. The probe offers a full complement of grabber test leads and a BNC scope interface. It will work with any scope with a bandwidth of 5 MHz or higher, sensitivity of 200 mV/div or better, and external-triggering capabilities.

The MX9100 has three operating modes. In the logic-analyzer mode, the usual analog scope becomes an 8-channel logic analyzer with a memory input depth of 16 bits. Each channel is displayed as a horizontal line in a "timing diagram" manner. In the trigger-probe mode, a real-time trigger signal is generated whenever an 8-bit user selected condition is met. Analog signals can be viewed while triggering the scope externally using a digital combination. The MUX mode allows eight digital signals in real time to be simultaneously displayed on the screen.



The MX9100 logic scope probe kit, including 11 test leads, 8 gray signal leads, one clock lead (yellow), a red power lead, and a black ground lead, costs $330. For more information, contact ITT Pomona, 1500 East Ninth Street, Pomona, CA 91766-3835; Tel. 909-469-2900; Fax: 909-629-3317.

CIRCLE 103 ON FREE INFORMATION CARD

MULTIMETER WITH THERMOMETER

Extech's Model 380505 handheld multimeter offers seven functions, including a Type-K thermocouple input for temperature measurements from 0°–1999°F. The multimeter also monitors five ranges in both DC and AC voltage, DC amps, AC amps, and resistance. All functions are displayed on a 0.95-inch LCD readout. The unit also provides diode and audible continuity tests, as well as polarity and over-range indications. It comes complete with a rubber holster, test leads, a temperature probe, and a 9-volt battery.

The Model 380505 multimeter with thermometer costs $59. For additional information, contact Extech Instruments Corporation, 335 Bear Hill Road, Waltham, MA 02154; Tel. 617-890-7440; Fax: 617-890-7864.

CIRCLE 104 ON FREE INFORMATION CARD

A/V RECEIVER WITH GRAPHIC USER INTERFACE

The first audio/video receiver in *Pioneer's* Elite line to offer a built-in graphic user interface (GUI) is the *Model VSX-97.* Featuring computer-like icons designed to guide the user through a variety of audio-video settings, the GUI facilitates on-screen programming menus. The GUI also features a video-edit mode that allows users to create customized videos by mixing any combination of audio and video sources. Users can also adjust the mix and fade levels for more refined video production.

The VSX-97 also offers digital audio-signal processing (DASP) based on the PD-00883 chip, which combines a Dolby Pro Logic decoder and sound-field processor on a single chip. DASP digitally controls delay time as well as the steering logic of the surround system. DASP is said to achieve three times the processing power of a conventional digital signal processor with significantly lower distortion. Through DASP, the receiver provides a standard stereo mode, three preset sound-field controls (movie, concert, and sports), and one advanced sound-field control that allows the user to program and store into memory four customized system configurations. For custom settings, users can choose four of an available ten "built-in components" and set the acoustic parameters of each through the GUI. The adjustable parameters include initial delay, "liveness" effect, room size, wall type, and mode.

Other features of the VSX-97 include the ability to transfer S-video to composite format and vice-versa, and multi-room and multi-source capability, and a "pure-line" switch that automatically turns off the receiver's fluorescent display and clock

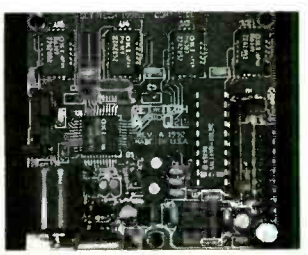
when a source component is directly connected to the power amplifier.

The VSX-97 audio/video receiver has a suggested retail price of $2,600.

CIRCLE 105 ON FREE INFORMATION CARD

DIGITAL VOICE RECORDER

GetTech's AudioQ-218 digital voice recorder will record up to 218 seconds of speech. The device offers four selectable sampling rates (4.8-, 8.5-, 9.6-, and 11-kHz), and sampling rates up to 17.8 kHz are available. As many as eight different variable-length messages can be stored in battery backed-up RAM. The recorder measures 2.6 × 2.6 inches.



Two independently adjustable audio outputs are provided. One high-level output will drive an 8-ohm speaker to 400 mW; the other can be used for output to an external amplifier or transmitter. An on-board regulator allows use from 8 to 15 VDC. An open-collector output for keying a transmitter or external device during playback is also available, as is customizing.

The fully assembled and tested AudioQ-218, including backup battery and 4 megabytes of RAM, costs $149 plus shipping and handling. For additional information, contact GetTech, 402 Riley Road, New Windsor, NY 12553; Tel. 914-564-5347.

CIRCLE 106 ON FREE INFORMATION CARD

CAR AUDIO SIGNAL PROCESSOR

Summit Electronics has licensed the *Aural Exciter with Big Bottom* audio signal processing technology, originally designed by Aphex Systems for use in the recording and broadcast industries. The technology

is incorporated in the *BAX-1* automotive audio signal processor. A pulse-width modulated power supply and variable gain have been added to the ½ DIN dash-mountable unit, which requires no added power or amplification to process low and high frequencies.

The BAX-1 is said to kick up the overall sound and perceived loudness of any car stereo system, and to allow the human ear to perceive the enhancements as a natural part of the overall sound. It adds a small amount of a processed signal back into the original, unprocessed signal, using a variety of mixing and balance controls. The BAX-1 also cuts above ambient noise caused by traffic, wind, and road conditions.

The BAX-1 Aural Exciter with Big Bottom has a suggested list price of $249. For further information, contact Summit Electronics, 12420 Montague Street, Arleta, CA 91331; Tel. 818-890-3025; Fax: 818-890-5103.

CIRCLE 107 ON FREE INFORMATION CARD

HANDHELD FREQUENCY COUNTER

Intended for use in the test, communications, security/surveillance, two-way amateur radio, law-enforcement, and communications-monitoring markets, the latest model in *Optoelectronics' line of Handi Counters* represents a substantial improvement in features and capabilities. The *Model M-1* handheld frequency counter is a full-range counter with coverage from 10 Hz to 2.8 GHz that provides ultra-high-speed measurements as well as very high-resolution ten-digit measurements. It features ten user-selectable gate times, ranging from 13 milliseconds to 10 seconds, with corresponding resolution from 10 kHz to 0.1 Hz.

The M-1 is based on a high-speed application-specific IC that is capable of 250-MHz direct counting. An embedded microcontroller provides digital filtering that reduces the display of random noise and oscillation without loss of sensitivity. Digital auto capture locks the counter display on the first reading to pass the filter. An arm/store button sends captured data into a three-register stack that can be recalled later.

The addition of an asynchronous serial data port allows the TTL data to be level shifted to RS-232C using the optional accessory interface (*Model CX12*). The interface includes data-logging software that can be used with any PC to log and time-stamp frequency data.

A 16-segment relative signal-strength bargraph is sensitive to low levels of RF and can be used to verify transmitter output or locate a stuck transmitter or an unauthorized source of RF. The bargraph is fully independent of the frequency-measurement circuitry.

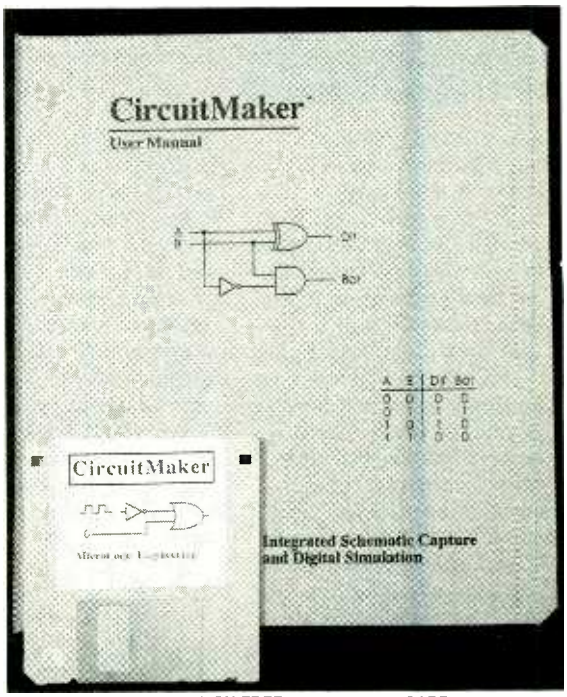
The M-1 costs $229. For more information, contact Optoelectronics Inc., 5821 NE 14th Avenue, Fort Lauderdale, FL 33334; Tel. 800-327-5912; Fax: 305-771-2052.

CIRCLE 108 ON FREE INFORMATION CARD

"Sorry. . .the computer's gone to lunch."

A Hands-on Electronics® REPORT

MICROCODE ENGINEERING CIRCUITMAKER



CIRCLE 119 ON FREE INFORMATION CARD

An integrated schematic capture and digital simulation program for Windows that's great for beginners and experienced hobbyists.

In the days when almost everything ran from DOS, learning to use a new software package meant immersing yourself more in the software's idiosyncrasies than in the task you were trying to perform. Once that initial shock was out of the way, going further than the basics virtually meant becoming a programmer.

Being a roll-up-your-sleeves kind of person, I didn't personally mind that too much, but I felt it wasn't fair to most folks and, more importantly, I knew things really didn't have to be that way. Well, by now the existence of Windows has proven that a PC compatible full of software can be easy to learn and operate with any level of interest or expertise.

Recently, I had the good fortune to come across a Windows-based software package that's so easy to use, it's suitable not just to teach a beginner how to use a computer, but about digital electronics as well. The package is Circuit Maker from MicroCode Engineering (1943 N. 205, West Orem, UT 84057; Tel. 801-226-4470). It allows you to quickly and easily draw, modify, and combine analog and digital schematics, and can simulate the operation of the digital portion of your circuits. Further, since it's a Windows application, it can print its waveforms and schematics on any Windows-selectable printer.

In a sense, the software is not really new, but it has only recently been ported over from the Macintosh "universe." That means the program has already been "worn-in" development wise, for those that don't like taking the first ride on any bandwagon.

On a PC compatible, it requires Windows 3.1 or higher, 2MB of free disk space, a VGA monitor or better, and a mouse—typical minimal-requirements for Windows applications.

Parts and Macros. To draw a circuit diagram (which can span several pages), you use the mouse to select devices from the provided library. Then you connect them using wires. Parts can then be moved, rotated, etc. Let's talk about parts, wires, text, and finally the ways they can be graphically manipulated.

The device library includes TTL devices; generic devices (such a gates and flip-flops); I/O and display devices such as switches; a pulse generator; LED's; 7-segment LED displays; analog devices such as transistors, resistors, capacitors, and inductors (which are only graphic symbols—they are not simulated); and miscellaneous devices such as PROM and RAM IC's. In all that's 120 digital (and simulated) devices and 18 purely graphical ones.

One feature of the digital devices that distinguishes this package from most simulator software in its price range is that they have programmable propagation delays. That allows you to simulate circuits made up of chips from varying families (pure TTL, low-power Schottky, etc.). Circuits like that have a greater need to be simulated anyway, so their simulation should be accurate.

If the bundled parts library is insufficient for your needs, you can create "macros" and add them to the library. Macros are devices you can use for simulation and/or graphical use. They can be moved between libraries, recalled from a library, edited, and resaved at any time. For a functioning macro (one that can be processed by the simulator) you start by drawing the schematic that describes its function, which, by the way, can contain nested macros. Then you decide on the device's name and package, which could be a dual-in-line or user-defined type.

To create a user-defined package

you first draw it in any Windows-based drawing program. Second, you import the package drawing into the device's schematic via the clipboard and add pins to it. Adding pins is automated with the help of a toolbar full of the two types of pins (active high and active low) in every orientation.

Whether user-defined or DIP, the package's pins are then labeled. Next, you connect the pins to their corresponding points in the device's schematic and save the macro. When the macro is chosen for use in another circuit, only its package is visible, its circuitry is not. To see the schematic diagram represented by the macro, it can be "expanded" using an option from the Macro menu. For purely graphical macros, you simply dispense with drawing a schematic, and therefore there's nothing to connect to the desired package.

Once created, macros are handled exactly as though they were parts. So from here on, when we discuss operations with parts, remember that the same applies for macros.

Placing Parts, Wires, and Text. Parts are listed on library pull-down menus (labeled "L1," "L2," etc.). To place one on a schematic, you start by selecting the right menu using an arrow-shaped cursor (called the "arrow tool", which is activated from the toolbar), then select its name from the menu. The menu will disappear and the arrow tool will be replaced by a picture of the part. Move the part where you want it and click the mouse to place it on the schematic. If the program's "Repeat" option is on, it's now ready to place another copy of the part elsewhere on the schematic. If it is off, the arrow tool reappears.

Parts are connected together using "wires," which are composed of line segments drawn between the terminals of parts. For that, the mouse is used along with a cross-hair cursor called the "wiring tool" which is activated from the tool bar.

You start by moving the wiring cursor close to a terminal. You can't tell how close is close enough because, unlike most Windows programs, no handle markers appear. However, you don't have to be precise because CircuitMaker's "Smart Wires" automatically snaps wires to terminals.

Clicking the mouse then starts the wire and the cursor disappears. At this point the program is waiting for you to move the mouse so it can give you an appropriate cursor. There is one cursor for drawing vertical line segments, activated by moving the mouse up or down, and another for making horizontal segments, activated by moving left or right. The vertical-segment cursor is a horizontal line and the horizontal-segment cursor is a vertical line. Both cursors span the whole drawing area to help you align the endpoints of segments with component terminals and such. From then on, single mouse clicks alternate you between the horizontal and vertical cursors, which allows you to make bends in the wire. A double click terminates the wire. If the wire is terminated near a terminal, the SmartWires feature snaps it to the terminal.

I found the disappearance of the cursor a bit disconcerting. Having it change shape or color would have been nicer. Also, I'm used to the more conventional click and drag format of wire placement. However, that automation typically means you relinquish your control over where bends occur until you go back and do some clean up, so there's something to be said for the CircuitMaker wiring concept.

Software paradigms aside, there is a different "draw back" to the wiring-cursor algorithm: it runs too fast on a fast machine (I used a 50MHz 486). What that means is that you'll be trying to double click the cursor to terminate a wire, only to have the program switch back and forth between the horizontal and vertical cursors. That can be overcome by lowering Windows' double-click speed from the control panel, although that might make it less than optimal for your other applications.

To start placing text on a schematic (say, to document its operation) you must select the Text icon from the toolbar. The usual Windows "I"-shaped text cursor then appears, which you place to the upper-left of where you want the text to appear. A click of the mouse opens a window at that position for typing the text. I really like that feature because the window's height and width can then be adjusted to control the wrapping of the text and the area it occupies. Another plus is that the text can be fully stylized with regard to point size, attribute, and

font. While the window is present all the usual Windows' text-editing features (double clicking on words, click and drag selection, etc.) are available.

Clicking the mouse outside the text window causes the window-frame and background to disappear leaving the text on the drawing itself. Simultaneously, a new text window opens where you clicked to accept another block of text.

By the way, my trouble with the wiring cursor lead me to discover something else: you can't undo a placement of wiring, parts, or text. If you don't like an item or its placement you must move it or delete it, the latter of which means selecting a different tool, which we'll mention later.

Editing. Individual objects (parts, text, wires, and in some cases a line segment in a wire) and groups of objects are most often edited with the help of the arrow tool. To select a single part for editing, just aim the cursor at the part and click. To edit multiple items click and drag the cursor to draw a rectangle over all the parts of interest. You can also use a Select-All option on the edit menu to select all the parts on a schematic at once.

Moving single objects is done by simply clicking and dragging them to their new location. Unfortunately, on fast machines, that means the program sometimes moves an item you only wanted to select for some other editing operation. Again, the cure is to alter the mouse's responsiveness from the control panel. One nice feature of moves is that all wiring remains intact, as though the wires connecting the selected part to the rest of the schematic were made of rubberbands. Moving is one of the operations that affects individual line segments in a wire, which combined with rubberbanding, makes it very useful for cleaning up schematics.

You cannot move multiple items except by cutting and pasting them. By the way, the cut, copy, and paste operations are the same as in any other Windows application. However, those commands are augmented by commands that allow you to copy schematics or waveforms from the simulator to the clipboard in either metafile or bitmap format. There's also a Duplicate option for making multiple copies of a part or group of parts without resorting to the clipboard.

The Edit menu also features Delete, Mirror, and Rotate 90° options. Delete and Mirror are self explanatory, while Rotate rotates each selected object around its center, not the center of the selected area. Deletion or rotation can also be accomplished using the delete or rotation tools, respectively, both of which are available from the toolbar for ease of use. However, the delete tool only takes-out one object at a time. Note, wires don't remain connected after a rotation or mirroring as rubberbanding only works for classical move operations. Of course, if you don't like the appearance of your schematic after a change, you can undo the last edit.

The edit menu also has three electronics-oriented options: Edit Delay, Edit PROM, and Edit Pulser. The first option let's you set the propagation delay of selected parts on a schematic. The second allows you to program data bytes into the program's PROM device. The last option lets you adjust the output of the software's pulser tool, used to inject signals (stimulus) into a schematic during simulation. That option lets you set the pulser for free-running or external triggering (via its two inputs—one for high pulses, the other for low ones), set the high and low time of the probe, and invert the probe's output. The probe output does not enter a high-impedance state simply because the protection that that feature would offer a real circuit is unnecessary for a virtual one.

Simulating. The simulator is excellent. Simulation of digital circuits is completely live, so the circuit responds to stimulus from the probe and switches in real time. That interactively is one thing that makes the program an incredible learning tool.

Operation of the circuit can be observed in one of four ways. First, with the Trace option enabled, the state of every node in the circuit is shown simultaneously as the simulation runs. In this mode, a wire at a logic one is shown in red, a wire at a logic zero is blue, and a wire at a high-impedance state as green. Those colors can be changed if you wish.

Second, oscilloscope probes can be connected to any nodes in the circuit thus causing the timing diagrams for those nodes to be shown in a separate "Waveforms" window. To see the timing diagrams, click on the waveforms icon in the toolbar, or select waveforms in the option window.

Third, the probe tool can be used to monitor any node in the circuit, to inject logic into a node, or toggle a switch position, while the simulation is running or when it is stopped. You start by selecting the probe tool from the toolbar. Touch its tip to a wire to see its state, and click the mouse to toggle that state. If you touch a switch with it, the switch will toggle.

Fourth, you can connect any of a variety of displays to key points in the circuit, as the displays run in real time, too. Provided are ASCII, discrete, and 7-segment displays.

To start a simulation, you click on the run icon in the toolbar. To stop a simulation, you click on a stop-sign icon that replaces the run icon in the toolbar. Alternatively, you could click on the step icon to advance the simulation one tick at a time. To reset the circuit to the starting state, there's a reset icon as well.

CircuitMaker gives the user the option of setting breakpoints—a set of logic conditions at key points in the circuit that will halt the simulation. Basically, inside the waveform window you indicate the logic state that each point of interest should be in when you want the simulation to stop, then run the simulator. That allows you to check the circuit for performance accuracy during critical moments of operation.

The Tutorial. Besides the hands-on approach the simulator affords, the best aid for beginners in digital electronics is the manual's easy-to-follow tutorial. It includes 6 very simple, yet important experiments complete with questions and solutions. It breaks all of the experiments down into simple steps that anyone can perform and has a helpful glossary of terms.

While CircuitMaker may need a little more polish to take fuller advantage of the Windows environment, at only $199.95 plus shipping, it's an excellent digital simulator and learning tool. A demonstration version is also available for $10. If the program sounds interesting to you, please contact MicroCode at the address given earlier, or circle No. 119 on the Free Information Card. ■

PRODUCT TEST REPORTS

By Len Feldman

Yamaha RX-V870 Stereo Receiver

With more and more consumers opting for home-theater audio/video integration, many major manufacturers are now offering stereo receivers that can handle all the amplification, decoding, and switching operations needed to recreate the theater experience you enjoy when you attend a "blockbuster" motion picture in a properly equipped movie theater. Further, many of these new receivers offer digital signal-processing circuitry that can allow your listening room to mimic a variety of acoustic environments such as an opera house, a concert hall, a disco or a jazz club. One such receiver is the Yamaha (6722 Orangethorpe Ave., Buena Park, CA 90620) RX-V870. It offers all the electronics you would need for a complete home-theater installation, including amplifiers for the center and rear Dolby surround channels. All you need to add are the speakers, a monitor for video, and one or more program sources (VCR, CD player, etc.).

CIRCLE 120 ON FREE INFORMATION CARD

The Yamaha RX-V870 Dolby Pro Logic surround-sound A/V receiver.

The digital sound-field processor (DSP) incorporated in the RX-V870 includes a full Dolby Pro Logic surround decoder, with four program settings for audio-only sources and four settings for audio/video program sources. The receiver features an automatic input balance control for Dolby Surround as well as a test-tone generator for easy speaker-balance adjustment. There are three center-channel listening modes available: normal, wide and phantom (when no center-channel speaker is installed).

The built-in AM/FM stereo tuner is capable of 40-station random preset tuning. In addition to standard video-signal inputs and outputs, the unit can accommodate S-video signals. The receiver features a sleep timer for automatic turn-off as well as on-screen displays that are helpful in accessing all of its control features. A fully programmable, learning remote control is supplied with the receiver and it can be used to control other Yamaha components as well as components made by different manufacturers.

While priced somewhat higher than its predecessor, the Model RX-V850, the new Model RX-V870 offers many improvements. For example, the addition of 70mm Theater and TV Theater Cinema DSP programs. The former adds depth to the Dolby Pro Logic sound field, providing the impression of a much larger theater and greater separation between dialogue, sound effects, and music. In the audio-only applications, a "Church" mode and a "Jazz Club" setting have been added. Finally, the on-screen display is a major plus in setting up the system and in fine-tuning its controls.

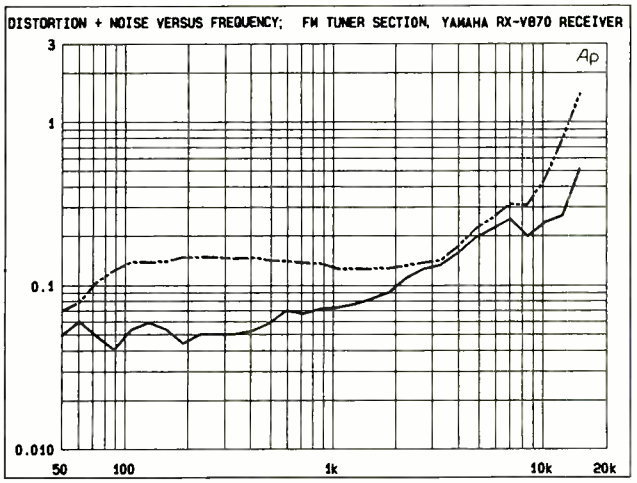
CONTROLS

The front panel of the RX-V870, though somewhat intimidating at first glance, is actually arranged in a logical fashion considering the number of features and control settings that must be handled. A power on/off switch and a stereo headphone jack are at the extreme left end of the panel. A well illuminated display area occupies the upper right section of the panel and offers useful status indications including surround-sound selections, time-delay selection (when used), tuner signal-strength, preset selection and frequency, and much more. Just below the display area are pushbuttons for center-channel mode selection and Pro Logic, "Enhanced," "70 mm," and "TV-Theater" modes, as well as pushbuttons for audio-only DSP modes including "Rock Concert," "Jazz Club," "Church," and "Concert Hall." A surround-sound on/

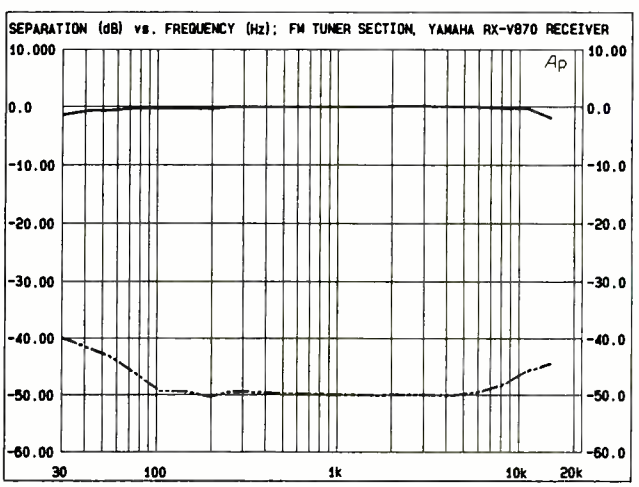
off button is also found here. Further down, below the display area, are buttons for adjusting time delay (when Pro Logic or DSP modes are active), and rocker-type buttons for adjusting the relative levels of the center, front, and rear channels. Along the bottom left of the panel are speaker-selector switches, a bass-enhancement button, and a tone-bypass pushbutton.

The upper-right section of the front panel houses a row of buttons used to select the program source. Just below these are eight numbered preset buttons that, when combined with a button that sequentially selects A,B,C,D or E groups of presets, provides for a mix of up to 40 AM and FM preset station settings. Below the preset buttons are an up/down tuning bar, a memory button, a tuning-mode button (automatic and manual), an AM/FM band-selector button, and the A/B/C/D/E button. The lower-right section of the panel houses the bass, treble, and balance controls as well as a selector switch that allows you to record one program source while listening to or viewing a different program source. A rotary master volume control is located at the extreme right end of the front panel.

The rear panel of the RX-V870 is equipped with separate FM and AM antenna-input terminals (an AM loopstick is an included accessory), the required number of stereo-audio and video input and output jacks (including S-video connectors), two sets of front-speaker terminals, speaker terminals for the rear and center-channel speakers and several jacks that Yamaha calls "accessory terminals." Those include front-out and front-in terminals (normally jumpered if the built-in front-channel amplifiers are used), rear-out and center-out jacks for those who prefer to use separate power amplifiers to drive those speakers rather than the built-in amplifiers, and a "low-pass" terminal used for feeding a mono amplifier, which in turn might be used to drive a subwoofer. The cut-off frequency for this last-named output jack is 200 Hz. At the extreme lower right of the rear panel there are two switched AC convenience outlets and one unswitched outlet.



This plot of harmonic-distortion-plus-noise versus modulating frequency shows that the distortion plus noise at 1 kHz was 0.074% for mono (solid curve) and 0.13% for stereo (dashed curve).



The stereo separation for the FM-tuner section of this receiver was exactly 50 dB at mid frequencies, and remained remarkably good even at high bass and treble frequencies.

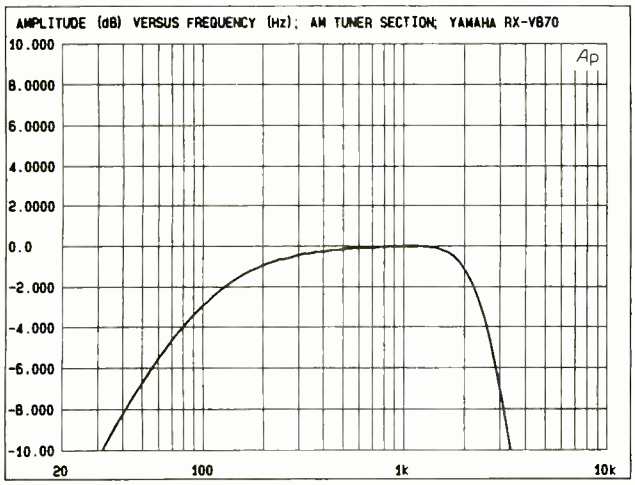
In addition to duplicating most of the control functions found on the front panel of the RX-V870, the remote control supplied with this receiver is used to activate the test tone used for speaker balance adjustment, for setting the sleep timer, for activating the on-screen display, and for muting volume level. As mentioned earlier, the remote control can also be "taught" the control signals for other components—even those produced by competing manufacturers. Special switch settings and blank buttons are provided for that purpose, along with overlay cards that fit over the existing buttons and can be labeled with the learned functions.

LAB MEASUREMENTS

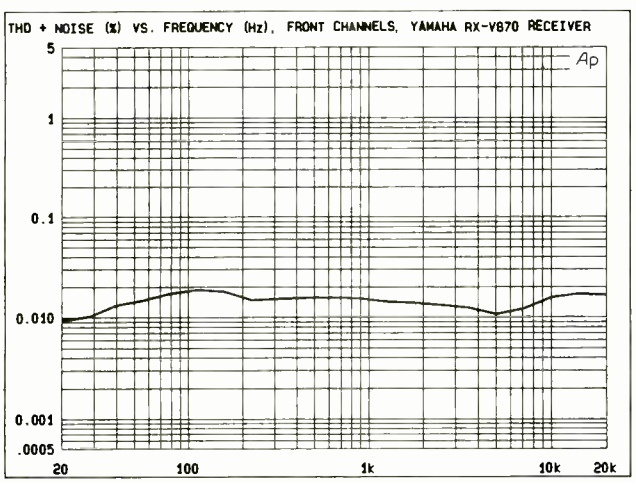
We measured the performance of the tuner section of this receiver first. The frequency response of the FM tuner section. was down 2.0 dB at the 20 Hz and 15 kHz frequency extremes, easily meeting the published specification of ±1.5 dB. The unit attained 50 dB quieting in mono with only 14 dBf of input signal, while in stereo, 37 dBf of signal strength was required for the same degree of quieting. Both results are somewhat better than what is claimed by Yamaha. Strong-signal signal-to-noise ratios measured 78.5 dB for mono reception and 72.5 dB for stereo signals.

At 1 kHz, harmonic-distortion-plus-noise versus modulating frequency for mono measured only 0.074%, while in stereo, the reading was 0.13%. Again, both results were substantially better than claimed by the manufacturer. The mono usable sensitivity (the signal level required to produce a 30-dB signal-to-noise ratio) measured approximately 9 dBf.

The stereo separation for the FM tuner section was exactly 50 dB at mid-frequencies, just as claimed by Yamaha. More remarkably, even at 100 Hz, stereo separation remained a high 48 dB, and at 10 kHz, where most FM-stereo circuits tend to show markedly decreased separation, the RX-V870 still boasted a separation of 46.5 dB. All other FM performance specifications either met or exceeded published claims, as can be seen by consulting the Test Results table that appears



Yamaha made no claims for the frequency response of the AM-tuner section of this receiver, and this plot shows why. Unfortunately, such performance is typical of many otherwise excellent stereo receivers.



This plot of the front-left and front-right channel harmonic distortion versus frequency (at the maximum rated output of 80 watts) verified Yamaha's published specification of 0.015%.

elsewhere in this report.

Yamaha made no claims for the frequency response of the AM tuner section of this receiver, and testing revealed a good reason for that omission. As is true of so many "high fidelity/stereo" receivers, the AM frequency response was not nearly as good as it could be if a little more design effort were applied to that portion of the circuitry. As matters stand, however, the −6 dB roll-off points for AM response occurred at 58 Hz and at 2.85 kHz. In all other respects, however, the AM-tuner section lived up to the published claims made for it, with a usable sensitivity reading of 95 μV/m, selectivity of 32 dB, and a signal-to-noise ratio (for strong signals) of 50 dB.

Turning to the pre-amplifier and amplifier sections of the receiver, we applied signals to the CD (high-level) inputs and measured the overall frequency response, which was down 1.5 dB at 20 Hz and at 50 kHz. Next, we plotted distortion versus frequency, with the input levels adjusted to maintain a constant 80-watts-per-channel (the rated output) at the front-left and front-right speaker outputs, which were connected to 8-ohm loads. At mid-frequencies, harmonic distortion was almost exactly 0.015%, as claimed by Yamaha. Even more remarkably, at 20 Hz, harmonic distortion was even a bit lower, measuring 0.01%. Most power amplifiers tend to show increased distortion at that extreme bass frequency, but the amplifier sections of this receiver handled those low frequencies with no trouble.

Many surround-sound stereo receivers provide reduced power levels for their center-channel output. However, repeated experiments have shown that, ideally, the center-channel output power should be as great as that available for the front-left and front-right channels. The Yamaha RX-V870 receiver subscribes to that ideal, offering the same 80-watt rating for its center-channel output as is

TEST RESULTS—YAMAHA RX-V870 AUDIO/VIDEO RECEIVER

Specification	Mfr's Claim	PE Measured
FM Tuner Section		
50 dB quieting (mono/stereo)	15.1/37.7 dBf	14.0/37.0 dBf
S/N ratio (mono/stereo)	81/76 dB	78.5/72.5 dB
Distortion (mono/stereo)	0.1/0.2%	0.074/0.13%
Stereo separation (1 kHz)	50 dB	Confirmed
Response 20 Hz to 15 kHz	±1.5 dB	±1.0 dB
Alt. channel selectivity	85 dB	87 dB
Mono usable sensitivity	9.3 dBf	9.0 dBf
Image rejection	45 dB	48 dB
IF response ratio	80 dB	Confirmed
AM suppression	55 dB	56 dB
Capture ratio	1.5 dB	Confirmed
Audio output level	700 mV	690 mV
AM Tuner Section		
Usable sensitivity	100 μV/m	95 μV/m
Selectivity	32 dB	Confirmed
S/N ratio	50 dB	Confirmed
Image rejection	40 dB	42 dB
Distortion	0.3%	Confirmed
Audio output level	200 mV	Confirmed
Audio Section		
Power output/channel (8 ohms)		
Front	80 watts	83 watts
Center	80 watts	100 watts
Rear	25 watts	27 watts
Input sensitivity		
Phono	2.5 mV	Confirmed
High-level inputs	150 mV	145 mV
Max. phono input (1 kHz)	90 mV	100 mV
Signal-to-noise ratio		
Phono (re: 5 mV)	86 dB	Confirmed
High-level inputs	93 dB	95 dB
Tone-Control Range		
Bass (50 Hz)	±10 dB	+11, −9 dB
Treble (20 kHz)	±10 dB	+10.5, −11 dB
Bass extension (50 Hz)	+7 dB	Confirmed
Frequency response (20 Hz-20 kHz)	±1.5 dB	+0 −1.5 dB
General Specifications		
Power consumption	300 watts	Confirmed
Dimensions (W×H×D, inches)	17⅛×6¼×18⅞	Confirmed
Weight	32 lbs. 9 oz.	Confirmed
Suggested price:	$899.00	

available for the front-left and front-right outputs. In fact, our tests revealed that if the center-channel amplifier is the only channel driven, it is capable of providing as much as 100 watts into 8-ohm loads. We also measured the output power available at the rear-channel speaker terminals and confirmed that those amplifier channels were able to deliver in excess of the 25-watts-per-channel claimed for them.

Tests of the tone-control circuitry showed that their action was typical of most such tone-control circuits. Finally, we applied low-level signals to the phono inputs of the receiver in order to measure the accuracy of the phono equalization. Mid- and high-frequency phono equalization was as close to perfect as we have seen, while at 20 Hz, deviation from the RIAA curve amounted to no more than −1.6 dB. Maximum input for the phono circuitry, for a 1-kHz test signal measured 100 mV, or 10 mV more than claimed by Yamaha.

Phono signal-to-noise ratio, referred to a 5-mV input signal, measured exactly 86 dB as claimed by Yamaha, while the signal-to-noise for the various high-level inputs, referred to an input level of 0.5 volts, measured 95 dB. The bass extension feature, activated by a front-panel pushbutton, provided a fixed 7 dB of bass boost at 50 Hz, as listed in the specifications.

HANDS-ON TESTS

A headline found in Yamaha's brochure detailing the features of this new receiver states, "Everything That a Receiver is Supposed to Do—and More That You Never Dreamed a Receiver Could Do." We couldn't agree more! While most present-day surround-sound stereo receives do a creditable job of Dolby Pro Logic decoding, few, if any, offer the additional 70mm movie-theater mode and the Dolby Pro Logic Enhanced mode provided by the Yamaha RX-V870. The 70mm mode offers sound-field expansion for both front and rear channels, producing all the dramatic intensity and sweeping grandeur of big-theater sound at its best.

We auditioned and viewed several excerpts from some of the better known action films on laser videodiscs, including scenes from "Raiders of The Lost Ark," "Top Gun," and "Always." They never sounded better.

Almost as impressive were the surround sounds we experienced when playing ordinary stereo CD's and subjecting them to one or more of the digital signal-processing modes available on this receiver. Especially noteworthy was the realistic ambiance created when listening to pipe organ recordings in the "Church" DSP mode and to several symphonic recordings played back using the "Concert Hall" settings.

When you consider all the features and flexibility offered by the Yamaha RX-V870, its suggested price of $899.95 is nothing less than a real bargain! For more information on the RX-V870 contact Yamaha directly, or circle No. 120 on the Free Information Card. ■

THINK TANK

By John J. Yacono

Pinouts and Tools

This month, I'll present some 7400-series chips that have alternate pinouts and functional blocks (as promised last time). It came as a surprise to me (and maybe to you, too) when I first learned that some 7400-series chips with the same function number, but different architecture (L, S, LS, H, or F), had differing "guts" and pinouts. In fact, I, frankly, don't know why that is the case.

Unfortunately, there are too many examples of alternate pinouts to review them all here. However, I can present a few examples of the functional discrepancies, with just one pinout each. Furthermore, rather than bore you with a gate-by-gate description of the chips, I'll present a truth table for each chip section.

The discrepancies in the 7400 series begin with the 7451. It has one pinout style for the standard, high-power, and Schottky versions (Fig. 1A) and another for the low-power and low-power Schottky (Fig. 1B). The key difference is that the unit in Fig. 1A has 2-input AND gates, while one section of the chip in Fig. 1B has 3-input AND gates. The truth table for the 3-input AND gate section is shown in Table 1, while the other sections are governed by Table 2. By the way, pins 11 and 12 for the chips represented by Fig. 1A should never be connected to anything.

The 7453 comes in two varieties: standard TTL (see Fig. 2A) and high-power (in Fig. 2B). The key difference is again in their AND-input stages. The standard unit has four 2-input AND gates, while the other has three 2-input gates. The truth table for the standard unit is shown in Table 3, and the other in Table 4. Note the pins labeled N and $\overline{N}$ are expansion inputs for chaining more than one unit together, and so do not appear in either table. Once again don't connect the unused pin (pin 6 in Fig. 2A).

Now I'll end this introduction with a real teaser; a chip with three pinouts: the 7454. The standard form of the chip is shown in Fig. 3A, and its truth table is in Table 5; the low-power and low-power Schottky format is in Fig. 3B and Table 6; and last, Table 7 and Fig. 3C provide the high-power version information.

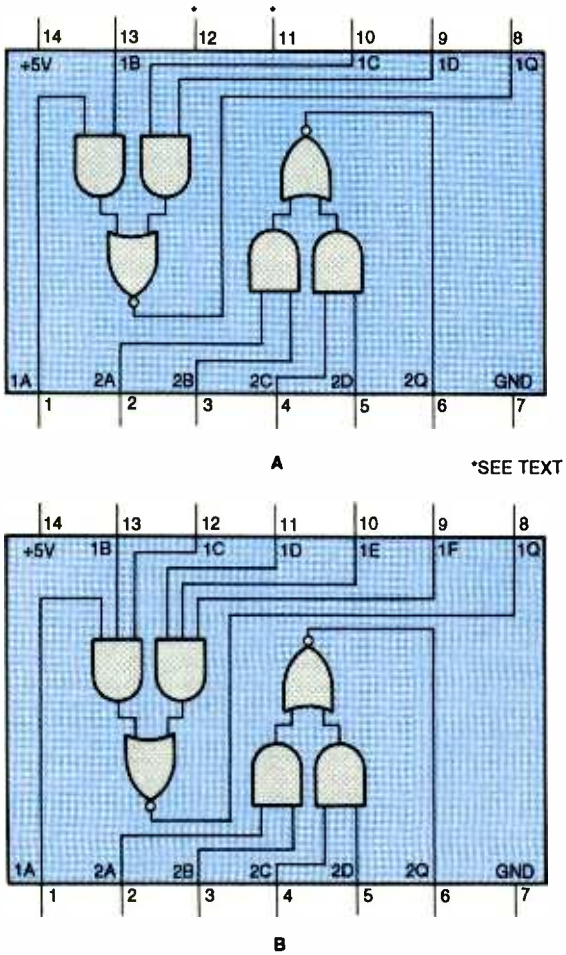


Fig. 1. Some versions of the 7451 have only 2-input AND gates (A), while others have a section based on 3-input AND gates (B).

TABLE 1—3 INPUT AND STYLE

Inputs						Output
1A	1B	1C	1D	1E	1F	1Q
H	H	H	X	X	X	L
X	X	X	H	H	H	L
All other combinations						H

TABLE 2—2 INPUT AND STYLE

Inputs				Output
A	B	C	D	Q
H	H	X	X	L
X	X	H	H	L
All other combinations				H

TABLE 3—7453 TRUTH TABLE

Inputs								Output
A	B	C	D	E	F	G	H	Q
H	H	X	X	X	X	X	X	L
X	X	H	H	X	X	X	X	L
X	X	X	X	H	H	X	X	L
X	X	X	X	X	X	H	H	L
All other combinations								H

TABLE 4—74H53 TRUTH TABLE

Inputs									Output
A	B	C	D	E	F	G	H	I	Q
H	H	X	X	X	X	X	X	X	L
X	X	H	H	X	X	X	X	X	L
X	X	X	X	H	H	H	X	X	L
X	X	X	X	X	X	X	H	H	L
All other combinations									H

TABLE 5—7454 TRUTH TABLE

Inputs								Output
A	B	C	D	E	F	G	H	Q
H	H	X	X	X	X	X	X	L
X	X	H	H	X	X	X	X	L
X	X	X	X	H	H	X	X	L
X	X	X	X	X	X	H	H	L
All other combinations								H

TABLE 6—74L54 AND 74LS54 TRUTH TABLE

Inputs										Output
A	B	C	D	E	F	G	H	I	J	Q
H	H	X	X	X	X	X	X	X	X	L
X	X	H	H	H	X	X	X	X	X	L
X	X	X	X	X	H	H	H	X	X	L
X	X	X	X	X	X	X	X	H	H	L
All other combinations										H

TABLE 7—74H54 TRUTH TABLE

Inputs									Output
A	B	C	D	E	F	G	H	I	Q
H	H	X	X	X	X	X	X	X	L
X	X	H	H	X	X	X	X	X	L
X	X	X	X	H	H	H	X	X	L
X	X	X	X	X	X	X	H	H	L
All other combinations									H

All the Tables and pinouts have used up a lot of space for this month's introductory topic. So we'll have to continue this discussion next month. As for now, to the mail bag . . . .

AN OUNCE OF PREVENTION

I recently read about the "AC-Short Circuit Indicator" by John A. Alvarez in *Think-Tank,* **Popular Electronics,** March, 1993. I have used a similar circuit for many years in electronics. I am enclosing a schematic diagram of the circuit as I use it (see Fig. 4). Switch S1 is a SPDT center-off toggle switch, which eliminates the need for plugging-in and unplugging the device being tested. Fuse F1 can be a fuse or circuit-breaker of suitable rating, which is included in the circuit to avoid blowing the appropriate house fuse.

I use several sizes of bulbs for I1. For testing a small device, I may use a 60-, 40-, or even a 25-watt bulb. For testing a large device, I may use a 200-watt bulb or a 250-watt heat lamp. I also use several sizes of bulbs when I use this circuit in what a friend calls my "poor-man's Variac." When I want to test a device at reduced line voltage, I start with a smaller bulb and go to larger ones until I get to the voltage I want.

I think I can best describe how SO2 is used by telling

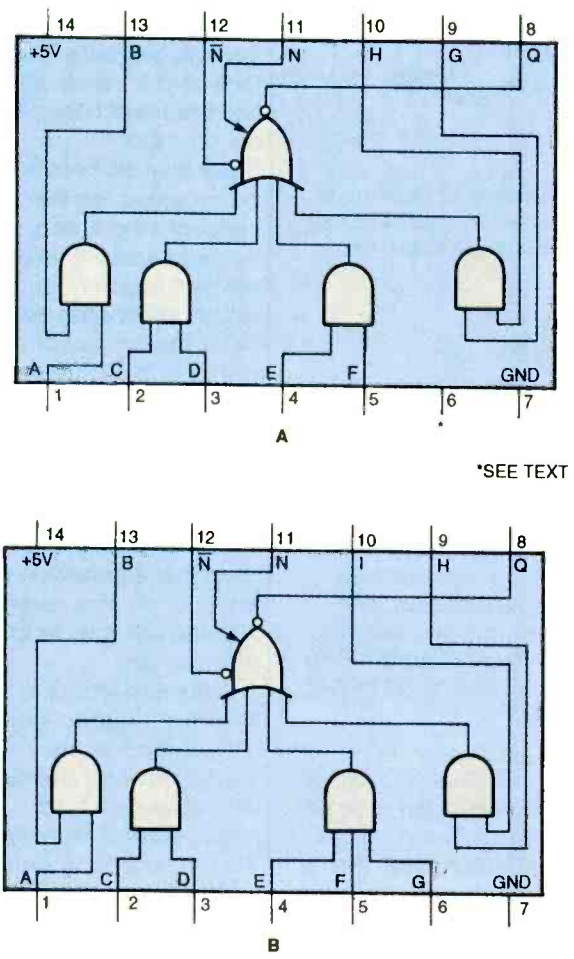


Fig. 2. While both versions of the 7453 are expandable (via their N and N̄ inputs), one has only 2-input AND gates (A), while the other has one 3-input AND gate (B).

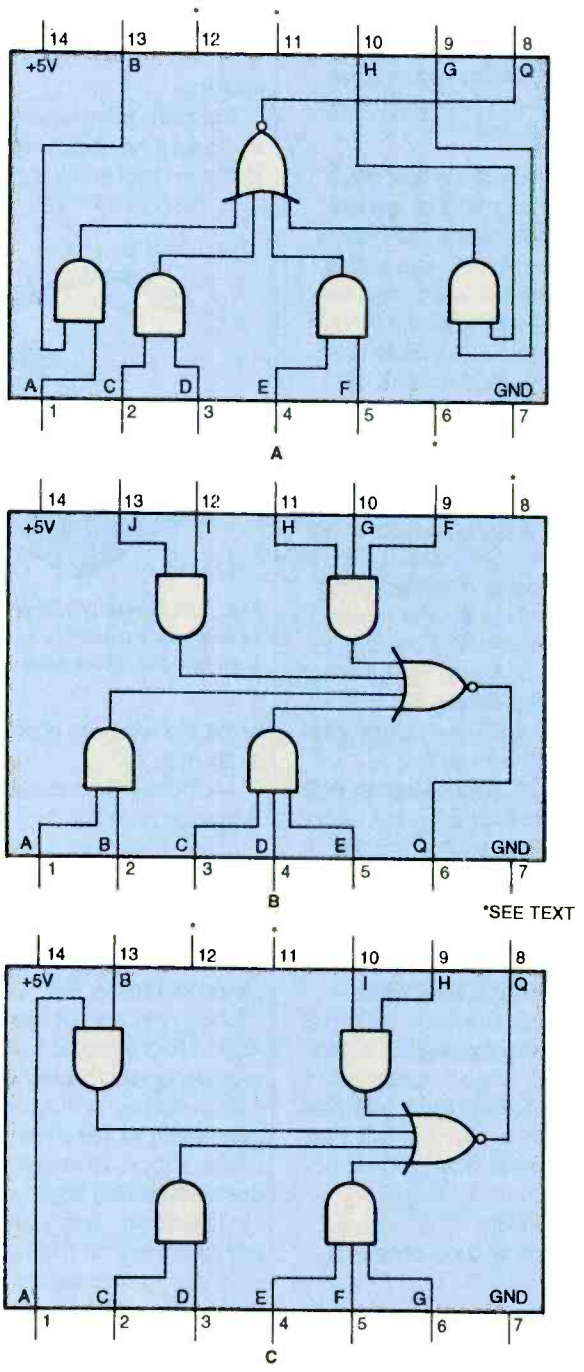


Fig. 3. The AND gates on a 7454 can be four 2-input types (A); a mix of two 2-input and two 3-input types (B); or three 2-input gates with one 3-input type (C).

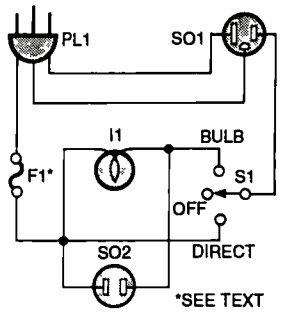


Fig. 4. This short-circuit checker not only protects your household wiring from "ill" devices under repair, but can act as a poor-man's Variac, too.

how I used it a few days ago. I wanted to test an electric motor that had been given to me, which I was told blows fuses. I used a 200-watt bulb for I1, and plugged a portable electric heater into SO2. The heater has two settings, 750 watts and 1500 watts. I set the heater to 750 watts and plugged in the motor. The bulb lit and the heater got warm, confirming a short in the motor. After repairing the short, I set the heater to 1500 watts. The motor ran (with no load), and the bulb glowed very dimly, so I switched S1 to "Direct" and the motor ran fine.

—Bill Stiles, Hillsboro, MO

Simple and useful. I wonder if a light-bulb socket or two in parallel with SO1 would be useful for that 250-watt heat-lamp bulb?

RIBBON CHECKER

I came up with a simple but effective way to easily check ribbon-cable assemblies. Take a short piece of ribbon cable that has one extra wire (use 26-conductor ribbon for DB-25 assemblies, or 37-conductor ribbon for Centronics connections) and peel one edge wire back about half way from each end (see Fig. 5). Strip the edge wires and apply circular lugs to them as test points. Install a female and a male IDC to each end of the ribbon to allow any combination of connectors (male-male, male-female, or female-female) to be checked.

With the cable to be tested plugged into the appropriate connectors, all the wires will, in effect, be connected in series. With an ohm meter or continuity checker connected to the lugs, you can check every wire and connection in one reading.

The darn thing worked so well that it has become a standard tool in my shop. I hope this will help others as it did me.

—Charles Blanchard, Wilmington, NC

I love doing tricks with ribbon cable (like multiple connectors on the same line). Once I made a Y-connection using a single piece of ribbon. First I attached one end of the ribbon to my project, which was designed to send two sets of signals, one to each connector at the other end of the ribbon. One of those connectors was applied upside down. Then I drilled out any holes on the two connectors that would cause a conflict. Two sets of signals, one cable, no conflicts!

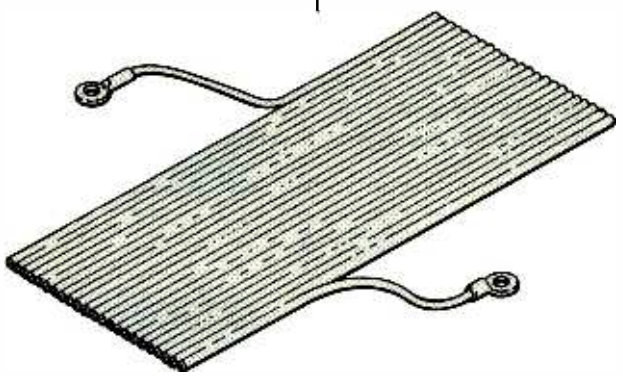


Fig. 5. A length of ribbon cable can help you check an entire ribbon-cable assembly with one measurement. Start by peeling back one wire from each end as shown and add connectors.

A HOT TIP

Like almost all electronics techs, my soldering iron sits turned on in its stand, hour after hour. Although the stand radiates heat effectively, it seems that I'm always replacing heater elements (at least a couple of times per year). Also, depending on its age, the element I'm using always seems either too hot or too cool for the next point to be soldered.

So, here's what I did. A trip to the local hardware store turned up a metal outlet box, a few feet of 16-gauge 3-conductor AC line cord, a three-terminal AC plug, and a switched-outlet receptacle. My junkbox provided one 1N4004 diode. Wiring the diode across the switch contacts (see Fig. 6) provided a simple method of inserting the diode into or shorting it out of the AC line. All that was left to alter was my iron, so I waited for the death of the element I was currently using. I replaced it with a 45-watt element and I plugged the iron into the switched (shunted-diode) outlet.

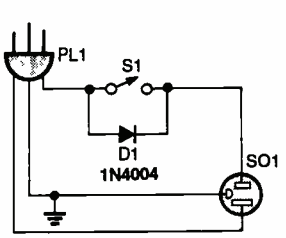


Fig. 6. This custom soldering-iron outlet can save your elements, tips, money, and time, and help save the environment. Pretty darn good for a one-evening project!

When the iron is idling along, powered through the diode, it uses less power, generates less heat, and the tip lasts much longer. A surprise came once when I used the iron on a small PCB I was fixing. It had been idling along and I had forgotten to switch to full power. I found that the 45-watt element did an admirable job, even when set to low.

When I had to have more heat, throwing the switch to high (simply shunting the diode out) restored the iron to its full 45-watt capability in less than 1 minute. Since the switched outlet has it's own cord, it travels with the iron whenever I need to go out on a job.

Not only are heat and power saved, the life of the element is increased, so the hassle of traveling to my element supplier has been virtually eliminated. Furthermore, the amount of old elements taking up space in the local dump has also been reduced. Remember, less garbage equals a better environment!

Oh yes, the results? This is the **seventh year** that I'm using that element and I hope for another seven! Also, the iron tips are lasting much longer!

—Bernard Maguire, Montreal, Quebec, Canada

I would never have thought your solution would work as well as it did. I mean, your getting 14 times the use out of one element so far. That's pretty incredible. Frankly, if it works that well, I think you've got the makings of a great product on your hands.

(Continued on page 89)

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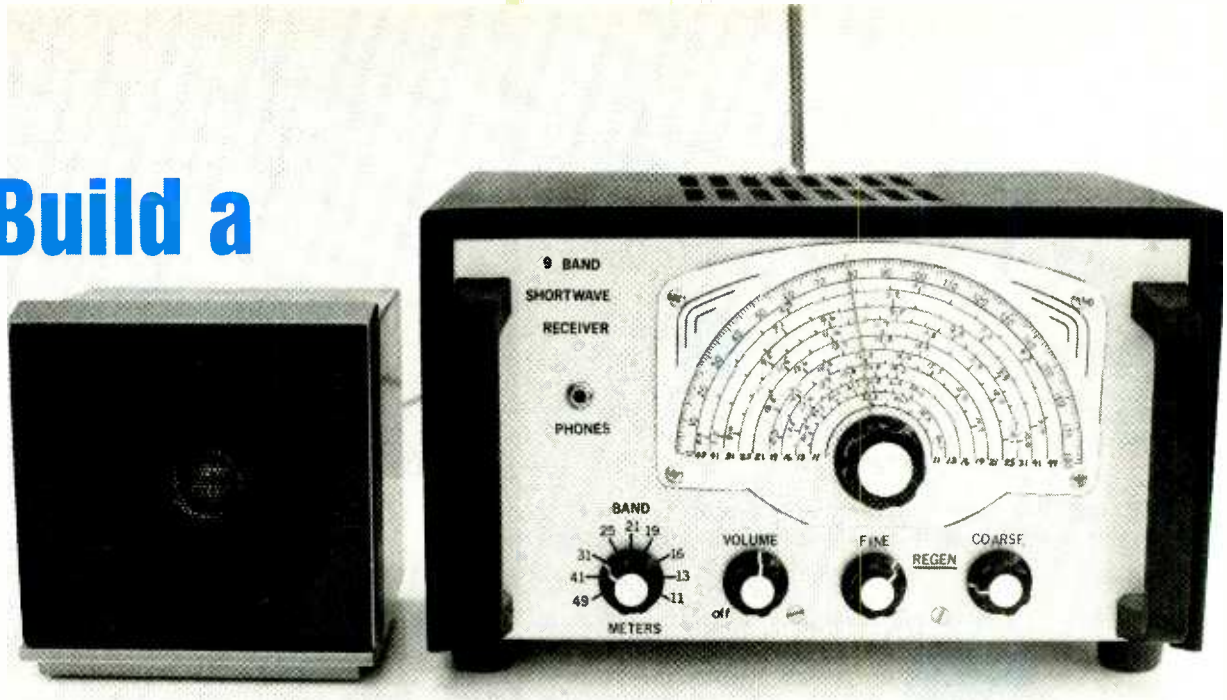


Nine-Band Shortwave Rec

Tune in on the world with this nine-band solid-state version of the classic regenerative receiver

BY LYLE RUSSELL WILLIAMS

Although once extensively used in military and maritime applications, today the regenerative receiver is generally viewed as a hobby or toy circuit. However, the redesigned regenerative receiver described in this article is much more than a toy or a historical curiosity. The *World Band Regenerative Radio* (which hereafter will be referred to as the WBR) can receive all nine shortwave broadcast bands, allowing you to listen to numerous foreign, English-language stations—such as the BBC, Radio Netherlands, Radio Canada, Radio China, and Japan Radio. If so desired, the number of bands can easily be extended beyond the initial nine provided on the basic receiver. It can also receive single-side band (SSB) and continuous-wave (CW) code signals.

Unlike traditional regenerative receivers, the WBR has a calibrated frequency dial and uses a short whip antenna. The unit also has an output that can be fed to a frequency counter to provide a digital frequency readout. Also, because there are no custom parts (including inductors), the WBR is easy to build.

Regenerative Radio. There are three favorable characteristics of regenerative radios: For a one-tube or transistor device, it has extraordinary sensitivity; for a one resonant-circuit device, it has extraordinary selectivity; and unlike a single-conversion superhet, the regenerative radio does not produce unwanted image signals.

A schematic diagram of the traditional tube-based regenerative receiver is shown in Fig. 1. That circuit is essentially an RF oscillator with variable feedback (that is connected to an antenna) with a resonant circuit composed of variable-capacitor C1 (the tuning control) and inductor L1. Feedback is provided through a second coil (L2), called a tickler coil, that is located on the same coil form as L1 and is wired into the tube's plate circuit. The amount of positive or regenerative feedback is controlled by a variable resistor that's connected across the tickler.

The quality (Q) factor of the resonant circuit without feedback is less than 50 when loaded by the antenna and the vacuum tube. When the feedback of the oscillator is adjusted so that it is just below the point of oscillation, the Q of the resonant circuit increases to around 1000. That increase in Q greatly amplifies the signal and narrows the bandwidth of the resonant circuit.

The tube is biased so that plate detection of an AM signal can take place. Thus, RF amplification and AM detection are accomplished with a single vacuum tube. The 3–30-pF trimmer capacitor (C2) that is connected in series with the antenna is used to reduce the loading effect of the antenna. In some cases, antenna loading can be large enough to prevent oscillation. The regenerative principle is sometimes used in different parts of superhet radios: The second detector, intermediate-frequency (IF) amplifier, or the radio-frequency (RF) amplifier stage can be regenerative. In the latter case, the stage is called a Q multiplier.

A review of approximately 40 regenerative-receiver designs revealed some interesting characteristics of the traditional circuits. There are over a dozen distinct types of RF oscillators (such as Colpitts, Hartley, Pierce, etc.), any of which could be used as the basis of a regenerative radio. But for

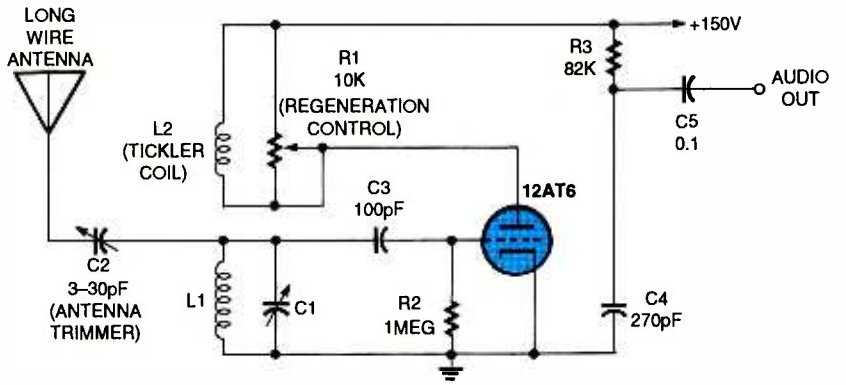


Fig. 1. The traditional tube-based regenerative receiver is essentially an Armstrong RF oscillator with variable feedback that is connected to an antenna and a resonant circuit.

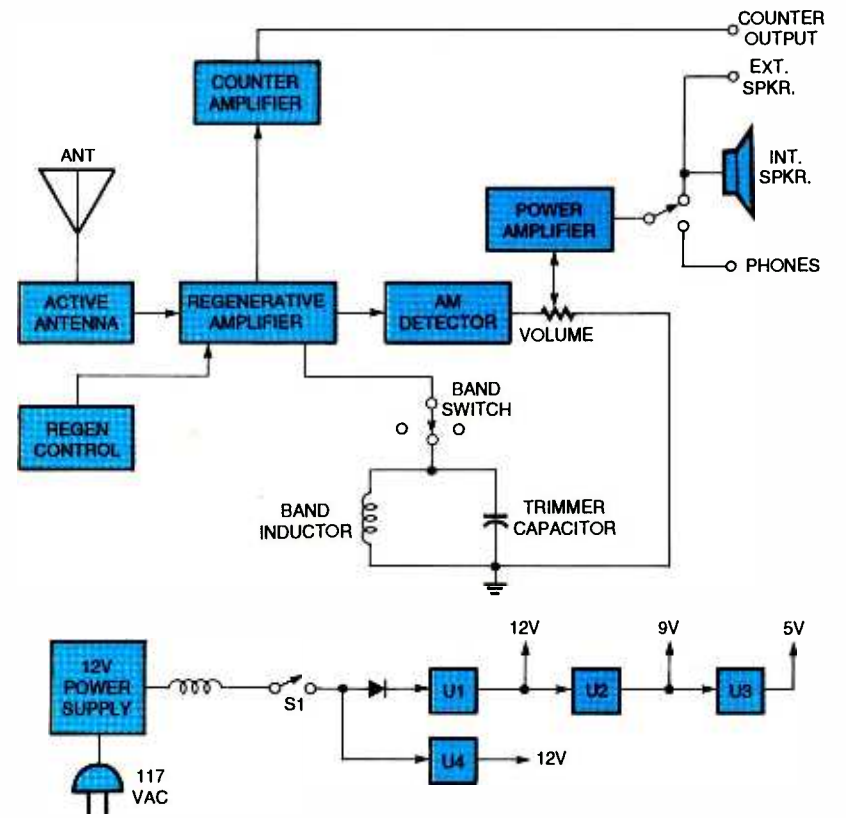


Fig. 2. As shown by this block diagram, the WBR is composed of several subassemblies: An active antenna, an amplifier (with a regeneration control and a band-switching circuitry), an AM detector, a power amplifier, and some form of output device (internal speaker, external speaker, or headphones), plus a multi-voltage power supply.

some reason, nearly all of the old designs used the basic Armstrong circuit shown in Fig. 1.

Tradition must have played a role in the strong preference for the Armstrong circuit. It was well known that using a pentode tube in a regenerative receiver was superior to the triode design. However, nearly all of the old circuits were of the triode type. Almost none of the old circuits had a volume control. The volume of the receiver had to be reduced by backing off the regeneration control, which had the undesirable effect of widening the bandwidth of the circuit. Fortunately, those and other undesirable characteristics of the traditional regenerative receiver have been overcome in this modern, solid-state design.

The WBR Receiver. A block diagram of the WBR is shown in Fig. 2. The receiver is composed of several subassemblies: An active antenna, an amplifier (with a regeneration control and band-switching circuitry), an AM detector, a power amplifier, and some form of output device (internal speaker, external speaker, or phones), plus a multi-voltage power supply.

The schematic diagram of the WBR is shown in Fig. 3. In that solid-state version of the regenerative receiver, a dual-gate MOSFET, Q4 (which is analogous to a pentode vacuum tube), is used as the regenerative amplifier. The dual-gate MOSFET is configured as a Colpitts oscillator, rather than an Armstrong type. The MOSFET's feedback from source to gate is provided via R18 and C33.

The circuit contains several standard fixed-value inductors, each of which is connected in parallel with a small variable capacitor. Those L/C pairs along with a SP12T rotary switch (S2) are used for band selection. Plug-in coils were very popular for band switching in the past, but this rotary-switch arrangement is cheaper and more convenient.

Regenerative amplification and AM detection are performed by two separate transistors, Q4 and Q5. The AM detector (which is called an infinite impedance detector) has the advantage of not loading the RF stage appreciably. Because D3 is operated with a slight forward bias, either a germanium or silicon diode can be used in that position. The DC voltage across R24 (the volume control) should be about 0.1 volts.

Regeneration is controlled by varying the voltage applied to gate 2 of Q4. That changes the transconductance of the transistor. The circuit also contains fine and course regeneration controls that allow delicate adjustments.

The traditional regenerative receiver required at least an indoor long-wire antenna for proper reception. The WBR, on the other hand, uses an active-antenna circuit, consisting of transistors Q1, Q2, and Q3. Thanks to that circuit, under most conditions, a short whip antenna is adequate.

The active-antenna circuit connects to gate 2 of Q4, while the resonant circuit is connected to gate 1. The resonant circuit is isolated from the antenna and tuning is independent of antenna length, allowing a

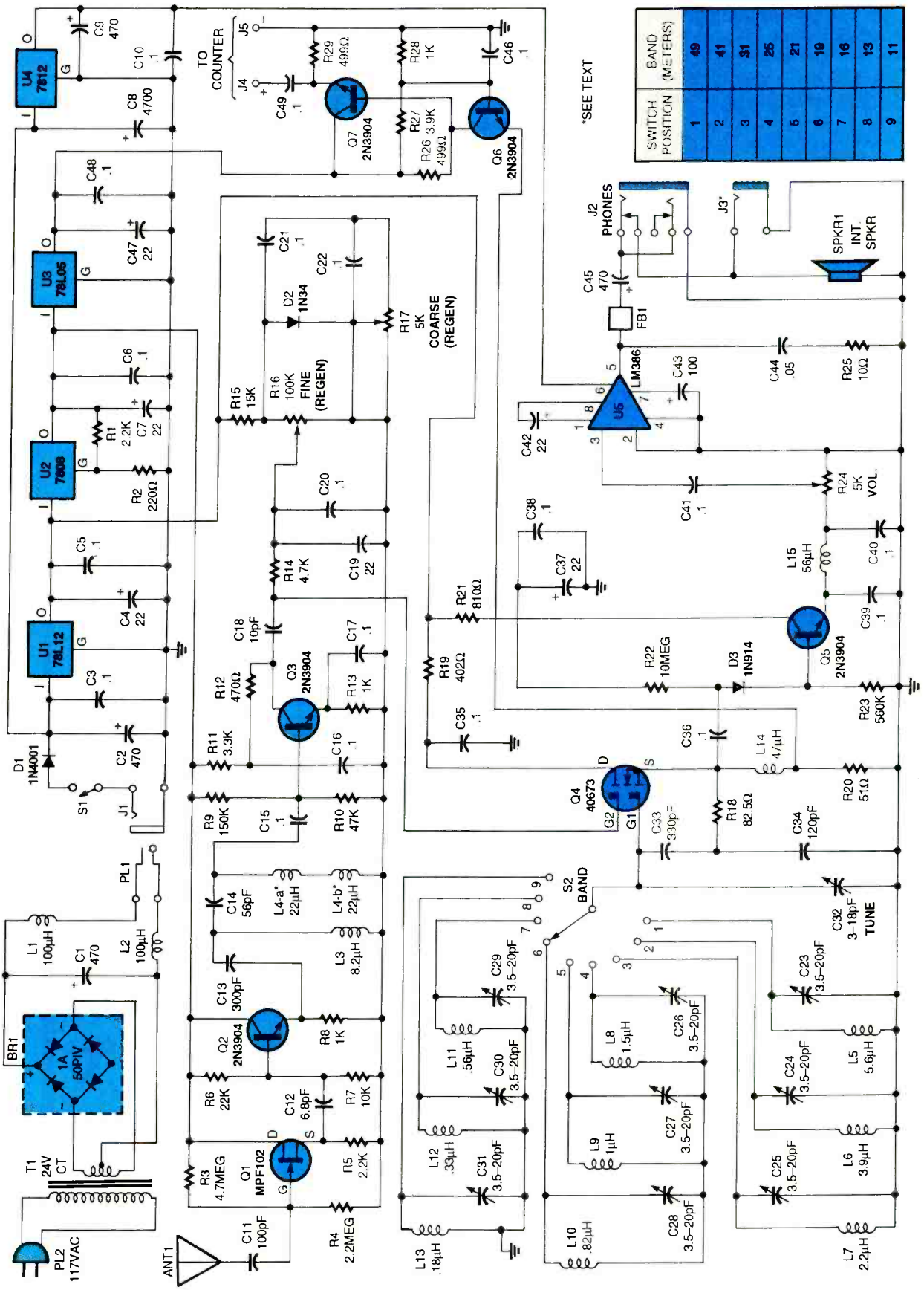


Fig. 3. In this solid-state regenerative receiver, a dual-gate MOSFET configured as a Colpitts oscillator takes the place of the vacuum-tube based Armstrong oscillator that was used in the traditional version.

calibrated dial to be used on the tuning capacitor. The level of regeneration as set by R16 and R17 is unaffected by the antenna, and so the WBR does not require an antenna trimmer.

Components C12–C14, C18, L3, L4, R6, R7, and R14 form a high-pass filter (which has a cutoff frequency of 3.4 MHz) that prevents local broadcast stations from overloading the circuit. If operated in a rural area away from strong stations, that filter can be disabled. (The high-pass filter may have to be modified if bands below 3.4 MHz are added to the WBR.)

Many traditional regenerative receivers had tuning ranges as large as 10-MHz per band. But in our circuit, using a low-value tuning capacitor allows the circuit to tune only the shortwave broadcast bands—which vary in width from 350 kHz to 700 kHz. Narrowing the range makes the receiver easier to tune. It is not necessary to use a reduction drive on the tuning capacitor. A simple knob with a pointer is adequate.

Although a standard 12-position rotary switch was used for S2, only 9 positions are needed. However, the three additional switch positions can be used to extend the range of the WBR. The extra positions could be used for the ham bands, WWV signals at 5 MHz and 20 MHz, or some other segment of the shortwave spectrum. In order to add the extra band, the band inductances must be determined. The inductances required for the extra bands, are given by:

$$L = [f \times 6.96 \times 10^{-5}]^2$$

where L is the desired inductance in henrys, and *f* the is the center frequency of the desired band in hertz. The equation assumes a mean tuning capacitance of 123 pF. To receive the WWV time signal at 5 MHz, the required inductor would be 8.25 μH.

Resistor R20 is used to sample the RF signal in the regenerative amplifier without affecting its operation. The signal is amplified by Q6 and Q7, and fed to J4 and J5 for application to an external frequency counter if desired.

Construction. Except for the power supply, the controls, the connectors, and the internal speaker, the entire circuit was assembled a 5- × 6-inch, single-sided, printed-circuit board. A template for the printed-circuit layout is shown in Fig. 4. Once you have etched your board and obtained the parts listed in the Parts List, construction can begin.

Guided by Fig. 5, begin assembly by installing the passive components (resistors and capacitors), making sure that the polarized capacitors are correctly oriented. After installing the passive components, install the semiconductors; start with the diodes, followed by the transistors, and then the IC's.

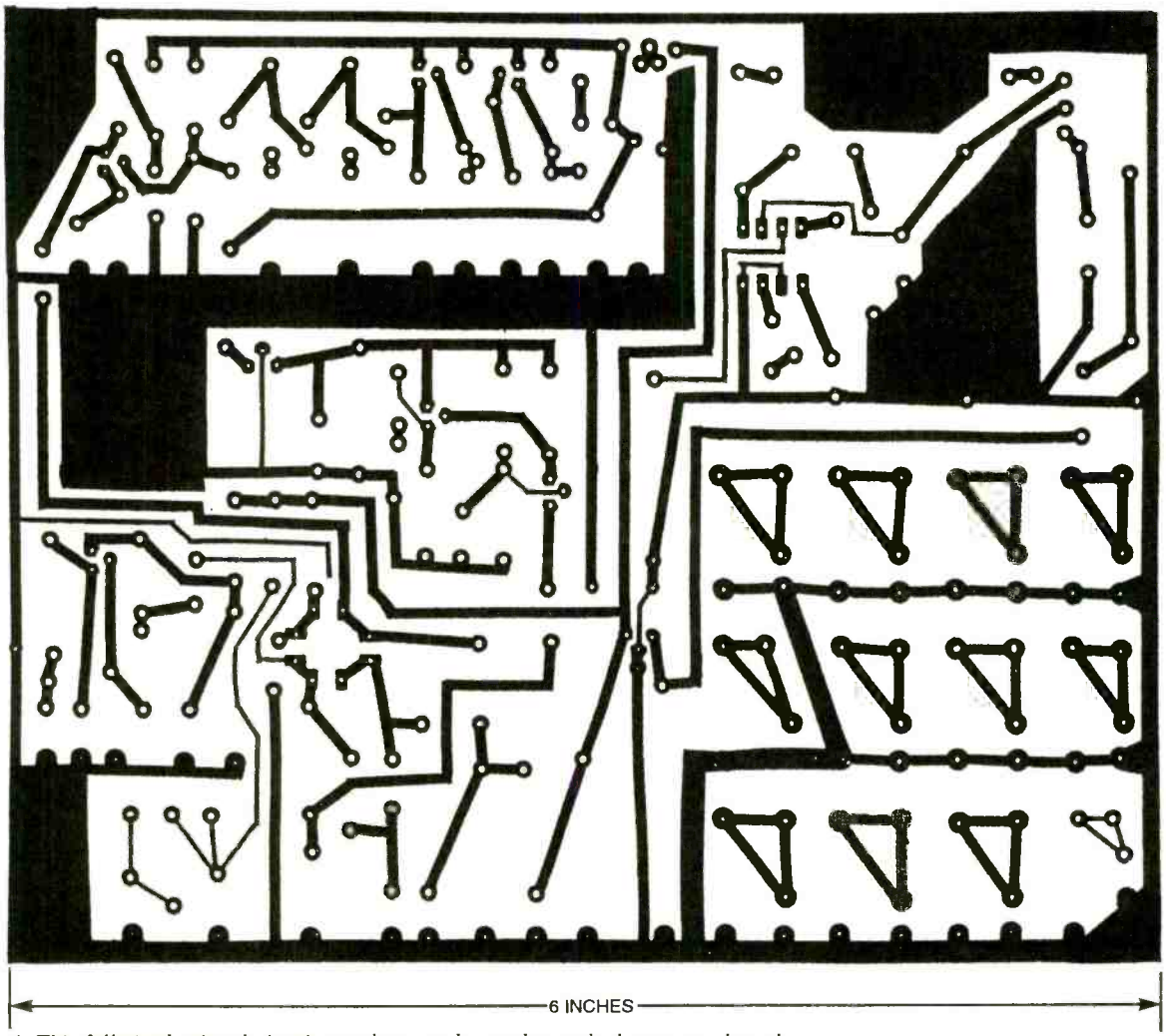


Fig. 4. This full-sized printed-circuit template can be used to etched your own board.

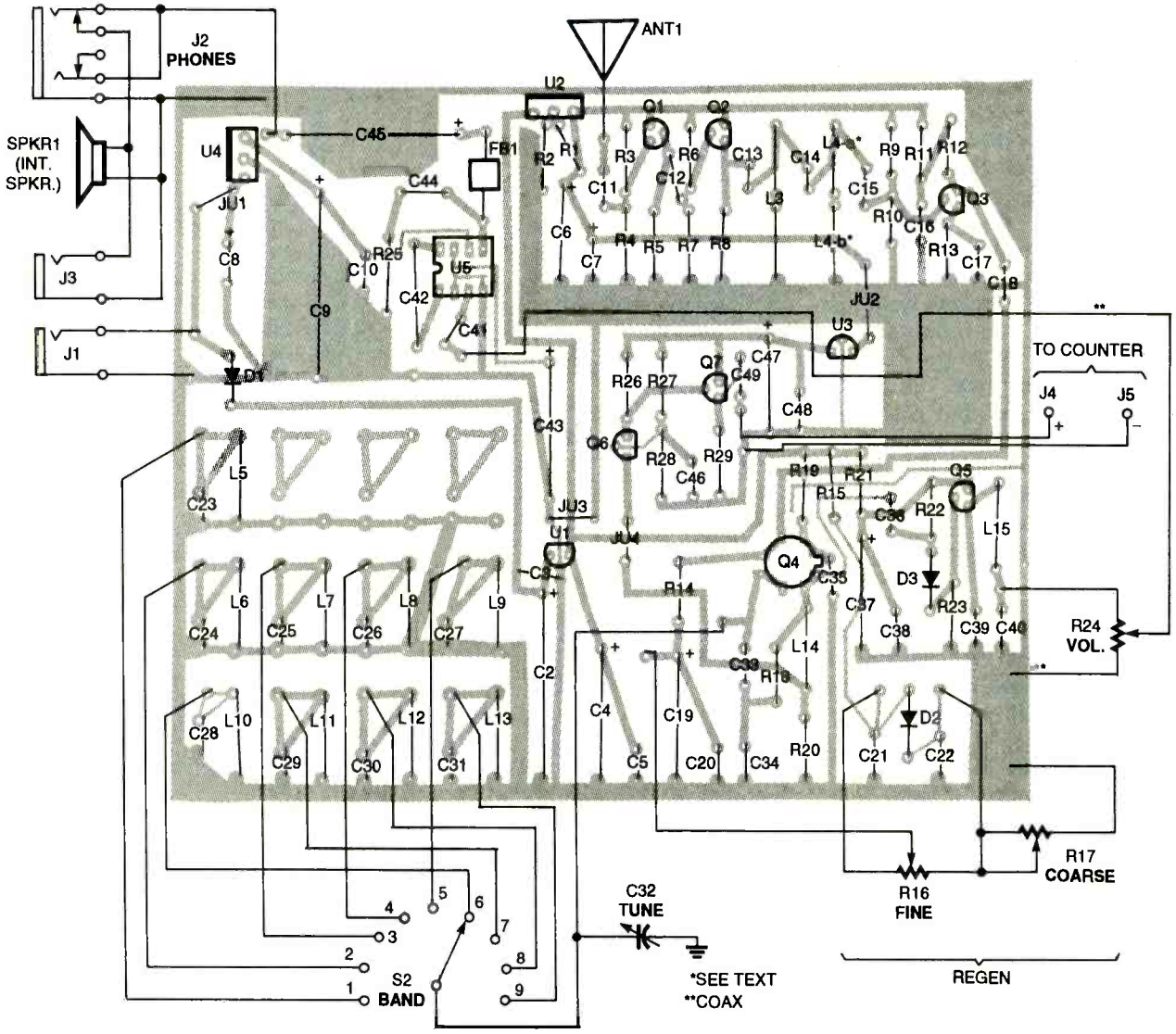


Fig. 5. When assembling the WBR's printed-circuit board, make sure that the polarized capacitors are correctly oriented. Also, when installing the semiconductors, pay particular attention to the orientation of Q4, and be careful that you do not confuse the 2N3904 general-purpose transistors with the low-power (78Lxx series) voltage regulators, both which are housed in the same TO-92 style case.

TABLE 1—FREQUENCY LIMITS OF THE INTERNATIONAL BAND

Band (Meters)	Band Limits (MHz)	Frequency Received (MHz)	L/C Band Trimmers
49	5.95 – 6.20	5.90 – 6.26	L5/C23
41	7.10 – 7.30	7.00 – 7.40	L6/C24
31	9.50 – 9.90	9.40 – 10.0	L6/C25
25	11.65 – 12.05	11.37 – 12.1	L8/C26
21	13.60 – 13.8	13.44 – 14.23	L9/C27
19	15.10 – 15.6	14.96 – 15.88	L10/C28
16	17.55 – 17.9	17.44 – 18.46	L11/C29
13	21.45 – 21.85	21.21 – 22.40	L12/C30
11	25.67 – 26.10	25.10 – 26.32	L13/C31

Pay particular attention to the orientation of Q4 (the dual-gate MOSFET). Be careful when installing the 2N3904 general-purpose transistors and the low-power (78Lxx-series) voltage regulators; those units are housed in the same TO-92 style case, so don't get them confused.

Note from the parts-placement diagram that there are three unused pad groupings in the area of the band-determining capacitor/inductor pairs. Those pads (as mentioned earlier) are provided for those who want to extend the band coverage of the WBR.

Once all of the on-board components have been installed, check your work for constructions errors—cold solder joints, solder bridges (and other shorts), misoriented or misplaced components, etc. When you are satisfied that there are no errors, put the board to the side momentarily and go on to the next phase of construction.

Power Supply. The next thing that

you will need is a power source for the WBR. There is, of course, nothing critical about the circuit's power source, and no printed-circuit layout is provided for that portion of the project. Instead, an external power supply, comprised of two chokes, a filter capacitor, and a bridge rectifier were wired together (see Fig. 3) on a small section of perfboard. The perfboard and a 24-volt transformer were then wire together and mounted to a block of wood. An AC line cord was then connected to the input of the supply and a suitable plug connected to its output. Doing things that way helps to keep power-line noise out of the receiver.

Of course, a standard plug-in 12-volt, 500-mA or so power adaptor can be used as the power source as well; if you decide to go that route, connect two filter chokes between the supply and the receiver. Once the power supply is complete, it is time to prepare the project's enclosure.

The Enclosure. The author's prototype was housed in a large aluminum enclosure measuring about 9¼ × 5⅜ × 6 ¾ inches. Prepare the enclosure by drilling holes in suitable locations for the controls, and mounting holes for the printed-circuit board and the unit's internal speaker.

The author's front-panel layout includes the band, volume, the fine and coarse regeneration controls, and a phone jack. The rest of the off-board components—the counter, auxillary speaker, and the power and antenna jacks—are mounted to the rear panel of the prototype.

After deburring the holes, dry-transfer lettering can be used to label each control, switch, and connector. Once labeled, mount the off-board components to their respective positions on the enclosure and, using short lengths of insulated wire, connect the off-board components to the appropriate points on the printed-circuit board. The connections to the volume control (R24) and the counter jacks should be made through small-gauge shielded cable.

Down The Dial. The tuning-dial pattern for the WBR was made by taking a blank pattern (like that shown in Fig. 6), and gluing it to a piece of cardboard using white paper glue (avail-

PARTS LIST FOR THE WORLD-BAND REGENERATIVE RADIO

SEMICONDUCTORS

U1—78L12 12-volt, 100-mA, voltage regulator, integrated circuit
U2—7808 8-volt 1-amp or 78L08 8-volt 100-mA, voltage regulator, integrated circuit
U3—78L05 5-volt, 100-mA, voltage regulator, integrated circuit
U4—7812 12-volt 1-amp, voltage regulator, integrated circuit
U5—LM386 low-voltage audio-power amplifier, integrated circuit
Q1—MPF102, VHF JFET
Q2, Q3, Q5–Q7—2N3904 general-purpose NPN silicon transistor
Q4—40673, MPF121, MPF131, or NTE222, or similar dual-gate MOSFET
BR1—DB101 1-amp, 50-PIV, bridge rectifier
D1—1N4001 1-amp, 50-PIV, rectifier diode
D2—1N34 general-purpose germanium diode
D3—1N914 general-purpose silicon diode

RESISTORS

(All fixed resistors are ¼-watt, 5% carbon units, unless noted.)
R1, R5—2200-ohm
R2—220-ohm
R3—4.7-megohm
R4—2.2-megohm
R6—22,000-ohm
R7—10,000-ohm
R8, R13, R28—1000-ohm
R9—150,000-ohm
R10—47,000-ohm
R11—3300-ohm
R12—470-ohm
R14—4700-ohms ¼-watt, 1%, metal-film
R15—15,000-ohm
R16—100,000-ohm panel-mount linear potentiometer
R17—5000-ohm panel-mount linear potentiometer
R18—82.5-ohm, ¼-watt, 1%, metal-film
R19—402-ohm, ¼-watt, 1%, metal-film
R20—51-ohm ¼-watt, 1%, metal-film
R21—810-ohm, ¼-watt, 1%, metal-film
R22—10-megohm
R23—560,000-ohm
R24—5000-ohm, panel-mount, audio potentiometer with SPST switch
R25—10-ohm
R26, R29—499-ohm ¼-watt, 1%, metal-film
R27—3900-ohm

CAPACITORS

C1, C2, C9, C45—470-μF, 16-WVDC, electrolytic
C3, C5, C6, C10, C15–C17, C20–C22, C35, C36, C38–C41, C46, C48, C49—0.1μF, ceramic-disc
C4, C7, C19, C37, C42, C47—22-μF, 16-WVDC, electrolytic
C8—4700-μF, 16-WVDC, electrolytic
C11—100-pF, silver mica
C12—6.8-pF, silver mica
C13—300-pF, silver mica
C14—56-pF, silver mica
C18—10-pF, silver mica
C23–C31—3.5–20-pF, miniature ceramic trimmer
C32—3–18-pF panel-mount air variable
C33—330-pF, silver mica
C34—120-pF, silver mica
C43—100-μF, 16-WVDC, electrolytic
C44—0.05-μF, ceramic-disc

INDUCTORS

L1, L2—100-μH, 2-amp (Radio Shack 273-102)
L3—8.2-μH (J.W. Miller 9310-34)
L4—43-μH (J.W. Miller 9210-58) or two 22-μH (J. W Miller 9310-44), see text
L5—5.6-μH (J. W. Miller 9310-30)
L6—3.9-μH (J. W. Miller 9310-26)
L7—2.2-μH (J. W. Miller 9310-20)
L8—1.5-μH (J. W. Miller 9310-16)
L9—1.0-μH (J. W. Miller 9310-12)
L10—0.82-μH (J. W. Miller 9310-10)
L11—0.56-μH (J. W. Miller 9310-07 or 9230-14)
L12—0.33-μH (J. W. Miller 9310-04 or 9230-080
L13—0.18-μH (J. W. Miller 9230-02)
L14—47-μH (J. W. Miller 9250-473)
L15—56-μH (J. W. Miller 9250-563)
FB1—General-purpose ferrite bead

ADDITIONAL PARTS AND MATERIALS

J1—2.1-mm DC power jack (Radio Shack 274-1565)
J2—⅛-inch panel-mount, closed-circuit stereo jack
J3—RCA jack
J4, J5—Individual pin-jacks
S1—SPST switch (part of R24)
S2—SP12T rotary switch
SPKR1—4–8-ohm, miniature speaker
PL1—2.1-mm power plug (Radio Shack 274-1567)
ANT—30-inch whip antenna (Radio Shack 270-1401)
T1—24-volt, 300-mA, center-tapped transformer
Printed-circuit materials, enclosure, 117-volt AC power plug with line cord, four small control knobs, one large pointer knob, wire, solder, etc.

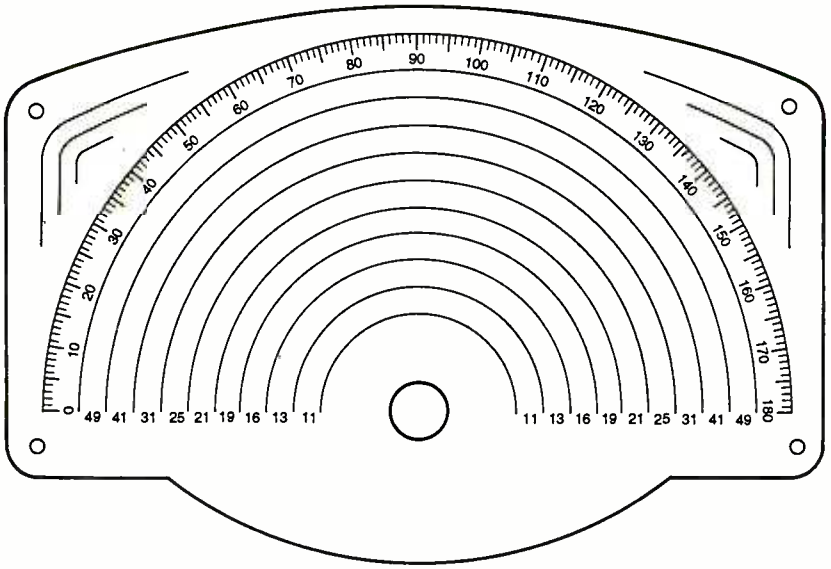


Fig. 6. The author started out with a blank tuning-dial pattern like this one, and added the appropriate frequency markings to the dial during the calibration procedure.

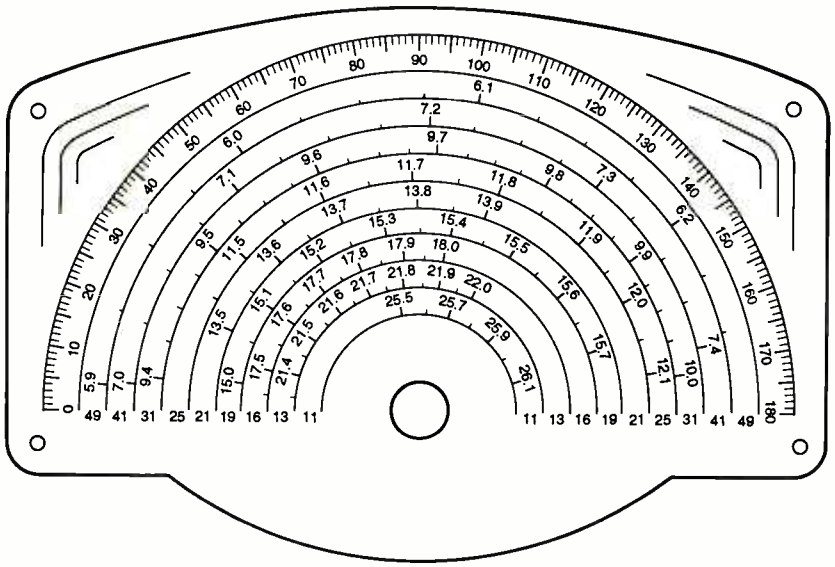


Fig. 7. Using a marker generator, the author first located and marked the 100-kHz points on the tuning dial, then the 50-kHz points, followed by 25-kHz points. This is what his dial looked like when completed. The dial shown here is strictly for reference. Each unit is different and must be calibrated according to the instructions given in the text to compensate for the tolerances of the actual components used in the set.

able from art-supply stores). Once laid down, a rolling pin was used to smooth out the dial pattern and to produce a good bond.

Once the glue dries, the excess cardboard can be cut away with a single-edge razor blade or X-acto knife. Cut the screw and the capacitor-shaft holes in the dial face and mount the dial on the aluminum enclosure with four 4-40 screws and nuts. The mounting nut for the variable capacitor goes outside the dial cardboard and helps hold the dial to the enclosure. Frequency markings on the dial will have to be added after construction is completed.

The dial pointer was made from a large paper clip. The paper clip was straightened out and filed down slightly. A hole was drilled in the side of a large control knob with a #66 drill bit (the size used to drill printed-circuit boards). The filed-down paper clip was then force fitted into the hole in the knob, and the knob was mounted on the shaft of the tuning capacitor.

Once the knob is mounted, set the tuning capacitor to maximum capacitance and place the pointer so that it points to the far left (log scale 0) position on the dial. After that, mount the unit's internal speaker to the inside surface of the enclosure. The connections between the internal speaker wires and the printed-circuit board should be made with short lengths of twisted-pair wire and kept close to the metal enclosure and away from the antenna.

The antenna was mounted to the back of the cabinet with two plastic brackets that were intended to anchor the bottom of window blinds. The antenna feedthrough was made by drilling holes to mount an SO-239 coax receptacle. Instead of mounting an SO-239, however, a piece of sheet plastic was mounted over the cutout and a hole was drilled in the center of the plastic. A wire from the antenna connection on the printed-circuit board was then passed through the hole in the plastic to the antenna termination on the outside of the enclosure. That type of feedthrough has a lot less capacitance than a coax connector.

Calibration. Calibration should be done before the outside cover is placed on the enclosure. The first step is to set the band limits. A frequency counter is helpful for that purpose. If a counter is available, connect it to the counter terminals, J4 and J5. Connect the power supply to the receiver and turn it on. Set R24 for maximum volume and set R16 (FINE REGEN) to its center position. Set S2 to 49 meters. Turn R17 (COARSE REGEN) control until the WBR oscillates (heard as a rushing sound, a hum, or whistle from the speaker) and the counter shows a steady reading. From Table 1, note that the band limits for 49 meters are 5.95 MHz to 6.20 MHz. Adjust C23 until the receiver covers that range as C32 is rotated from maximum to minimum capacitance—a range of 5.9 to 6.26 MHz was obtained in the author's receiver.

Referring to Table 1, switch S2 to a higher frequency band and adjust R17 (COARSE REGEN) for continuous oscillation if necessary. While rotating C32 from minimum to maximum capacitance, adjust the appropriate trimmer capacitor so that the receiver tunes the international band. On some of the bands, the tuning capacitor will tune a wider frequency range than needed. It doesn't matter whether the desired band is on the upper or lower part of the range.

Trimmer capacitors C23 through C31 should have enough range to allow the proper band limits for each

band to be set. But if the frequency range is too high, a small fixed capacitor can be soldered across the appropriate inductor (L5 through L13). If the frequency range is too low, the inductor for that band will have to be changed to the next lowest value.

The dial should be calibrated when the receiver is completed and no further changes are expected. Each band should be calibrated when the fewest radio stations are on the air. The lower frequency bands are clear during the daytime, and the higher frequency bands are clear at night.

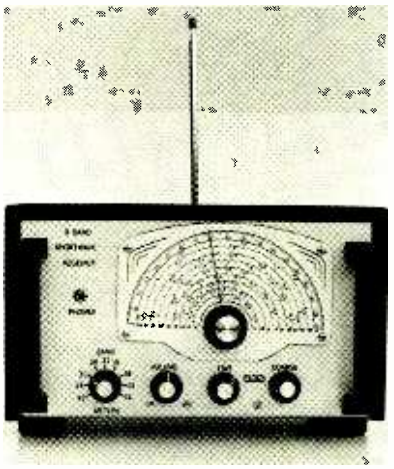
A marker generator capable of generating squarewaves of 100 kHz, 50 kHz, and 25 kHz that was built from plans found in the 1988 *ARRL Handbook* was used to calibrate the dial. Use a frequency counter to find the approximate location of the first multiple of 100 kHz on the dial. Start by turning on the WBR and allowing it warm up for at least 30 minutes. Rotate R17 until the WBR oscillates. Back off R16 until oscillation stops; then advanced it until the set almost oscillates. Set the marker generator to 100 kHz and turn it on.

Loosely couple the output of the marker generator to the antenna of the WBR. A wire from the output of the marker generator placed near the WBR's antenna should be adequate. A signal that is strong enough to be received but weak enough that the regeneration control can be set to its most sensitive position is desired. Turn C32 (TUNE) slightly until a weak signal is heard as a rushing sound or a hum. If no signal is heard, increase the coupling to the marker generator and try again. When a signal is heard, turn the marker generator off and on to verify the origin of the signal. Using a pencil, lightly mark the point on the dial. Move the tuning capacitor up the dial and mark the next 100-kHz point.

When all the 100-kHz points are marked, switch the marker generator to 50 kHz and mark points between the 100-kHz points. Make those points distinguishable from the 100-kHz points. Once the 50 kHz points have been marked, switch the marker generator to 25 kHz and add those points. When all the points for all bands are on the dial, remove the dial from the radio, write over the dial markings in ink and add the frequency numbers. Erase any pencil markings left visible. Spray the completed dial with clear lacquer or cover with a clear plastic sheet. The finished dial should look something like the one in Fig. 7. If the receiver drifts out of calibration, adjust the appropriate trimmer capacitor (C23–C31) until the stations appear in the correct place for each band.

Using the WBR. A regenerative radio does not operate like a superhet. It requires more adjustment to properly receive a given station. That is part of the charm of this vintage circuit. Once the technique is learned, the receiver can be easily operated.

The narrowest bandwidth and highest sensitivity is obtained when the regeneration control is set just below the point of oscillation. The optimum setting of the regeneration control changes as the receiver is tuned to different frequencies. As the tuning capacitor is tuned up in frequency (less capacitance), the regeneration control has to be backed off to prevent oscillation.



Here is the author's attractively laid out prototype of the WBR. Note the professional-looking lettering that adorns the front panel.

Turn the radio on, select an appropriate band, extend the antenna to its maximum length, turn the volume (R24) all the way up, rotate C32 to the minimum capacitance (highest frequency) position, set R16 to its center position, rotate R17 until the receiver oscillates and back off until the set just stops oscillating.

Rotate C32 to tune down the scale until a station is heard. Adjust R16 for maximum sensitivity; back off R24 if the station is too loud. When a different station is tuned, it will be necessary to readjust R16 for optimum reception. Potentiometer R17 should need readjusting only when the set is switched to a different band.

To use a frequency counter, connect the counter to J4 and J5 of the WBR. Very strong stations will provide enough signal at the counter output to produce an accurate station-frequency reading. To use the counter for weaker stations, tune in a station and turn up the regeneration control until the receiver oscillates. Going into oscillation causes the frequency to drop a few kHz. Tune up the band slightly until the oscillator produces a beat note against the station. Adjust C32 for minimum frequency (pitch) of the beat note. Then read the frequency on the counter. If the band is congested, this procedure cannot be used but the approximate frequency can still be determined.

If the sensitivity is too low for a given situation, add a few feet of wire to the whip. If an indoor or outdoor long-wire antenna is available, wrap two turns of the insulated wire around the whip to create a loose couple. Directly connecting a long-wire antenna to the whip will usually result in the receiver being overloaded.

When the WBR was being developed, I tuned in a ham operator on 40-meter LSB (lower sideband) from Miami who was describing to other hams the conditions as hurricane Andrew moved onto the Florida coast. A few days later, the same hurricane hit near my location in Louisiana.

For receiving LSB, locate the station using the same procedure as used for AM stations. Then turn up the fine regeneration control until the receiver oscillates continuously. Turn the tuning capacitor slightly up in frequency then slowly tune down until the operator's voice is intelligible. Changing the fine regeneration control slightly may be helpful for obtaining a good signal. The required tuning is delicate.

Receiving USB is the same except that the tuning capacitor must be tuned up the band until the speech is intelligible. CW (Morse code) stations will be heard in the vicinity of amateur voice stations. Like SSB they are received with the radio oscillating. Often several code stations will be heard at once, but the audio tone of each will be different. ■

Hamming in the Fabulous Fifties

Turn back the clock to the golden age of ham radio.

BY KARL T. THURBER, JR., W8FX

Many electronics hobbyists look back with nostalgia at the simpler, pre-high-tech days of the 1950's. That era was especially significant for amateur radio because it spaned the early years of the Novice license, which gave most newcomers their start. Of course, the electronics world was much, much different then: Transistors and other solid-state devices were almost unknown. FM repeaters, packet radio and various exotic digital-communications modes, OSCAR satellite communications, and—perhaps most significantly—personal computers (PC's) simply didn't exist then. In fact, for the most part, it was an "analog world," not the digital world we know today.

In the 1950's, radio amateurs could still operate on the 11-meter band (now the 27-MHz CB band), amplitude modulation (AM) was king of the radio airwaves, and only strange "Donald Duck" quackers were experimenting with single-sideband (SSB) communication. Needless to say, many of those who received their first amateur-radio license during that era have very fond memories of those seemingly sleepy but nevertheless heady days.

Enter the Novice Radio Amateur. Probably the biggest trend of the 1950's to influence amateur radio was the introduction of the Novice-Class operator's license. The Novice "ticket" offered entry not only into a wonderful hobby but, for many, an introduction to a lifelong career in radio or electronics. The Novice license did these things, even if you had to trek down to the nearest Federal Communications Commission (FCC) office to take the exam, which was administered by a stern FCC engineer—there were no volunteer examiners then. Success was yours when the examiner told you to take your papers out and have them notarized.

The Novice-Class license came into existence in July, 1951. After several revisions to FCC Docket 9295, the Novice, Technician, and Amateur Extra-Class operator's licenses were authorized. The new license classes replaced an older licensing system that provided little attraction for newcomers. While Novice and Technician authorizations were to take effect on July 1 of that year, the Extra Class didn't take effect until January, 1952.

At first, the Novice Class was a beginner-only license, not one you could hold for a lifetime as you can today: the license term was one year and it was non-renewable, period.

You were supposed to get your code speed and knowledge of radio regulations and theory up to snuff in that period, or out you went.

The FCC initially allocated portions of three HF bands for Novice use. The small Novice sub-bands fell in the 80-, 11-, and 2-meter amateur-radio bands. Power was limited to 75 watts input, or about 50 watts output. Above all, the transmitter's oscillator stage had to be crystal controlled. Being "rock-bound" (referring to the crystal frequency you were tied to) helped ensure that newcomers didn't operate out-of-band. (Still, many beginners received FCC "pink-ticket" citations for out-of-band harmonic signal radiation from their often crude transmitters; many one- and two-tube rigs radiated strong harmonics at two or three times the operating frequency.) Even with these limitations, Novices of the 1950's found that their low-power transmitters (usually 10-25 watts) could actually "work out" (or at least be heard) for quite some distance.

Beginning radio amateurs looked to more experienced seniors, or "Elmers" (as we call them today) to provide guidance and help. Most old timers gladly accepted that responsibility, helping youngsters eager to get their Novice tickets by setting good examples of proper operating practice and providing technical assistance as needed. As a result, the beginner was usually able to get help with a low-budget project—both parts and palaver—when needed.

In those days, when seeking Elmer-style help, it didn't seem to make a great deal of difference if you were wealthy or poor, or what caliber station you could afford. If you were an amateur or prospective amateur, you experienced a special sort of bonding and were treated fraternally. Unfortunately, as the hobby has grown larger and become "more professional" over the years (there now are around 600,000 licensed amateurs in the United States alone), some of this camaraderie has disappeared.

Those 1950's Stations and Their Operators. Most 1950's-era pioneering Novices upgraded to higher class licenses—remember, it was an "up or out" system in which they had but a year to show that they had the right stuff to be full-fledged amateurs. The 1950's-era Novices shared several rights of initiation and mutual experiences they still cherish. For example, all of them looked fondly forward to tossing out their "rocks" (crystals) and opting for VFO control and higher power.

Still, many found to their surprise that CW—pounding brass—was actually a neat way to communicate (especially using a sporty semi-automatic key, or "bug"). Others found that AM was the way to go if you wanted to "rag chew." Interestingly, instead of the rapid back-and-forth banter that's commonplace today on SSB and FM modes, amateurs using AM radio tend to make formal "transmissions," or extended verbal presentations, that make for slower-paced and more thoughtfully framed contacts (QSO's).

The Philmore transmitter kit shown here was a popular item in the early and mid-1950's, especially since everything was furnished, including the straight key! I know: the kit was my very first transmitter—and I wish I had saved it.

Considered today, the amateur stations of the 1950's—even state-of-the-art, top-of-the-line stations of the time—were simplistic compared to the sophisticated transceivers, PC's, and other accessories that today's amateurs use and take for granted. In the early 1950's, stations were mostly homebrewed—at least the transmitters were. Amateurs tended to build their own equipment to learn how the circuits worked, to better appreciate improvements they could make, and, of course, to save money.

However, by the end of the decade, factory-finished models and do-it-yourself transmitter kits (such as those by Heathkit) were the rule. Transceivers? They weren't really on the scene yet; bulky, separate vacuum-tube transmitters and receivers were the general rule. The bigger the radio "boat anchor," it seemed, the better the signal.

Unfortunately, the receivers of the 1950's were a sore spot for amateurs. Frequently, one's transmitter far outreached the ability of his or her receiver to capture incoming signals. Typically, receiver sensitivity was low, selectivity was poor, and both electrical and mechanical frequency stability left much to be desired.

Dial calibration was typically haphazard, and many sets had just a bandspread dial that was uncalibrated, or made do with a generic "0 + 100" logging scale. Amateurs dreamed of sets with calibration markers every 5 or 10 kHz. Oh yes, Collins Radio even offered receivers with 1 kC or better calibration, but very few Novices could afford the premium-priced sets that were the pride of the Cedar Rapids, Iowa factory. So there really was a good reason for the FCC to require crystal-controlled transmitters and a separate means of checking your transmitted signal.

Where Amateurs Shopped. Where did radio amateurs buy their parts and equipment? There were few franchised radio outlets—no Radio Shacks then—and "ham stores" where you could work trade-in deals were only plentiful in the big cities. Consequently, the big radio mail-order houses like Henry Radio, World Radio Labs (WRL), Walter Ashe, Lafayette Radio, Burstein-Applebee, Fort Orange Radio, and Allied Radio, were postal magnets. They were the sources of many of the parts and equipment that radio beginners needed. That, of course, was if they couldn't beg, borrow, or steal components from a nearby old-timer's junkbox or from the scrapped radios and TV's often found in neighborhood repair shops.

A great, but long gone, source of parts and equipment for amateurs living near some large cities was the city's "Radio Row" district of stores—a sort of Marconi-style Mecca—that sold surplus and wholesale radio components. Chicago, Boston, Los Angeles, and other large cities had their Radio Rows, but the biggest of all was New York City's sprawling Cortlandt Street area in Manhattan. There you could buy almost anything to complete a radio construction project on the cheap.

New York area amateurs bought

their parts from colorfully named Radio Row stores like Blan the Radio Man, Cantor the Cabinet King, G & G, and Krantz Bros. For new and used amateur gear, you usually couldn't get a better deal than at Bill Harrison's (W2AVA) Harrison Radio emporium. Today, such Radio Rows are almost nonexistent. The closest you can come to experiencing the Radio Row of the 1950's is by shopping in Tokyo's fabled Akihabara electronics district, perhaps the last Radio Row.

Donald Duck, TVI, and the Cold War. Radio-wise, the 1950's was the decade in which "the bomb" made civil defense get serious, CB radio got off the ground, single-sideband (SSB) modulation came of age to threaten AM, and the specter of television interference (TVI) reared its ugly head. It was also the decade that saw the Cold War peak, witnessed the red-baiting McCarthy era wax and wane, and experienced the launch of Sputnik I. Also, it was an era in which radio amateurs experienced regulatory fears for their precious international frequency allocations. Let's take a closer look:

The Korean War didn't have a great influence on amateur radio. Hams—unlike in World War II—continued to operate during the Korea years. In the early 1950's, getting ready for "the big one" didn't refer to a coming California earthquake. Rather, it was defending the country against nukes and all that defense entailed. Civil Defense (CD) efforts burst onto the scene around 1950, once it was realized that the Russians really had the bomb. By 1952 public-service minded amateurs by the thousands had volunteered their stations to emergency communications under the newly formed Radio Amateur Civil Emergency Services (RACES).

At the same time, amateurs chafed at the need for them to comply with "CONELRAD" (CONtrol of ELectromagnetic RADiation) rules. They were the 1957 government requirements for amateurs to monitor commercial radio broadcast stations for CD warnings while operating their radios. Why? Transmitting during a bomber attack might let the "Russkies" home in on your station!

The Citizens Radio Service has had ups-and-downs over the last 44 years since it was established in June, 1949. It was slow going at the start. Frequencies were assigned in the then UHF wasteland of 460–470 MHz, and almost no one really used such outlandish frequencies in those days. The frequencies were so unpopular due to the poor UHF communications gear of the day that the FCC was under great pressure to find some HF spectrum space for CB.

Hiram Percy Maxim (1869–1936), affectionately known as "The Old Man" of radio, co-founded the American Radio Relay League (ARRL) in 1914. Maxim was known as a feisty, straight-arrow standards-setter who was revered highly in the amateur community. His strong influence was still felt in the 1950's amateur community.

In 1958, the FCC gave the old amateur 11-meter band to CB'ers (over the shrill protests of amateurs) to form the Class-D Citizens Radio Service. There was even a "save 11 meters" campaign launched by one of the radio magazines, complete with an operating contest to show that amateurs really used the band. That effort was designed to convince the FCC to let amateurs keep the band, but the commissioners weren't convinced.

Many of today's amateurs entered the hobby long after SSB's struggle for acceptance, not realizing that "AM was king" in the 1950's. In those years, most amateurs derisively thought of SSB as that silly "Donald Duck" modulation since, without the proper receiving equipment, the signals are strange-sounding indeed. That form of modulation—without the carrier wave characteristic of AM—was all but indecipherable unless one knew the secret of carefully tweaking the BFO (beat-frequency oscillator) knob on their receiver. That is, if their radio *had* a BFO (many sets of the era didn't).

In the early 1950's, the biggest threat to amateurs was television interference, or TVI. Around the country, as hundreds of new VHF (and later UHF) TV stations took to the air, amateurs became painfully aware of the threat to their operating freedom and the very existence of their hobby posed by the boob-tube. In rural eras, TV signals from distant cities were usually very weak and highly susceptible to interference. In the big cities, amateur-radio and TV signals tended to live side-by-side and signal overload from amateur transmitters was common.

The TVI ogre was driving amateurs off the air by the thousands as TV viewers vastly outnumbered hams. While no magic bullet was developed to cure TVI, as the decade wore on the problems of TVI were slowly recognized and gradually licked by better RF filtering and shielding of both transmitters and receivers. The formation of joint radio-amateur/TV-viewer "TVI committees" also helped resolve the many problems of radio-frequency interference (RFI).

On the international front, the Cold War was at its peak in the 1950's as the "missile gap" and the shortage of engineers and scientists concerned many Americans. Those concerns of

the space age hit home on October 4, 1957 when the Soviet Union launched the first artificial earth-orbiting satellite, Sputnik I. Once word of the successful Soviet launch flashed to hamshacks around the world by Radio Moscow (which in the 1950's flooded the airwaves with high-power, multiple-frequency transmissions to the West), amateurs quickly turned to their receivers. They were easily able to intercept the satellite signal and looked to the sky to try to trace its faint path.

Amateurs became local authorities on satellites in towns across the country as they listened to the Morse-like "beep-beep" of the satellite on its easily received 20.005-MHz carrier. The Soviets even offered a distinctive confirmation card (QSL) for reception reports on their signal, along with a small but colorful lapel pin complete with a tiny red Sputnik.

Furious preparations for the 1959 Geneva World Administrative Conference (WARC) dominated the international radio scene in the last few years of the decade. The Geneva WARC was to be the largest international radio conference since the big 1947 Atlantic City meeting. There, the victorious superpowers divided up the globe, radio-wise, based on the new world map that resulted from the end of World War II.

The 1959 WARC could have been disastrous for radio amateurs. There was real concern that they would lose many of their frequencies as newly-independent countries asserted themselves politically, and commercial radio interests demanded even more radio frequencies. However, amateurs somehow preserved the status quo for at least the western hemisphere's frequency allocations while holding spectrum adjustments elsewhere to a minimum.

Amateur Radio Magazines of Yore. Over the years, many magazines serving amateur radio and shortwave enthusiasts have come and gone. Senior-citizen amateurs who were active in the 1920's through the 1940's may remember such then-popular publications as *The Transmitter, Radio News, Modern Radio, R/9, Amateur Radio Review, Midwest Radio, Radio Relays, Ye Brass Pounder,* and several others. Many of those magazines were intended for specialized or local and regional audiences. By the 1950's, for all intents and purposes, there were just two major publications for radio amateurs left: *QST* and *CQ* (see the boxed copy entitled "Names and Addresses" for the addresses of those publications and all others mentioned in this article).

QST was, and still is, the official journal of the American Radio Relay League (ARRL), the nonprofit national association of radio amateurs. Hiram Percy Maxim (1869–1936), affectionately known as "The Old Man," co-founded the ARRL in 1914 with Clarence D. Tuska. The organization originally was designed to keep the country's radio amateurs in contact with one other through relaying on-the-air messages, but now it's a broad-based hobbyist group. The first issue of what would become *QST* was published in December, 1915.

CQ's origins are somewhat murkier, but date at least to the end of World War II. The current contest-and-operating oriented publication went under new management about 1980 and officially traces its beginnings to 1945. However, in the 1930's there was at least one other publication called *CQ*, but it was for commercial, rather than amateur, radio operators.

CQ readers of the 1950's looked forward each month to the monthly pidgin-dialect "letter to the honorable editor" by that mischievous radio amateur originally from Osockme, Japan (and later, from "Feenix, Arizona"), Hashafisti Scratchi. The cartoon reportedly appeared first in the old Radio magazine as early as 1934, was interrupted by World War II, and later appeared in *CQ* as late as the 1970's. At that time, ethnic sensibilities dictated that publishing such a stereotype would be inappropriate, and the feature was dropped. But old-timers remember it well, just as they recall the antics of the late John T. Frye's "Carl and Jerry" exploits in the *Popular Electronics* of the 1950's and the late Gil Gildersleeve's highly entertaining "Jeeves" cartoons that appeared in *QST* for decades.

Getting in the Fifties Radio Mood. Nostalgia for all things fiftyish is in vogue. Equipment that a few years ago was considered variously as junk,

Recalling Waseca

I've never even been to Waseca, Minnesota, and don't know anything about the town, so I can't actually "recall" it. However, I do know that Waseca was special to radio amateurs in that it was the longtime home of the E. F. Johnson Company, one of amateur radio's proudest equipment manufacturers of the 1950's.

Any article about tube-type transmitting gear always includes at the top of the list the Viking series of transmitters and linear amplifiers produced by E. F. Johnson. Reportedly, between 1949 and 1966 the Johnson factory produced, in kit or wired form, more than 53,000 rigs. First off the production line was the Viking I and II. Later came the Viking Ranger, Valiant, Adventurer, Navigator, Pacemaker, Courier, Thunderbolt, and about a dozen other memorable models—few Johnson transmitters were "unmemorable." If you flip open almost any *CQ* or *QST* from the 1950's, you'll likely find a big Johnson equipment ad.

Many Johnson rigs are still around today, as are what are likely Johnson's best known accessories, the Viking Match Box and Viking Kilowatt Match Box antenna tuners. For many radio amateurs who got their start in the 1950's and 1960's, the Match Boxes put the name "antenna tuner" into their vocabulary. Furthermore, they're not cheap even in the flea market today.

By the early 1960's, solid state and SSB were dawning in the amateur market, and Johnson didn't get aboard the train fast enough. Transceivers (rather than just transmitters) produced by Collins, Drake, Hallicrafters, National, Swan, and other American manufacturers were gaining in popularity. Too, high-quality, innovative Japanese imports were on the way. The management at E. F. Johnson reacted to all that by abandoning the amateur market and concentrating on the Citizens Band and land mobile-communications markets. (Johnson SSB CB sets are known for their quality and even today are converted for 10-meter amateur use.)

E. F. Johnson is no longer an amateur-radio supplier today. The respected Viking name was taken over in the 1970's by the William M. Nye Company, and several Johnson items were continued. These included a line of 3000-watt antenna tuners (follow-ons to the Viking Kilowatt Match Box), low-pass filters, SWR bridges, phone patches, keys and keyers, and other accessories.

To amateur-radio newcomers who aren't familiar with the old E. F. Johnson equipment, take a look around at the next hamfest or swap meet. Ask a few questions about the equipment, and look inside at the "battleship construction." Then, perhaps you, too, can recall Waseca! ■

doorstops, or boat anchors are often considered classics. There's even a burgeoning market in books, booklets, magazines, and newsletters serving the market for older radio equipment and paraphernalia. Let's look at some of the books and publications that may spark your interest in the era.

The book *Communications Receivers*, 2nd Edition, by Ray Moore, has a great deal of data on American-made communications receivers from 1932 to 1981. RME, National, Hallicrafters, Hammarlund, Collins, and many others are covered—58 companies in all. Including variations on the 375 illustrated receivers, over 700 sets are covered. The 115-page book is $17.95 plus $2.50 postage and handling from RSM Communications.

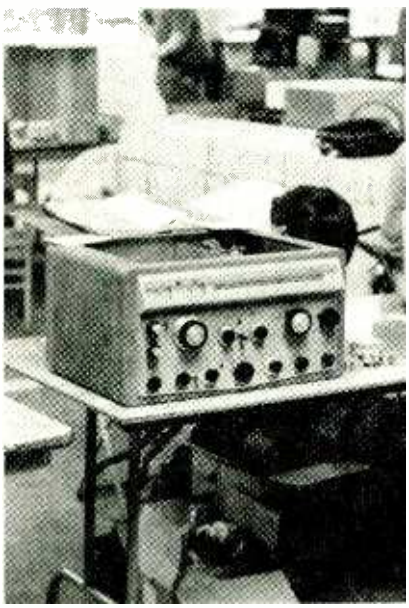
The Hallicrafters Story describes the fabled Hallicrafters Company, which in the 1950's was a synonym for "shortwave radio receiver." In those days, radio amateurs and SWL's hoped to see a Hallicrafters under their Christmas tree. Author Max C. de Henseler, HB9RS, covers the company's operations from 1933 to 1975, when it effectively disappeared. Included are photos of most sets, a sampling of magazine advertisements, and tube complements. The book is $14.95 plus $2 shipping (total $16.95) from the Antique Radio Club of America, Inc. Orders from outside the U.S.A. are $18.95 in U.S. funds, shipping by surface mail.

Major amatuer-radio publications such as *CQ*, *QST*, and *73 Amateur Radio Today* constitute a treasure-trove of information about older equipment. The classified ads in those magazine can give you a good picture of the used-equipment market.

The back issues of the contemporary amateur publications are even better than current issues for finding out about vintage equipment and getting a feeling for operating in the 1950's. A good source of back-issue radio magazines, though a chancy and casual one, is the next radio flea market in your area. Back issues of amateur-radio, communications, electronics, and computer magazines typically can be had for 10 cents to $1 apiece, depending on condition, demand, and age.

Edited and published by Barry R. Wiseman, N6CSW/0, the nostalgic specialty magazine *Electric Radio* is for those who appreciate older tube-type equipment. Each issue explores vintage radio gear and the people who once produced it. Issues also provide information on the modification, repair, and building of old-style equipment. The magazine also works toward a greater understanding of the AM mode.

Despite the interest in tube-type gear and AM, ER puts this bygone era and its equipment into perspective,



Looking somewhat forlorn as it waits for a new owner at a radio hamfest, this high-end E. F. Johnson Viking Invader 2000 was an impressive all-mode, high-power amateur transmitter from the 1950's. It covered 3.5–30 MHz in seven bands. It could operate on SSB, AM, and CW, trying to bridge the gap between older and emerging communications modes.

acknowledging the technical superiority of modern-day equipment, but lamenting its expense and complexity. While ER appeals to amateurs of all ages, it gets special approval from those who, like myself, were first introduced to amateur radio in the 1950's.

Each issue runs about 40 pages. Domestic subscriptions are $24 by second-class mail and $34 via first class. Canada and overseas are more. Contact Electric Radio.

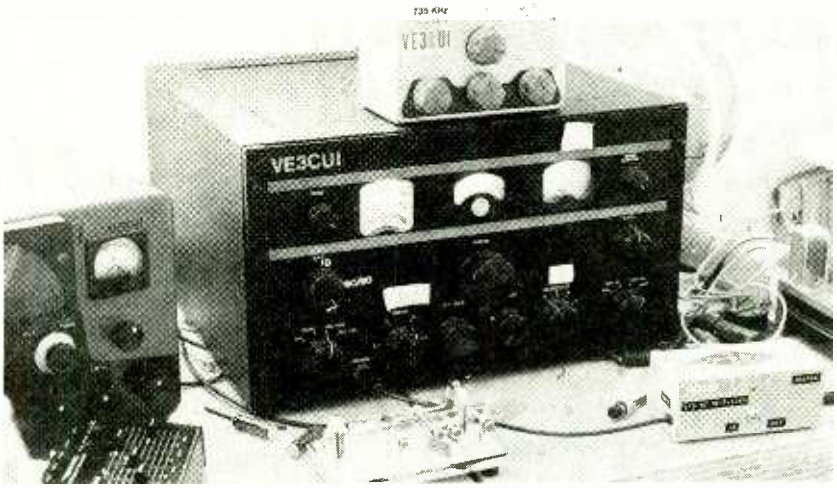
To really get into the fifties mood, you might wish to read David Halberstam's 1993 book, *The Fifties*. While it's oriented toward the era in general and not to communications topics of the 1950's, it's an excellent guide to the period and its mystique. The 800-page book is published by Villard Books, New York, at $27.50. It's available in most bookstores.

Setting Up a 50's-Style Station. As one first licensed in 1954, I hold a special place in my heart for the amateur radio gear of the 1950's, equipment that's mostly big, clunky, heavy AM stuff. To many who got their feet wet then, the sight of a Heath DX-100 or Johnson Viking II transmitter, or a National HRO-60 or Hallicrafters SX-88 receiver is a sight for sore eyes. The great radio names of the 1950's include Central Electronics, Gonset, Sideband Engineers, Hallicrafters, Barker & Williamson, Heathkit, WRL, E. F. Johnson, National, Collins, Harvey Wells, and Eldico, among others. Most (though not all) of them no longer are in business, or are pursuing other manufacturing avenues.

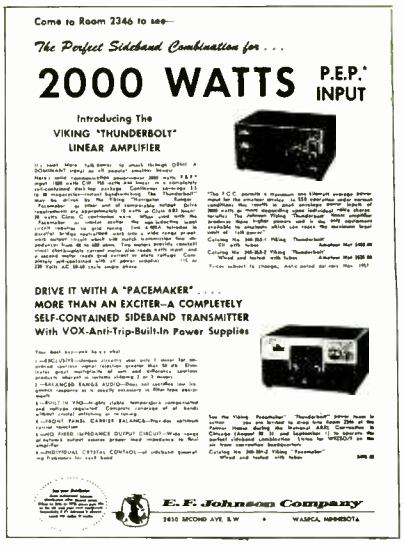
While the big 1950's radio names are gone today, the "good ole days" of AM radio are indeed alive and well. Most shortwave radios, possibly one already in your house, can readily receive AM signals. It may be that the only real price of admission to 1950's-style hamming is that of a vintage AM radio transmitter. While most receivers and transmitters today are solid state, and many hobbyists look with disdain on vacuum tubes in this solid state world, some vacuum-tube era equipment still can do a creditable on-the-air job. For many, there's magic in the old sets—especially those charming golden-age classics—whose tube filaments glow brightly and warmly in the dark and possess a character not always found in modern-day radios. Many classic radio hobbyists install a second station in their home that's furnished as completely as possible with vintage-era gear.

Where do you find such equipment? Sources include local amateurs, radio hobbyists, and radio club members; magazine classified ads; sellers at radio flea markets and hamfests; garage and yard sales; and used amateur equipment dealers. Here are some considerations for purchasing older gear:

With regard to a receiver, decide whether you want a general-coverage or a ham-bands-only radio. Older general-coverage sets typ-



While all the gear in this photo may not be strictly 1950's, most of it is definitely vintage. The centerpiece in this Canadian station is a 1944 RCA AR-88LF receiver. Sitting atop it is a 1950's-era Heathkit Model QF-1 "Q-Multiplier," for improved receiver selectivity. To the left is a Johnson Ranger AM and CW transmitter.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E. F. Johnson Company

Between 1949 and 1966 the Johnson factory produced, in kit and completed form, more than 53,000 rigs. First was the Viking I and II. Later came the Viking Ranger, Valiant, Adventurer, Navigator, Pacemaker, Courier, Thunderbolt, and about a dozen other models.

ically cover 540 KHz to 30 MHz. Hambands-only radios normally cover only the "old" (pre-1979) WARC HF amateur-radio bands from 1.8 to 30 MHz, so they may not cover the newly authorized bands at 10, 18, and 24 MHz. Selectivity, sensitivity, and stability are—along with current condition—the key determinants of receiver quality and price. Well-known makes among older receivers include Drake, Collins, Hallicrafters, National Radio, Hammarlund, RME, and TMC.

As far as transmitters are concerned, many of the massive 1950's AM and early SSB rigs are available today and can make good buys. Often, they're easier to restore than receivers. CW-only Novice rigs are relatively simple affairs, typically being crystal controlled and running 75 watts or less; many of them still make useful CW rigs. Some of the better-known transmitter names include Collins, Heathkit, E. F. Johnson, Harvey Wells, and WRL, and several of the receiver manufacturers also produced transmitters.

Then, too, if you're into nostalgia radio, but don't want to go to the trouble and expense of setting up a complete vintage amateur-radio station (or don't have the room), consider something less ambitious. That can be a display of old-style microphones, Morse straight keys, semi-automatic keyers ("bugs"), vacuum tubes, crystals, and other accessories.

Summary. This article turned back the clock for a nostalgic peek at an era considered by many to be the "golden age" of amateur-radio communications. We covered the impact of the then-revolutionary Novice Class operator's license, looked at where radio amateurs shopped for radio gear and what radio magazines they read, relived some of the big radio issues of the decade, suggested how to get into that 1950's radio mood, and presented suggestions on acquiring your own vintage amateur station. ■

Names and Addresses

AM International
9 Dean Dr.
Bow, NH 03304

AM Press/Exchange
2116 Old Dover Rd.
Woodlawn, TN 37191

AM Radio Network
Box 73
West Friendship, MD 21794

Antique Radio Club of America, Inc.
Attn: Ron Frisbie
312 South 10th St.
Akron, PA 17501

CQ
76 N. Broadway
Hicksville, NY 11801-2953
Tel. 516-681-2922

Electric Radio
PO Box 57
Hesperus, CO 81326
Tel. 303-247-4935

Ham Trader Yellow Sheets
PO Box 2057
Glen Ellyn, IL 60138

QST, American Radio Relay League
225 Main St.
Newington, CT 06111-1494
Tel. 203-666-1541

RSM Communications
PO Box 1046
Key Largo, FL 33037-1046
Tel. 305-853-0379

Society for the Promotion of Amplitude Modulation (SPAM)
PO Box 27
Potrero, CA 92063
Tel. 619-478-9347

Antique Electronics Supply
6221 S. Maple Ave.
Tempe, AZ 85283
Tel. 602-820-5411

Ardco Electronics
PO Box 95
Berwyn, IL 60402

Fair Radio Sales
1016 E. Eureka St.
PO Box 1105
Lima, OH 45802
Tel. 419-227-6573

HI Manuals
PO Box 802
Council Bluffs, IA 51502

Surplus Sales of Nebraska
1315 Jones St.
Omaha, NE 68102
Tel. 402-346-4750

Build This Electronic Casino

Play three of the most popular casino games with this handheld, low-power project.

BY JAY KIRSCHENBAUM

If you like electronic games, you should enjoy building and testing your luck with this project. The project, appropriately dubbed the *Electronic Casino*, lets you play three popular casino games—blackjack, craps, and slots—with realistic casino rules for each. The blackjack game, for example includes doubling, "soft" hands, and automatic play of the dealer's hand.

Under program control, the project keeps a running count of your bankroll as the game is played so that you can try to beat your previous high total; or, if you wish, you can challenge a friend to see who can accumulate the most "cash." With some simple sound effects and a four-digit display, the circuit lets you how you're doing as the game progresses.

About the Circuit. Figure 1 shows a schematic diagram of the Electronic Casino. At its heart is Microchip Technology's PIC16C56 microcontroller, U2. That 18-pin IC contains 1K of on-board RAM (which holds the game software), an internal oscillator, and 12 I/O lines (labeled RA0–RA3 and RB0–RB7), each of which can be programmed as an input or an output. In our circuit, four of those lines (RA_0–RA_3) are always inputs, and are used to monitor the status of the four input switches; S1 through S4. Lines RB_0–RB_7 are always outputs, with RB_0–RB_6 feeding U1, an Intersil ICM7211 LCD controller/driver. The final line, RB_7, feeds the base of Q1, which is used to drive BZ1.

An 3.58-MHz crystal XTAL1, along with C2 and C3 are used to set U2's internal oscillator. There is nothing particularly special about the crystal; however, because the software delays and timing are written assuming a 3.58-MHz crystal is used, the circuit will not operate properly if a crystal of a different frequency is substituted.

The microcontroller, U2, has an on-board power-up reset circuit, so the chip only requires that the $\overline{MCLR}$ input (pin 4) be tied to V_{DD} to initialize the circuit when it is first turned on. However, a manual RESET switch (S5) connected directly to the $\overline{MCLR}$ input (pin 4) can be pressed at any time after power-up to reset U2.

As mentioned, the RB_0–RB_6 outputs (pins 6–12, respectively) of U2 are connected to the LCD driver, U1. That 40-pin CMOS device—with its 28-segment drivers (seven per digit) and a display back-plane driver—is designed to feed a four-digit LCD readout. To place a number into one of the four display digits, the number is output in binary by U2 at RB_0–RB_3 (pins 6–9, respectively) and fed to the data inputs of U1 at pins 27–30. Simultaneously, the digit (0–3) is output in binary at RB_4 and RB_5 (pins 10 and 11) and applied to the ADDR1 and ADDR2 inputs (pin 31 and 32) of U1. When that information is stable, pin 12 (RB_6) of U2 is taken low and then high to transfer the information to U1. The data received by U1 is then internally decoded by U1, and the information used to light the appropriate display segments.

Because the circuit requires very little power, it can be powered from a 9-volt battery (B1 in Fig. 1). The battery voltage is clamped at +5 volts by a simple regulator circuit comprised of R5 (a dropping resistor), D1 (a 5-volt Zener diode), and Q2 (a 2N3904 general-purpose NPN silicon transistor).

But all of that circuitry would be just a bunch of silicon and carbon without the program—which was written in assembly language—that tells it what to do. So let's briefly discuss the game program.

About the Software. The assembly-language program written for the Electronic Casino is quite long; for that reason it will not be shown in its entirety here. However, for those adept at programming microprocessors

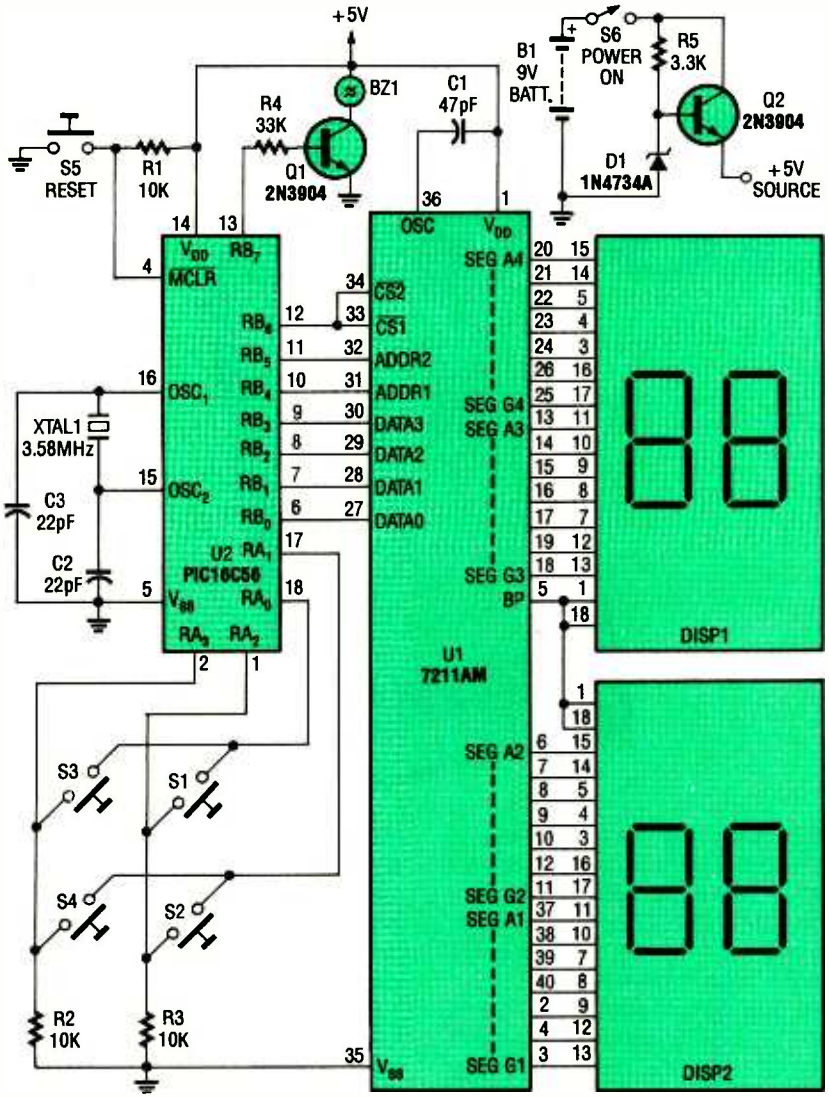


Fig. 1. The Electronic Casino's operation revolves around two chips: U1 (an ICM7211AMIPL liquid-crystal display driver) and U2 (a PIC16C56-XT microcontroller); the game software is resident in 1K of the microcontroller's on-board RAM.

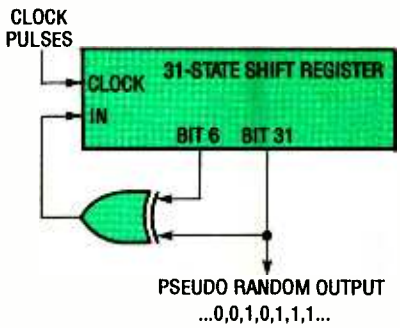


Fig. 2. Shown here is just one of a whole family of shift-register circuits used to produce pseudo-random sequences.

and who have access to the equipment, the listing can be downloaded from our BBS (516-293-2283; 8, N, 1). If you do not have access to such equipment, a preprogrammed chip can be purchased from the supplier listed in the Parts List. (Unprogrammed IC's and programming tools are available from Digi-Key Corp., 701 Brooks Ave. South, P.O. Box 677, Thief River Falls, MN 56701-0677.)

While the entire program is too long to describe here, the subroutine that "deals" the cards in blackjack, "rolls" the dice in the craps, and "spins" the wheels in the slot machine uses a relatively simple, random-number generator that you might find useful in other projects. Needing only twelve lines of assembly code, the routine is a software implementation of a random-number generator that consists of a 31-stage shift register (see Fig. 2) and an XOR gate whose inputs are connected to the 6th and 31st stages, with its output feed back into the 1st stage.

As the shift register is advanced by the clock pulses, the sequence of "1's" and "0's" that appear at the output are an approximation of a true random sequence. The circuit actually steps through 2,147,483,647 approximately random "1's" and "0's" before the sequence repeats!

The circuit is simulated in software by using four of the 32 general-purpose registers that are available in U2. As shown in Fig. 3, those 8-bit wide registers (R1–R4) are imagined to be arranged end-to-end, in a shift-register configuration: *i.e.*, R1 feeding R2, R2 feeding R3, and R3 feeding R4.

In the assembly-language routine (refer to Listing 1), the first two steps move the contents of register R1 to a temporary storage register, TEMP. The contents of the TEMP register are shifted once to the right in step 3. In steps 4 and 5, the contents of R4 are moved to another temporary register, W, and its output is XOR'ed with the contents of R1 (which at this point resides in the TEMP register). That operation XOR's all the bits of TEMP with the corresponding bits of W, and places the result in the temporary register (TEMP), overwriting its previous contents.

Since the 7th bit of the TEMP register (shifted once to the right) and the 7th bit of W were originally the 6th and 31st bits of the shift register, the 7th bit of the TEMP register now contains the software analog of the output of the XOR gate shown in the original circuit.

Note that the TEMP-register contents are shifted twice to the right in steps 6 and 7 to put the 7th bit into the carry bit of the microcontroller (U2 in Fig. 1). Finally, the entire register (R1–R4) contents are shifted one bit to the right in steps 8 through 11. In that operation, the carry bit becomes the 1st bit of R1 and the 7th bit of R4 contains the new output bit of the pseudo-random generator.

To simulate the deal of one card in blackjack, the pseudo-random subroutine is used four times to produce a random four-bit binary number. That can be any number between 0 and 15; however, a routine in the main blackjack program screens out the 0, 14, and 15, insuring that a random number between 1 and 13 is obtained. That corresponds to one of the

PARTS LIST FOR THE ELECTRONIC CASINO

SEMICONDUCTORS

U1—ICM7211AMIPL liquid-crystal display driver (Intersil), integrated circuit
U2—PIC16C56-XT microcontroller (Microchip Technology), integrated circuit
DISP1, DISP2—2-digit liquid-crystal display (Digi-Key #LCD001VT-ND or #LCD001, Standish #3935-365-920, or similar)
Q1, Q2—2N3904 general-purpose NPN silicon transistor
D1—1N4734A 5.6-volt, Zener Diode

RESISTORS

(All fixed resistors are ¼-watt, 5% units.)
R1–R3—10,000-ohm
R4—33,000-ohm
R5—3300-ohm

CAPACITORS

C1—47-pF, ceramic-disc
C2, C3—22-pF, ceramic-disc

ADDITIONAL PARTS AND MATERIALS

XTAL1—3.58-MHz crystal (Digi-Key CTX-049 or similar)
BZ1—Piezo buzzer (Star Micronics model QMB-105 or similar)
S1–S5—Single-pole momentary-contact pushbutton switch
S6—SPST toggle switch
B1—9-volt transistor-radio battery
Printed-circuit materials, enclosure, battery holder and connector, IC sockets, 4 nine-pin terminal strips (Digi-Key #A208 or similar), wire, solder, hardware, etc.

Note: The following parts are available from K and V Electronics, Box 250320, Columbia Station, New York, NY 10025-9991; U1, U2 (programmed and tested), and buzzer BZ1, for $29.95; A pre-drilled, double-sided printed-circuit board with plated-through holes for $19.95. Please add $2.50 for shipping and handling to each order. New York residents, please add appropriate sales tax.

13 different cards in the deck (the suit doesn't matter in blackjack). A similar procedure is used to roll the dice in craps and to advance one of the slot wheels by one step.

Building the Circuit. The entire circuit was assembled on a double-sided, printed-circuit board measuring about 3⅛ by 4½ inches. A template for both sides of that relatively compact printed-circuit pattern is shown in Fig. 4: The template in "A" is the solder side, while "B" is the component side. Its small size makes it suitable for handheld units. If you are unable to make double-sided boards, the board can be purchased from the supplier listed in the Parts List.

Whichever route you decide to take, when assembling the board, it is recommended that the IC's and the display be socketed. Sockets simplify the replacement of blown chips and allow the board to be tested without the IC's in place. Note, however, that the displays do not fit into standard IC sockets; for that, the author used two 9-pin terminal strips for each dual display module.

Figure 5 shows a parts-placement diagram for the double-sided foil pattern shown in Fig. 4. Begin construction by soldering the sockets in place; follow that with the resistors, capacitors, transistors, diode, buzzer, and the crystal (XTAL1). Bend the leads of the crystal to 90° before installing it so that when the crystal is mounted, it lies flat against the circuit board. Be sure to observe the correct polarity for the transistors and the diode.

Connect S1–S5 to the corresponding solder pads. Depending on the type of installation you decide on, it may be necessary to first mount the switches to the enclosure and run wires between the switches and the circuit board. In any event, once the circuit is fully assembled, it is time to check your work.

First connect a 9-volt power source (with the correct polarity) to the "+" and "−" terminals of the printed-circuit board (see the parts-placement diagram). A bench-type regulated DC power supply or a 9-volt battery can be used for this task. Using a voltmeter, check that the voltage at pin 1 of U1's socket, and pins 4 and 14 of U2's socket are at 5 volts and that all the other pins of the sockets are at 0 volts.

Next, test switch S5 by monitoring the voltage at pin 4 of the socket for U2 while S5 is depressed. The voltage should drop to 0 when S5 is depressed

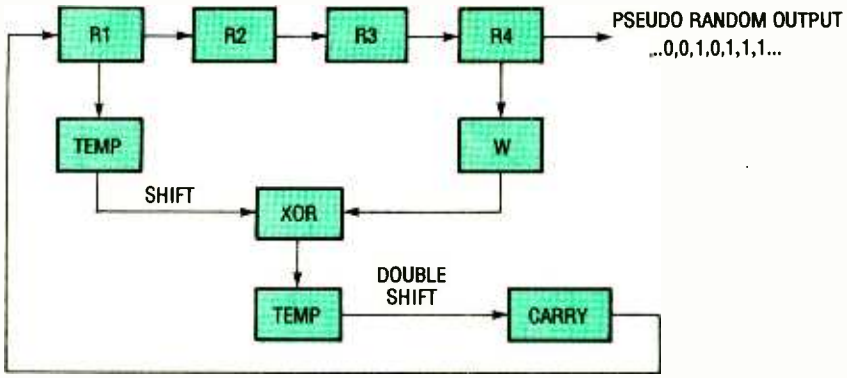


Fig. 3. The double shift puts bit 7 of TEMP into CARRY. From there it is shifted into the first bit of R1.

LISTING 1—PARTIAL LIST OF SUBROUTINES

```
;SUBROUTINE PSEUDORANDOM

1       START   MOVF    R1, 0       ;move R1 to TEMP
2               MIVWF   TEMP
3               RRF     TEMP, 1     ;right shift TEMP
4               MOVF    R4, 0       ;mov_ R4 to W
5               XORWF   TEMP, 1     ;exclusive–or TEMP and W
6               RRF     TEMP, 1     ;right shift TEMP twice
7               RRF     TEMP, 1
8               RRF     R1, 1       ;right shift R1, R2,
9               RRF     R2, 1       ;R3, and R4
10              RRF     R3, 1
11              RRF     R4, 1
12              RETLW   0           ;return to main program
```

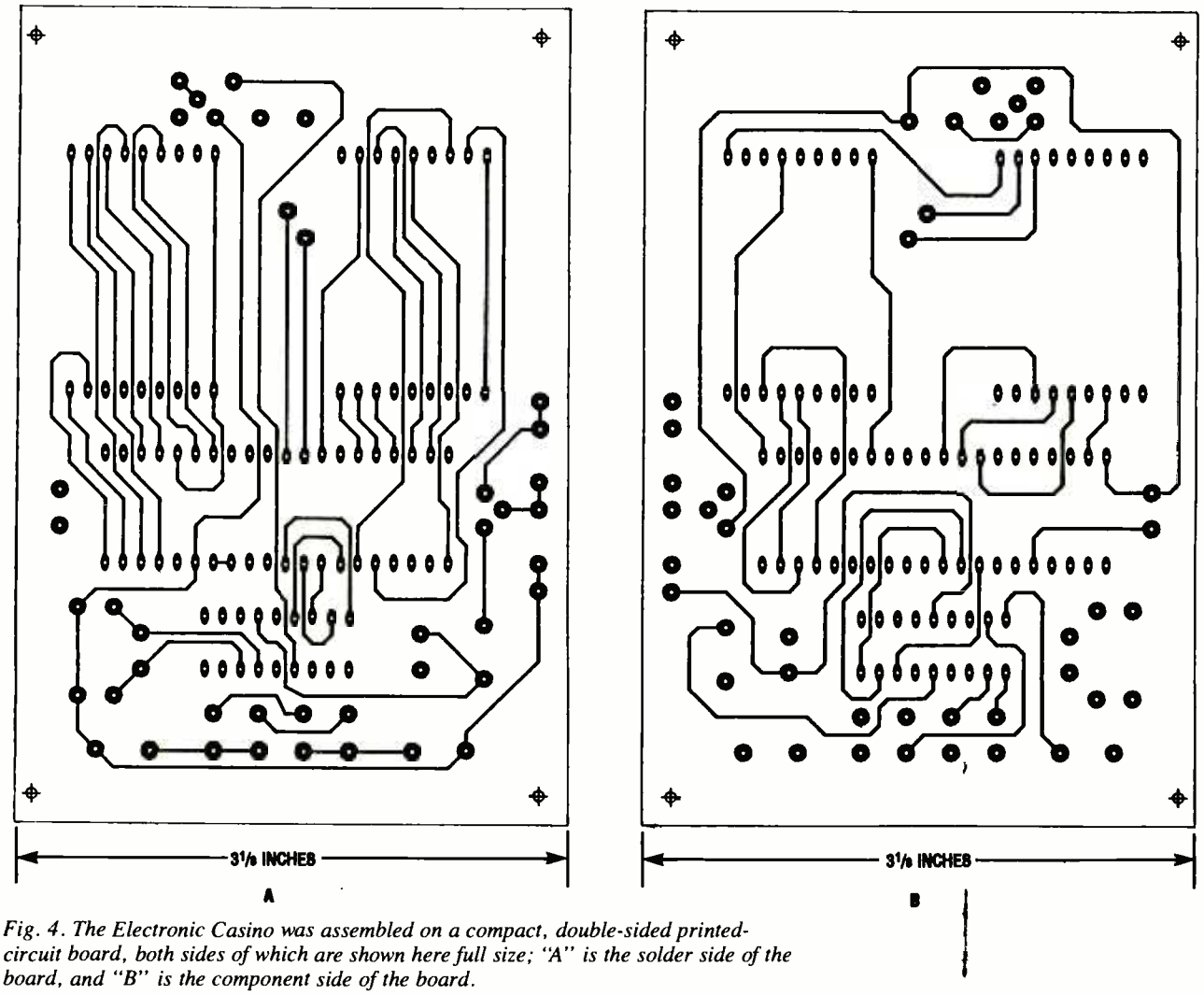


Fig. 4. The Electronic Casino was assembled on a compact, double-sided printed-circuit board, both sides of which are shown here full size; "A" is the solder side of the board, and "B" is the component side of the board.

and return to 5 volts when released. Switches S1–S4 can be tested by placing a jumper wire between pin 1 of U1's socket and pin 17 of U2's socket and another jumper between pins 14 and 18 of the socket for U2. Now monitor the voltage at pin 1 of the U2 socket. It should be 0 volts unless either S1 or S2 are pressed, in which case, the voltage would rise to 5 volts. The same result should be observed at pin 2 of the socket for U2 if either S3 or S4 is pressed. When those tests are complete and all is well, remove the two jumper wires.

The buzzer connection can now be tested by connecting one end of a wire to pin 14 of U2's socket and momentarily touching its other end to pin 13. You should hear a brief sound from the buzzer each time you touch pin 13, and again as the connection is removed. Because the buzzer responds to a changing voltage (not a steady one), there should be no output while the jumper is held to pin 13. If all is well, remove power from the circuit.

If one or more of the tests were not successful, check your work for solder bridges between adjacent pins, and cold solder joints. Also check that Q1, Q2, and D1 have been correctly oriented.

Once everything has checked out okay, install the display modules and IC's. Be sure that they are correctly oriented, and that none of the leads fold under the body of the component. Complete the circuit by attaching S6 and the battery clip as shown on the parts-placement diagram (see Fig. 5).

If you like, you can install the project in an enclosure of your choice. Dry transfer lettering can be used to label the various front panel switches and displays.

With the chips now installed, reapply power to the circuit. The display should begin flashing the digits "1," "2," and "3," repetitively. You are now ready to select your game and begin playing!

The program has a built-in battery saver that blanks the display if no key is pressed after about two minutes. To restore the game at a later time, press the RESET switch (S5) and the game will continue where it left off when the display was blanked.

Let the Games Begin. The RESET button is used during play to change between the three games. The other four buttons, labeled S1 through S4, control the play. In normal operation, the display shows the status of the game you are currently playing, however you can press S1 at any time to see your bankroll. The game returns to the appropriate display when you release switch S1.

On power up or after RESET is pressed,

(Continued on page 91)

GIZMO

A CHRONICLE OF CONSUMER ELECTRONICS

The ABC's of PDA's

...are we on the brink of the Digital Information Age?

As we go about our lives in the highly-touted Information Age, most of us still rely on old-fashioned purveyors of data—telephone, radio, the printed word, and television—for the bulk of our information exchanges. The situation seems somewhat different at work, where the computer reigns supreme and fax machines have become *de rigueur* in recent years—but computers and faxes have also been around for decades. Even the relatively new tools used by business travelers—cellular phones, notebook computers, electronic organizers, portable fax—are variations on the same telephone- and computer-based equipment used back in the office.

Are we ready for something dramatically new? Perhaps something that will bridge the gap between the way we communicate and handle information at work and at home? Or maybe something that will seamlessly merge the way we do work at the office and the way we do work on the road? Maybe an inexpensive, portable, handheld product that would allow us to send and receive phone calls, faxes, and E-mail—not to mention take notes, organize our time, and play games? Sounds good to us—we're ready!

According to John Sculley, the former chairman of Apple Computer, the industry is ready, too. Back in January, 1992, in his keynote address at the Winter Consumer Electronics Show, Sculley announced: "The Digitals are coming!" Citing recent developments in digital technology, he proclaimed, "This will be a decade where people will fundamentally transform the way they live their lives—the way they think, work, learn, and communicate . . . Not only are consumer electronics converging with personal computing. More interestingly Entertainment, communications, and publishing are also converging with computers and consumer electronics."

At the following year's WCES, representatives of Casio and Tandy espoused a computer/consumer philosophy remarkably similar to that of John Sculley and Apple, speaking of the need for a small consumer device that will provide "increased functionality, flexibility, and features" and "anytime-anywhere" information, all "at a consumer-affordable price."

That summer, in his keynote address at the first Personal Communications and Computing show-within-a-show (at Summer CES 1993), Gordon Bridge, president of AT&T EasyLink, noted that "the marriage of communications and computer technology . . . has forever changed the way we do business and is changing the very fabric of our society." He emphasized not the alliance of computers and consumer electronics, however, but of computers and wireless communications technologies.

As you might expect, those speakers were not merely verbalizing their own wishful thinking. Each was describing his company's version of the information/communications product of the future. Sculley coined the moniker "Personal Digital Assistant" or "PDA" to describe

Apple's proposed Newton. Tandy and Casio found that to be a fitting handle for their own Zoomer PDA. AT&T went with "Personal Communicator" (*not* to be confused with "PC") to describe the EO 440.

In this article, we'll examine two entries in the PDA product category, the Newton and the Zoomer, and the first personal communicator, the AT&T EO 440—what they are and how they work, the companies that created them and the technologies that enabled them to do so. We'll explore how PDA's might fit into, or even change, your lifestyle, and how a personal communicator might change the way you work. Then we'll provide hands-on reviews of Sharp's Newton product, the ExpertPad; Tandy's Z-PDA Zoomer; and the EO 440. We wrap up this month's issue with a look at how the Zoomer and Newton stack up against one another.

JUST WHAT IS A PDA?

A Personal Digital Assistant, in its most basic definition, is simply "a device that uses digital technology to bridge the gap between personal computers and consumer electronics." Casio President John H. McDonald fine-tunes (and hypes up) the definition somewhat, when he describes the Zoomer as a "breakthrough device . . . combining the power of a PC, an affordable consumer price, and the simplicity of pen and paper."

Though microprocessor based, the PDA is not just another, smaller, computer. In fact, it might be called the first truly *personal* computer—so personal, in fact, that you might not even realize it's a computer. Its operating system is virtually transparent to the user. The PDA's interface is pen- and icon-based, its architecture is object-oriented, and its target market will encompass not only computer-literate businessmen, early adopters, and techies (although those are expected to buy the first-generation PDA's), but average consumers who have never overcome their fear of computers.

There are several specific criteria that a device must meet if it is to be considered a true PDA. It must be easy to use, portable, powerful, versatile, expandable, affordable, and able to communicate.

To reach its target audience—and differentiate it from the emerging class of pen-based, palm-sized computers—the PDA must be virtually as easy to use as a pen and paper. It can not have a QWERTY keyboard or a complex operating system to master. Information can be input by tapping on icons and writing on a touchscreen with a pen-like stylus; scribbles can remain handwritten or be translated into ASCII text via handwriting-recognition technology.

A PDA must have powerful computing capability, must offer a variety of practical applications, and must be easily expanded to accommodate additional memory and still more applications. It should also provide a communications link to the outside world, allowing fax, E-mail, paging, modem, and even cellular services.

Furthermore, all that simplicity, power, and versatility must be contained in a handheld, portable package. A PDA must allow one-handed use on a plane, in a car, or while standing at a pay phone. Long battery life is essential.

Finally, to become a true consumer item, the PDA must be affordable on a mass scale. That means eventually reaching the price point of other popular consumer-electronics items, such as VCR's and CD players.

The Newton, which is marketed by Apple Computer as the "MessagePad" and by Sharp Electronics as the "Expert Pad," and the Zoomer, sold as the "Z-7000" by Casio and as the "Z-PDA" by Tandy, have been designed with all those requirements in mind. Let's see how Apple and Sharp, and Casio and Tandy, tried to meet those goals. (For simplicity's sake, in this article we refer to the Newton and the Zoomer as product categories; elsewhere in this issue we review Sharp's Newton ExpertPad and Tandy's Z-PDA Zoomer.)

NEWTON-ION PDA

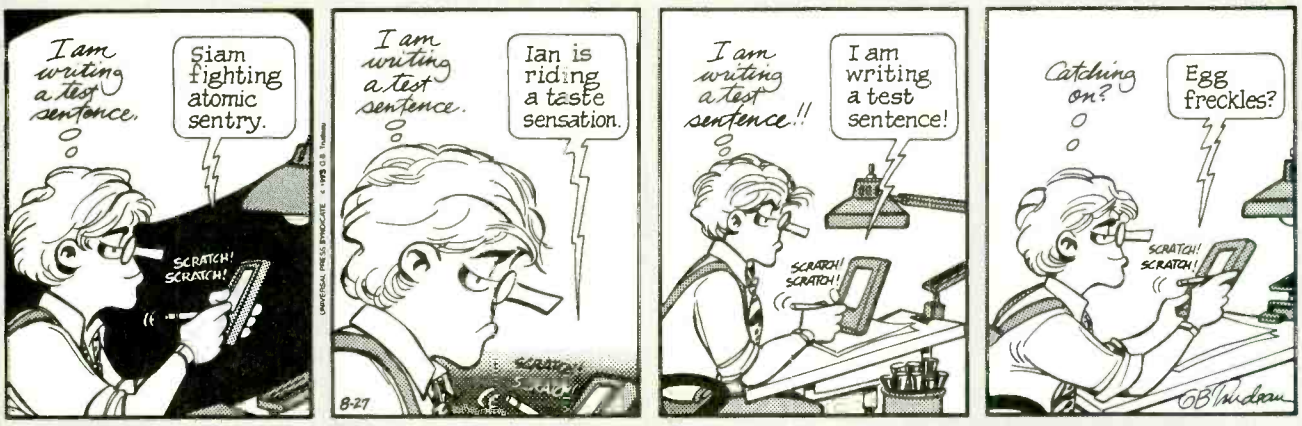
When the folks at Apple first conceived the idea of a PDA-type device, they determined that it must be as a unique device from the ground up and not rely on any existing computer architecture. As a result, there's a lot of neat, ground-breaking stuff under its hood—particularly the Newton Intelligence operating system, which does away with the usual file manipulation, directory paths, and saving to RAM or disk, that's required in today's computer operating systems.

There are four major parts to Newton Intelligence: the Recognition Architecture, which converts cursive and/or printed handwriting to text; the Communications Architecture, which handles various I/O devices using Newton's PCMCIA slot, RS-422 serial port, and infrared transmitter/receiver; the Information Architecture, which replaces the DOS maze of files and directories with a whole new approach to data storage and sharing; and Intelligent Assistance, which allows Newton to adapt to your handwriting style and work preferences. The processing power is provided by the ARM 610 chip from GPS, which delivers 32-bit RISC (Reduced Instruction Set Computing) performance with low power consumption.

Handwriting recognition is vital to any device that promises pen-and-paper convenience. Newton's system allows you to use script or print, or a combination of the two, and converts the handwriting to text as you write, with a slight delay. The system recognizes not just shapes, but pen strokes—it interprets the movements that make up individual letters, numbers, and words. You can also set the system to match your handwritten words to the 10,000 entries in its internal dictionary. If it still has trouble recognizing a word or phrase, you can correct it using a pop-up on-screen keyboard. It's possible to define blocks of text or drawings, move them around the screen (or into other Newton applications), insert spaces or lines, and erase by simply "scrubbing" out your errors. A graphics interpreter neatens up drawings, rounding off circles, squaring

Doonesbury

BY GARRY TRUDEAU



up boxes, straightening lines. If you prefer your artwork as is, you can disable that feature.

It isn't necessary to translate all your scribbles to text. You can simply store your handwritten notes as is, in "digital ink." However, because Newton looks at the way letters are written and not just their shapes, you cannot go back later on and translate your scrawl into text.

In terms of communications, an optional Newton-compatible fax/modem can be inserted in the unit's PCMCIA slot. (Industry-standard PCMCIA fax/modems are not supported, however.) The infrared transceiver can be used to "beam" information to another Newton or to a Sharp Wizard electronic organizer, and the serial port to link Newton to a PC, printer, or fax modem. Faxes can be sent, but not received.

The PCMCIA slot can also be used for third-party add-on applications, additional memory, or backing up data—but not simultaneously.

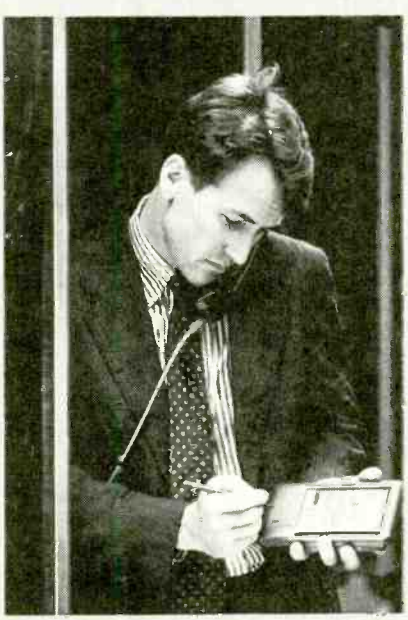
"SOUP"-ED UP OPERATING SYSTEM

Forget everything you know about DOS, Unix, and other file-based computer operating systems. Newton Intelligence is about data-sharing, not data-filing. Everything is stored in one place, and can be easily accessed from any application.

Any data that you enter into the Newton is automatically tagged by the Information Architecture and saved in an object known as a *frame*. Each frame consists of tagged locations called *slots*, which can hold data, program code, or other frames. Several related frames reside together in *soup*, and soups are stored in, well, *stores*, which can reside in main memory or on a PCMCIA card.

That "free-form" style of organization is the electronic equivalent of jotting down notes on Post-Its and scraps of paper, with one major difference. Once the data is in the soup, it can easily be recalled, unlike all those little pieces of paper that are so often misplaced. You needn't decide how to label a bit of information as you're writing it; you can organize it to suit your needs at a later date. You can also link, group, and regroup all those pieces of information as you see fit.

What makes all that possible is Intelligent Assistance. Say you want to fax a document to Joe Client. If he's already listed in the name directory, you can jot down "Fax Joe," and Newton will automatically retrieve Joe's full name and fax number. If there is more than one Joe in your name file, it will ask you to choose the correct one. If you aren't currently hooked up to a fax line, Intelligent Assistance will store the "Fax Joe" order until it can be sent. "Fax" is one of the system's "action words"—others include "call" and "send." Newton perceives those words as commands, and acts upon them when you highlight them and then tap the Assist icon.



The Newton can be used for note-taking at home, in the office, or on the road.

As intended, all of this internal wizardry is totally transparent to the user, who simply turns on the Newton and begins an application. In fact, there is no start-up sequence at all—at power-up, you automatically return to the application last used, and move to a different application by tapping on its icon. Once again, you enter that application in the same place that you left off last time. There's no need to load or save a file, although you can organize them in folders if you wish. Otherwise, Newton simply stores them chronologically, and you can scroll through a list of the notes you've made.

ZOOMING INTO THE FUTURE

At first glance—and, to some extent, at first use—the Zoomer and Newton almost appear to be clones. But looks can be deceiving, as a peak inside the Zoomer will prove.

Rather than starting from scratch to design a totally new product, Casio and its development partners, GeoWorks and Palm Computing, used modifications of existing hardware and software to build the Zoomer. Casio specially designed the unit's Intel-compatible CPU, which is equivalent to a 7.5-MHz 8086. The operating system is a GeoWorks' GEOS, again specially designed for use in the Zoomer. Handwriting recognition is from Palm Computing.

GeoWorks modified its desktop GEOS operating system to reside in the Zoomer's ROM. Although GEOS is a DOS-file-compatible operating system, it isn't a slave to the DOS file structure. GEOS is an object-oriented, multitasking environment with an easy-to-use graphical interface.

In actual use, GEOS acts a lot like the Newton's operating system, although GEOS is somewhat slower and has less intelligence. After all, something had to

Senior Writers: Chris F. O'Brian, Teri Scaduto. ©Gernsback Publications, Inc, 1993. Gizmo is a registered trademark. All rights reserved.

Aimed at consumers, not just business executives, the Zoomer PDA offers a wide variety of applications.

be sacrificed to deliver the Zoomer's long battery life. Casio and Tandy felt that speed would be a fair trade-off for 100 hours between battery changes.

Palm Computing supplied a PDA version of its PalmPrint software—the most widely used handwriting recognition system in North America. Rather than recognizing full words as the Newton does, PalmPrint identifies individual letters, which are defined by tiny templates that have been pre-trained to recognize both upper and lower case block letters; cursive writing can't be translated to text on the Zoomer. Like the Newton, the Zoomer's handwriting recognition is based on pen-stroke motion, not the image of a character, but unlike the Newton, the Zoomer cannot be trained to "learn" its owner's handwriting. The Zoomer, however, does recognize delayed strokes—going back at the end of a word to dot the "i" for instance—and deferred recognition—going back at the end of a meeting, or the end of the day, to translate handwritten notes to text.

Deferred recognition comes in handy because the Zoomer is slow to translate print to text. Of course, you can also opt to leave your notes as is, in "PowerInk." PowerInk entries are treated as objects, not as a layer on top of an application, so they can be moved, indexed, tagged with a reminder alarm, etc., just like electronic text. Palm Computing also specifically developed Palm Organizer—which includes the date-book, address book, and notebook functions—to work with PowerInk entries.

For linking to the real world, the Zoomer provides an infrared transceiver for exchanging data with other Zoomers and Casio B.O.S.S. electronic organizers. A serial port is available for linking to a PC, printer, or optional fax/modem. Software

SIMON SAYS . . .

. . . take a giant step toward the integration of wireless communications services!

AT&T isn't the only company pushing a personal communicator. BellSouth Cellular Corp.'s (500 Northpark Town Center, 1100 Albernathy Road, Suite 300T, Atlanta, GA 30328) version is the IBM-designed *Simon*, a souped-up cordless phone that also incorporates a wireless send/receive fax, paging and E-mail capabilities, a full-function personal organizer, and a pen-based notebook/sketch pad. All of that comes in an 18-ounce, 8 × 2.5 × 1.5-inch wireless package, so it's truly portable.

Simon looks like any small cellular handset, but instead of a keypad it has a brightly lit LCD readout. The pen-based touchscreen serves as the phone's keypad and is used to access and operate the device's other applications. No special stylus is required, although a pen-like instrument facilitates on-screen writing. You can simply tap on the screen with your finger to access various applications.

Although Simon is pen-based, it includes no handwriting-recognition technology. It uses what BellSouth Cellular calls "pen-annotation technology," which means that the user's handwriting will appear as written instead of being digitized to look like a printed word. That might sound rather limiting, but Simon isn't intended to be a data-input device. Electronic ink is sufficient for most of Simon's functions; when text is required, it can be tapped in on a pop-up keyboard.

As a phone, Simon works just like any other cellular phone (except that the keypad is a touchscreen). It has the features you would expect to see, including a built-in 911 emergency-call button, last-number redial, auto-dial (from the address book), roaming preference, and password protection.

Simon's fax application allows faxes to be sent over the cellular network using a built-in wireless modem, or over standard phone lines using an optional RJ-11 cable. Group 3-compatible faxes are sent at 9600 bps. Simon can send or receive up to three pages at a time (optional memory-expansion cards are available). It's possible to zoom-in on a portion of a page, scribble notes and comments, and send it right back.

A built-in cellular numeric pager receives up to nine pages. Users can receive a page and return a call to that number at the press of a single button. When equipped with an optional PCMCIA paging card from MobileComm, Simon can also receive alphanumeric pages and electronic messages on a national, regional, or local basis. Messages are stored in the paging network so that they can be read as soon as Simon is turned on.

Integrated software provides access

BellSouth Cellular Corp.'s Simon personal communicator looks just like a cellular phone.

to Lotus cc:Mail over the cellular network or standard telephone lines, allowing users to send and receive E-mail through any cc:Mail post office that supports remote dial-in. A PCMCIA add-on card allows messages to be received through most other public E-mail systems.

Simon's personal organizer includes a calendar, an appointment scheduler, a to-do list, an address book, a world clock, a calculator, and a note/sketch pad. Users can write directly on the screen, or can use the pop-up keyboard to tap out typed messages within any of the organizer functions. The electronic address book provides convenient auto dialing.

Although Simon is still awaiting FCC approval as we write this, BellSouth Cellular Corp. plans to begin selling the product in select markets in Florida in December 1993. Nationwide distribution is expected by April 1994. ■

for accessing America Online is built-in. Palm Computing sells the PalmConnect package, a complete set of tools to link the Zoomer to IBM PC-compatible and Macintosh personal computers. The package allows two-way exchange of information with a desktop computer. The Zoomer also has one PCMCIA slot for adding communications applications such as a pager, or to add or backup memory with industry-standard PCMCIA cards.

The Zoomer operates in an easy, icon-oriented environment—its "computer" is hidden from the user, although its file structure can be examined if desired. As with the Newton, a tap on one of the Zoomer's icons, located below the LCD screen, brings up the associated application, right at the spot where you left off last time.

Other consumer-friendly features can be found below the LCD—a cursor control pad and two Nintendo-like "fire" buttons. Although the only thing they are used for in any of the applications currently built into the Zoomer is scrolling around the screen, they strongly suggest future game-playing applications. The three games that come with Zoomer—Solitaire, Uki (similar to Othello), and Pyramid (another one-player card game)—are all played using the stylus.

EO 440 PERSONAL COMMUNICATOR

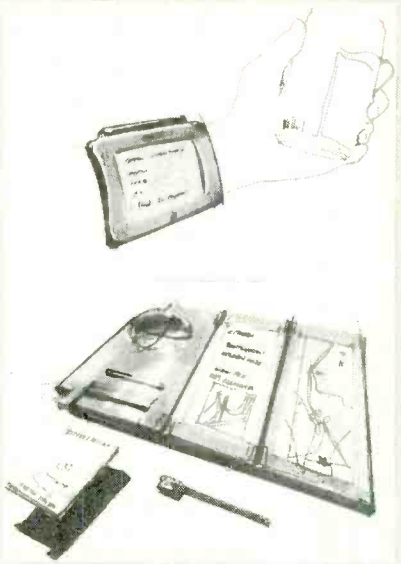
The EO 440 Personal Communicator, is not meant for fun and games—although our evaluation sample did include a crossword-puzzle application that we particularly enjoyed. Much larger than a PCA, and priced way beyond the range of most consumers, the EO 440 is first and foremost a business tool, and its emphasis is strongly placed on communications. Yet its basic concept—combining information management and wireless communications in a small, easy-to-use device—as well as some of the technology it uses, are close enough to those of the Zoomer and Newton to justify its inclusion here.

According to EO, you can't compare the EO 440 to a desktop or notebook PC any more than you can compare it to a fax machine or a cellular phone. Although it contains elements of each of those, it is not intended to replace any of them. Instead, it is designed to fill the growing need of mobile professionals for an integrated device that provides intuitive, versatile, and highly portable communications and information exchange. To that end, the EO 440 Personal Communicator allows users to send and receive faxes and E-mail, and, when equipped with the optional cellular attachment, voice calls, anywhere and anytime.

AT&T is the majority shareholder of EO, Inc., which has strategic alliances with Matsushita, Marubeni, and Olivetti. Developed by EO, the 440 Personal Communicator carries the AT&T brand and is sold at AT&T Phone Centers.

At the 440's heart is AT&T Microelectronics' proprietary, RISC-based 92010 Hobbit microprocessor. According to that company, the high-performance, low-power (20-MHz, 3.3-volt) Hobbit provides two to three times the performance of a 20-MHz 386SL. It is not compatible with Intel/Microsoft or Macintosh standards. EO 440's are available with either 4 or 8 megabytes of RAM, expandable to 12 megabytes.

GO Corporation's PenPoint operating system, whose "pen-and-paper metaphor" provides an easy-to-use interface, is stored in the unit's 8-megabyte ROM. As with the PDA's, information can be input in electronic ink and translated to type or left as is. Applications are accessed by tapping on icons, and pen gestures are used to navigate through the system. Unlike those on the Zoomer and Newton, the EO 440's screen is not touch-sensitive; an electronic pen is required for writing and tapping on icons. At 7.5 inches diagonal, the screen is much larger than those found on the PDA's, and its VGA-equivalent resolution is much higher. Accurate handwriting recognition requires some training of the EO 440 and the user, who must write the way the device expects to see letters formed. Cursive handwriting cannot be recognized on first-generation EO 440's. However, the recognition software is in a replaceable module, and as the recognition technology improves—as it had better, if the PDA/Personal Communicator product categories are to survive—users will be able to upgrade.



Apple engineers devised some possible Newton product concepts, including the "Newton inventory watch" (top) and a GPS-based mapping application (bottom).

Nine bundled applications are built in to the EO 440. For communications, there is GO Mail, GO FAX, and EO Phone. GO MiniNote is used for jotting down words and drawings that will not be transcribed to text. EO Sound allows spoken messages to be attached to any document. EO Calc offers standard- and scientific-calculator functions, and EO Lock provides security. Information can be exchanged with IBM-compatible computers directly via cable or remotely by modem, thanks to Sun-Select's PenTops/Pen Central. Pensoft Personal Perspective provides all the organizer functions—calendar, to-do-list, address book, and note-taker. Because the bundled applications are stored in ROM, the Personal Communicator is ready to use straight out of the box, with applications launched immediately. A hard drive is not required, but is available as an option.

The EO 440 really is a mobile communications center. When equipped with the

The AT&T EO 440 is a stand-alone mobile office that functions as a cellular phone, portable fax, modem, and notebook computer.

TABLE 1

		Newton	Zoomer	EO440[a]
SPECIFICATIONS	Size — (H×W×D)	7×5×1"	6.8×4.2×1"	10.8×7.1×0.9"
	Weight	14,4 oz.	15.3 oz.	2.3 lb.
	Battery Type	4 AAA	3 AA	Rechargeable
	Battery Life (Maximum)	35 hours	100 hrs.	4 hours[b]
	LCD Size	3×4.1"	3.1×4"	4.3×5.9"
	LCD Resolution	336×240	320×256	640×480
	PCMIA Slot	Yes	Yes	Yes
	CPU/Power	20 MHz/32-bit	7.5 MHz	Hobbit–20 MHz 13 mips
	Operating System	Newton Intelligence	GeoWorks	PenPoint
	Price			
HANDWRITING RECOGNITION	System	Newton Recognition Architecture	PalmPrint	PenPoint
	Print Recognition	Yes	Yes	Yes
	Cursive Recognition	Yes	No	No
	Deferred Translation of Ink	No	Yes	Yes
BUILT-IN APPLICATIONS	Personal Organizer	Yes	Yes	Yes
	Dictionary/Thesaurus/ Spell Checker	No	Yes	No
	Calculator	Yes	Yes	Yes
	Form Calculator	Yes	Yes	Yes
	Expense Tracker	No	Pocket Quicken	No
	Time/Date Stamp	Yes	No	Yes
	World Clock	Yes	Yes	Yes
	Games	No	Yes	Yes
	Language Translator	No	Yes	Yes
	U.S. & International Data	No	Yes	Yes
	Reference/Trivia	No	Yes	No
COMMUNICATIONS	Fax	Send only[c]	Send only[c]	Send/receive
	E-mail	Yes	Yes	Yes
	Paging	Future add-on	Future add-on	No
	Voice Annotation	No	No	Yes
	PC/Printer Links	Yes[c]	Yes[c]	Yes
	DTMF Dialer	Yes	No	Yes
	America Online	No	Yes	No
	AT&T Mail	No	No	Yes

a) As equipped per review unit.
b) 7 hours with optional extended life battery pack.
c) Requires optional add-on.

PDA/PCC comparison at a glance.

optional cellular-ready, high-speed modem, the EO 440 is the mobile businessperson's link to the world. The 14,400-bit-per-second data modem includes 9600-bps send/receive fax capability. The Personal Communicator connects to any standard RJ-11 phone jack for faxing. And when the optional cellular-phone package is added, the user has a wireless link to modems, faxing, and E-mail. The EO 440 comes with a free subscription to AT&T Mail from AT&T EasyLink Services. Besides providing fax and E-mail messaging, EasyLink serves as a gateway to the Internet, CompuServe, MCI Mail, SprintMail, Novell MHS, and cc:Mail. So the EO 440 Personal Communicator clears up the clutter by replacing a cellular phone, portable fax, pocket organizer, and—in some respects—a notebook computer.

The Personal Communicator also can be expanded and added in a variety of ways. It has a serial port for connection to a PC, a PC-A7 parallel port for printers or external disk drives, a keyboard port, an RJ-11 phone jack, a power-adaptor jack, a port for a cellular communications module, a PCMCIA Type II slot, and a slot for a JEDEC standard DRAM card.

The personal-organizer functions operate much like those of the Newton. "Associative Linking" is the EO's equivalent of Newton Intelligence, making associations between references in various applications and the names and numbers found in the address book—EO's information central. And, while it's handy to be able to enter "Meeting with Fred" on the appointment schedule and have the device remind you of Fred's full name and address, Associative Linking really comes into its own when it comes to communications.

Documents to be mailed or faxed, or to be received, are stored in the EO 440's In

Box and Out Box, respectively. Tapping on the In or Out Box icons lets the user see what's there, and sending a document requires just another couple of taps, and maybe some handwritten instructions. If, for instance, you're on the road when something comes up at the home office that requires your immediate attention, the EO 440 would allow you to receive the document by fax, mark any necessary changes, add a quick note, and send it back—all in a matter of minutes, whether you're in a cab on the way to the airport, at a convention, or visiting a client.

All of its capabilities take their collective toll in terms of battery life. The EO's rechargeable batteries supply only up to four hours use. That time is significantly reduced if the cellular option is used. An optional nickel metal-hydride extended-life battery increases battery life up to seven hours.

WHO NEEDS THEM?

Obviously, even these first-generation PDA's and Personal Communicators have impressive capabilities, but just where do they fit in the scheme of things? Who can benefit from using a PDA or a Personal Communicator?

The answer is clear for Personal Communicators. Almost three-quarters of all business professionals spend at least 20% of their working time away from the office. Those people are fueling the growing demand for cellular phones, portable fax machines, electronic organizers—all the devices that are consolidated in one EO 440. The device fits easily in a briefcase and weighs just over two pounds (the cellular option adds another pound), so it's easy to bring along almost anywhere. AT&T also expects customers in niche industries to configure the Personal Communicators for specialized purposes, such as sales automation.

The EO 440 might not change the way people do business, but it can certainly make business as usual a heck of a lot easier. In the long term, AT&T hopes to bring the Personal Communicator to the consumer market as well. The major obstacle at this point is price. Starting at $2000 (without the modem) and ranging up to $4000 (with 8-MB RAM, an internal modem, a 20-MB hard drive, and a cellular phone module), the EO 440 has quite a way to go before it can be within reach of consumers.

Newton and the Zoomer are closer to an acceptable consumer price point, each retailing at about $700 at introduction. That's still way too high for most consumers, of course, but new product categories have to start somewhere. As sales increase, prices are sure to come down.

A more pressing question is whether the

(Continued on page 92)

CIRCLE 50 ON FREE INFORMATION CARD

Here's Newton!

SHARP PI-7000 EXPERT PAD. Manufactured by Sharp Electronics Corporation, Sharp Plaza, Mahwah, NJ 07430-2135. Price: $899.

What, you might ask, is Newton?

Newton is digital. Newton is personal. Newton is as powerful as a computer. Newton is as simple as a piece of paper. Newton is a new kind of technology. Newton will help you communicate. Newton can send messages to another Newton through thin air. Newton will help you get organized. Newton can help you make phone calls. Newton learns about you to help you more. Newton will be everywhere tomorrow.

Well, all of that is what Apple Computer Inc. says in its advertisements about its Newton technology. Taken at face value, those ads are not misleading, but they raised our expectations too high. The first Newtons, although impressive, don't live up to their advance billings.

What is Newton really? Newton is not a product, *per se*. Newton is a technology developed by Apple Computer. The Newton product that we review here is built by *Sharp Electronics Corp.*, and is called the *Expert Pad Model PI-7000*. Apple's product, called the MessagePad, is also built by Sharp. The two products are identical electronically, but are packaged slightly differently. Apple's MessagePad has a slip-off case, while Sharp's Expert Pad has an integrated, hinged cover.

The Expert Pad, when closed, measures about $4.4 \times 7.2 \times 1.1$ inches and weighs just under one pound when the batteries are installed. Although it fits in the breast pocket of a suit jacket, we wouldn't want to carry it there all day. It runs on four "AAA" batteries, either alkaline or rechargeable nickel-cadmium. A lithium battery also provides a memory backup. A mechanical interlock system makes it difficult for the main and backup batteries to be removed at the same time, thus ensuring that the data will not be accidentally deleted.

In normal use, all input to the Expert Pad is though a touch-sensitive screen. A latched protective cover, hinged on the right side, swings open to reveal the LCD. A double hinge allows the cover to swing fully around so that it lies flat along the back of the device. The inside surface of the cover has a convenient guide to some of the gestures that are used for input.

Along the right side of the screen is a storage place for the stylus. Strictly speaking, the stylus isn't necessary; a fingernail, chop stick, or any hard object that won't scratch the display can be used. Along the bottom edge of the screen are seven touch-sensitive icons that make up the Expert Pad's permanent menu.

The seven menu icons are: Rolodex cards for the Name File, a calendar for the Date Book, a bin for the Extras Drawer, a set of arrows for scrolling or obtaining an overview of the chosen function, a counterclockwise helix for the Undo function, a magnifying glass for the Find function, and a light bulb for Newton's Assistant function. A Notebook for keeping free-form notes is always open, although it can be covered by other applications.

The Preferences menu, which is accessed through the Extras Drawer, permits the user to configure the Expert Pad in a number of ways. That's where we entered our name, address, and phone and fax numbers, and where we set our password to protect our data from prying eyes. That's also where we set the time and date, and set the country so that our keyboard and paper size would be appropriate. (Different keyboards provide accent marks and other symbols not used in English.) The most important options in the Preferences

menu, however, are those used for setting the handwriting recognizers and for practicing handwriting.

One of the claims made about Newton devices is that they learn about their users. In many ways, that's true. The most important thing for a new user to do is to try to teach the Expert Pad something about himself—starting with his handwriting.

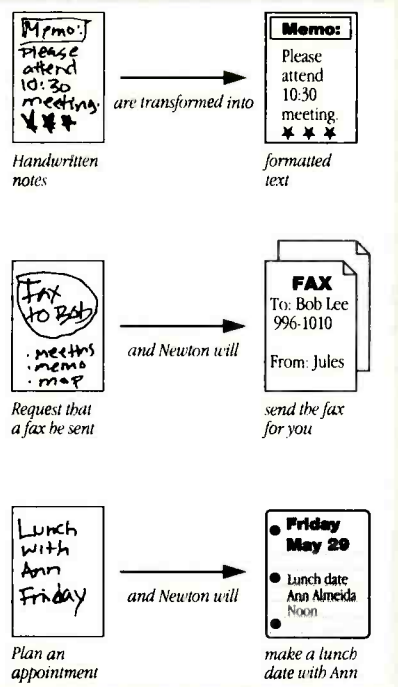
The handwriting recognition of Newton Technology is the most advanced currently available on any PDA, but it is also the most frustrating. It can accept both cursive and printed text, or—as most of us write—a combination of the two. We normally write a capital "A" as a block letter. We write other letters differently depending on whether or not they are at the beginning of a word, or depending on the character that precedes or follows them. For example, in the word "roar," the first "r" would look like a lower-case block-printed letter, while the final "r" would look like a typical script lower-case letter.

A Letter Styles function allows the user to teach the Newton Intelligence how he writes. For each letter of the alphabet, the Expert Pad shows a variety of possible shapes for each letter. It also shows the strokes that are used to write them. The user can then select "sometimes" or "rarely" for each variation. If, for instance, you never write a "z" with a line through it, you would tap on "rarely."

Training is a two-way street: The Expert Pad also teaches the user through its Handwriting Practice function, in which it displays words from its dictionary and asks the user to write them. After the word is written, the Expert Pad displays a list of up to three words that it considered as possibilities, along with a confidence percentage. For example, after we wrote "wear," the Expert pad was 91% confident that we had written "wear," but gave "wears" a 66% chance, and "win" a 65% chance. Other words that came up as we repeatedly wrote the word included "wool," "we or," "ulcer," and "meal."

The Newton handwriting-recognition system often came up with words that we thought looked nothing like what we wrote—even if we searched for some resemblance. The reason it does that, however, is both a benefit and a hindrance.

For fastest operation, Newton uses word recognition, not character recognition (although it is possible to set the Expert Pad to recognize characters as well). The Expert Pad looks not only at the shape of the letters, but at the way in which the strokes are made, and how the letters are linked to form a word. Rather than translating single letters, Newton examines full words, matching them to the words that appear in its dictionary. Words can easily be added to the recognition dictionary, so that Newton can learn to recognize the proper



Newton Intelligence allows the Expert Pad to understand enough about what you're doing to actually help you.

names in your Address Book, for instance.

Newton's word recognition is fast, but the device cannot convert previously written notes to text at a later time.

Correcting wrongly recognized words is sometimes simple. For example, we wrote the phrase "The Sharp Expert Pad," which was translated, "the sharp Expect Pact." Tapping on each word brought up a list of possible alternates. In each case, the list contained the correct word, and all that was required to fix things was to tap on it. It took maybe three seconds to get the correct text.

At other times, however, correcting the Expert Pad was an exercise in frustration. For example, we wrote the sentence, "Sue wore a red dress," which was translated to "Sue wire auditing." Fixing "wire" was a simple matter of two taps with the stylus—one to call up the word list, and another to select "wore" from it. Alternately, we could have just written over the "i," changing it to "o." To fix "auditing" we had to tap the keyboard icon at the bottom of the word list to call up a small on-screen keyboard on which we could type in the correct three-word phrase.

We concluded that the handwriting recognition of Newton Intelligence is, indeed, impressive technology, especially considering all the necessary processing horsepower that is crammed into the small, battery-powered device. But it is not a practical way to enter a lot of data, or to take quick notes. (We often have trouble reading our own scrawled notes—reading the Expert Pad's interpretation of such scribble would be next to impossible. Of course, we could just leave our handwritten notes in "digital ink," but writing on an LCD with a stylus makes our writing even harder to read, and the screen's resolution makes reading difficult.

Most people, however, don't need to jot-down large amounts of information as we would during an interview or at a press conference. Most day planners are full of short notes: Meet Joe at his office 10 AM; Sarah's birthday; Financial report due; etc. With short entries, where correcting incorrectly recognized words isn't too frustrating, Newton excels, and Newton gets better at identifying words as you add frequently used words to its dictionary. (Every time you "type" in a new word that isn't in its dictionary, the device asks if you want to enter it.) There's a down-side to that: The more words in the dictionary, the slower the handwriting recognition.

Because the Notepad is always open, it's a convenient place to jot down random pieces of information. To start a new note, all that's required is to draw a horizontal line across the screen. The line is transformed into a bold, straight line that contains a date-and-time stamp, and a kind of command menu. Tapping on the file-folder icon permits the note to be filed in a category (which can be user-defined), while tapping the envelope icon permits the file to be output to another device such as a printer or fax, or "beamed" via an infrared signal to another Expert Pad. The Notepad can display all notes, or just those in a chosen category. If you don't remember what category a note is filed in, just tap the Find icon, and the Expert Pad will search through all notes for any occurrence of the word you want to find. (It can also search across all applications, if desired.)

The other main applications of the Expert Pad are its Name File and the Date Book. The Name File can store such information as names, addresses, company names, E-mail addresses, four phone numbers per entry, and birthdays. The information can be displayed as a business card, or as a card with attached handwritten (or translated-to-text) notes.

The Date Book contains an appointment calendar and a to-do list. A small monthly calendar always appears on the top of the date book. Tapping any date on the calendar calls up the appointment list or to-do list for that day. Tapping and dragging permits multiple days to be called up. For example, you could look at a week's schedule, or appointments for all Mondays in the month.

What makes the Expert Pad different from any other organizer? It's the Newton Intelligent Assistant, which adds some human-like smarts to the Expert Pad. For example, if we were to write, "Fax Carl"

and then tap the Assist icon, the Expert Pad would be smart enough to go through our address book and find Carl and his fax number. If there were more than one Carl in the book, Newton would ask us which one we meant.

Writing "Meet John and Marc 2/21" would launch the Date Book to February 21, and place the text there. We could move the appointment to the right time (since we hadn't input it previously) and set an alarm to remind us.

Other key words that the Assistant recognizes include "call," for dialing, "remember" for the to-do list, and "time" for finding the correct time in different time zones. Newton also recognizes "breakfast," "brunch," "lunch," and "dinner." If you jot down "Lunch Susan Monday," the Expert Pad would assume you meant to meet her at noon on this coming Monday. Had you specified breakfast, brunch, or dinner, it would have assumed 7 AM, 10 AM, or 7 PM, respectively. It would ask if that's correct, and then store the information in the Date Book.

Along with its personal-information management functions, the Expert Pad also features a built-in calculator, and form calculators for metric conversions, currency exchange, loan payments, and interest.

We wish that we had been able to put the Expert Pad through its paces sending faxes and E-mail and printing. Unfortunately, we couldn't. We did not receive the required printer cable from Sharp, and the Expert Pad does not support standard PCMCIA fax modems.

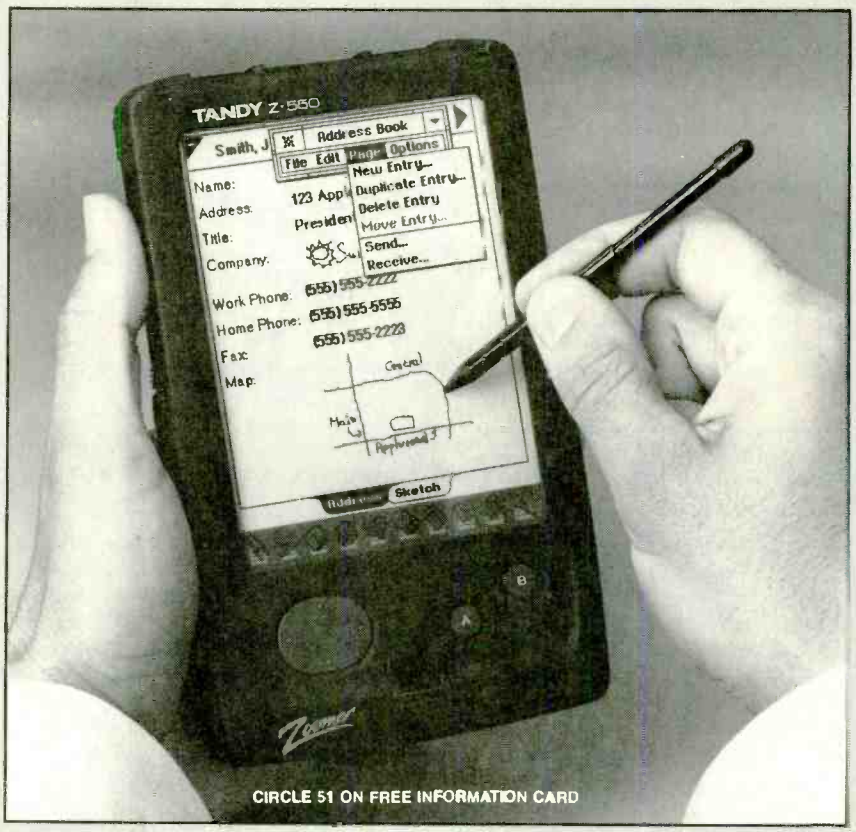
The Expert Pad's handwriting recognition was impressive—but not good enough. We often were so frustrated at what Newton said we wrote that we "scrubbed" out what we had written and started over again, and again, and again. Scrubbing out was a novelty, though. Running the stylus in a zig-zag through the offending word or sentence reduces the text to a cloud of dust, which disappears with a little "puff" sound. Deleting entire entries is even better—the "paper" crumbles into a ball and flies into a garbage can. If we had been using pen and paper during our handwriting recognition tests, our garbage pail would have been overflowing.

And that about sums up the first-generation Newton. It's neat—and it's frustrating. ■

Zooming Along

Z-PDA ZOOMER PERSONAL DIGITAL ASSISTANT. Manufactured by Tandy Corporation, 1800 One Tandy Center, Fort Worth, TX 76102. Price: $699.

The *Tandy Zoomer Z-PDA* doesn't try to knock people out with new technology.



CIRCLE 51 ON FREE INFORMATION CARD

Instead, it packs a one-two punch with extraordinary battery life and a host of practical features.

Tandy chose an 8-bit processor, custom-designed by Casio, to power the Zoomer. The advantage to using such a relatively low-power CPU is that the device can run for about 100 hours on a set of three "AA" batteries. The trade-off is that the Z-PDA is not as fast as it could be, and it can't perform such high-tech wizardry as recognizing cursive handwriting.

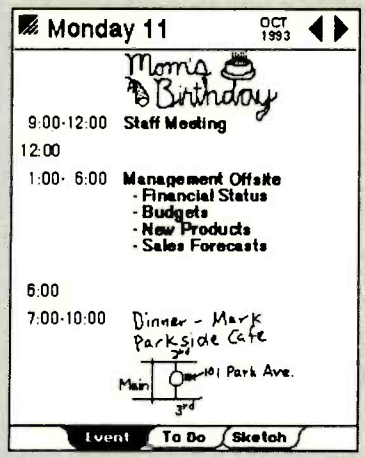
Tandy figured that long battery life—and easily replaceable batteries—were essential for what it hopes will be a mass-market device. We were impressed when a Radio Shack spokesman told us that the product was designed so that if a user received a low-battery warning while boarding a plane in New York for Los Angeles, he could use the Zoomer during the whole flight, and not worry about buying a new set of batteries until he reached the West Coast.

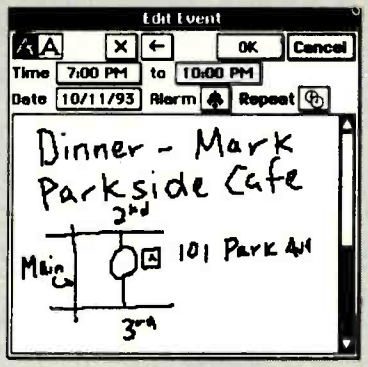
Even if we'd had the opportunity to do some traveling during the product-review period, we wouldn't have been able to test that out. In dozens of hours of testing, we never got a low-battery warning!

Had we had cause to replace the AA's, however, the Zoomer's two lithium button cells would have backed-up our data during the switch. Those last for approximately five years, and Tandy recommends putting a reminder to replace them in the Z-PDA's date book, five years after the date of purchase.

The date book is just one of the "host of practical features" mentioned above. The Zoomer also provides an address/phone book, a notebook/sketch pad, Pocket Quicken financial-tracking software, a world clock, a calculator, a forms calculator, a pop-up user-configurable keyboard, pop-up help screens, access to America Online (with an optional modem and a monthly subscription fee), a dictionary, a thesaurus, a spell checker, a language translator, three games, and a reference section. All of that is packaged in a charcoal-colored case that measures about 7 × 4¼ × 1 inches and weighs under a pound. The double-hinged front cover flips up and over the top, folding flat along the back of the unit to reveal the LCD. Ten icons arrayed below the LCD each represent one or more of the Z-PDA's functions.

Although using the Z-PDA is purported to be an "intuitive" process, first-time users will be glad that Tandy included a video introduction to Zoomer's many features. Otherwise, they'd be forced to go directly to the rather hefty, 145-page user's manual—which might bring up unpleasant associations with computer/software manuals. Because the video merely touches on each application, it is necessary to refer to the manual frequently in the beginning, and on occasion later on. We would have liked to see an abbreviated "quick-start" manual along with (or instead of) the video. We find it much easier to flip through a short booklet than to search a video tape for a particular subject.





Standard text, PowerInk, and drawings can be mixed in most of the Zoomer's applications.

The first thing we wanted to try out, of course, was the Z-PDA's handwriting recognition. We popped the stylus out of its well on the Zoomer's bottom panel and pulled it open to its full 4-inch length. Although the storage well is a handy place to keep it, the stylus itself is somewhat uncomfortable to use—it's like writing with a pencil stub. You can substitute any blunt pen-like instrument—a pen with a plastic cap or a wooden chopstick, for instance—and a certificate for a free, full-size stylus comes with the Zoomer.

From the videotape, we had learned that the stylus was used for a few things other than writing. Tapping on an icon, menu, or command activates that function, and tapping on the screen moves the cursor to that location. Dragging—holding the pen down and dragging it across handwritten or computer text—"selects" that text so that it can be edited, copied, or moved. The pen can also be dragged across the menu bar or icons to move them around the screen. Finally, the pen is used for making editing gestures. A backward "L" gesture acts like a carriage return, adding a line. A "pigtail" gesture (a vertical line with a loop in it), familiar to editors and proofreaders, is used to delete text.

To practice using the stylus and writing on an LCD, we tapped on the pad-and-pencil icon to bring up the Note Book. The techniques that we practiced can be used in any of the applications, however.

The Note Book consists of a table of contents page and blank pages on which to write or draw. A title bar at the top of each page can be used to label a new entry. Similar subjects can be grouped together in the table of contents, and tapping on a title in the table of contents recalls that entry. Just below the title bar is a row of "tool" icons: on-screen buttons labeled with a handwritten "A" for using PowerInk (handwriting that is not translated to text); a typed "A" for handwriting recognition; an "X" to erase the whole page; a backspace arrow to erase the previous character; and a briefcase full of sketch tools.

At first, we tapped on the handwritten "A" to use PowerInk. With PowerInk, we could write or draw, or both, using cursive writing if we chose. Our writing would be stored exactly as it appeared on the screen, and would not be transcribed to text. For many applications, PowerInk is sufficient. After all, there's no need to translate "Pick up milk and bread" into printed text. Even in the address book, you can use PowerInk. Zoomer asks you to verify the first letter of each person's name, so that the entry can be filed alphabetically.

Feeling like kids on the first day of school, with brand new notebooks and freshly sharpened pencils, we began to write. Using PowerInk is a breeze, and it was fun to write and doodle on an LCD. When we tapped on the handwriting-recognition tool, however, that first-day-of-school anticipation quickly turned into the nightmare of a surprise quiz—given in a foreign language. Our first attempts were translated into complete gibberish, combinations of letters, numbers, and punctuation marks that made us wonder if the Zoomer was cursing at us. In fact, the first few sessions had us cursing right back. Zoomer's handwriting-recognition definitely takes some getting used to!

We're happy to report, however, that the situation improved with time and experience. The manual provides some pointers on writing in a manner that the Z-PDA can interpret. We picked up other helpful hints through trial-and-error. Practice didn't make perfect, but we have gotten to the point that Zoomer can understand about 85% of what we write, and we are now very proficient at making quick corrections, using either gestures or the pop-up keyboard. In fact, it was sometimes convenient to keep the keyboard on-screen to supplement our writing, using it to fill-in where Zoomer's handwriting recognition most often failed: with punctuation, spaces, and lines.

As soon as we felt confident in our ability to input information, we tried out some of the other applications. Applications are opened by tapping on the appropriate icon. Opening one application automatically closes the previous one. When you return to an application, you return to the precise spot at which you left it.

The Address Book resembles a standard paper version, with fields for name, address, and work, home, and fax phone numbers. However, you can customize your address book by adding, deleting, or changing those fields. Zoomer provides a list of 16 standard choices (including zip code, country, company, title, E-mail, other phone), and four custom fields. Those might be used to note birthdays, anniversaries, spouse's and children's names, or any other useful information. The Address Book includes a sketch pad, which allows you to attach a drawing to any entry. It's also possible to create a second Address Book, so that you can keep your business and personal contacts separate.

You can also work with separate business and personal Date Books. Zoomer's Date Book application offers several calendar views and scheduling/reminder functions—so many, in fact, that it takes some time to learn to navigate through the various calendar views to easily find the one you want.

You can look at daily, weekly, monthly, and six-month calendars; tapping with the stylus will call up a specific date, week, or month. A tap on the right and left arrows at the top right corner moves you forward or backward through the calendar that you've viewing. Tapping the Tool Box icon allows you to write directly on the calendar. Scheduling events is done using the daily view. Sketches can be attached so that, for example, you can draw a map to help you get to a scheduled meeting. It's possible to schedule recurring events—weekly meetings, birthdays, and the like. An alarm can be set to remind you of appointments.

Zoomer's To Do list is also accessed through the Date Book's daily view. Each task can be assigned a priority level, and can be checked off when completed. Don't put off 'til tomorrow . . . Zoomer will simply move the task reminder up to the next day until it's checked off.

Text documents that you've created can be faxed or sent via E-mail, if you connect your Z-PDA to a modem. We connected ours to a Zoom pocket fax/modem. A special adapter cable was required because the Zoomer doesn't have a standard serial connector. Because of the built-in support for America Online, accessing the service—which provides news, travel, stocks, and product support "departments"—was easy.

Perhaps the most sensible built-in ap-

THE PDA FACEOFF

So which is better, the Zoomer or the Newton? Even though the two products are clearly after the same market, there is no clear winner. The two products are significantly different, and each excels in some areas. The table at the right shows our opinion of where one unit is better than the other, and where there is no significant difference.

Categories	Newton	Zoomer	Tie
Power/Speed	*		
Battery Life		*	
Personal Organizer Functions			*
"Intelligence" (Associate Data Linking)	*		
Handwriting Recognition	*		
LCD			*
Price			*
Portability			*
Built-in Applications		*	
Announced Third-Party Applications	*		
Communications Capabilities		*	

The Newton has a more powerful processor than the Zoomer, so it is faster and it should, in the future, have more powerful applications. The downside of its high power is that battery life is significantly reduced as compared to the Zoomer. Sharp claims that battery life should be about 35 hours after the unit is trained (which drains the battery faster than other applications). Because we spent most of our time training the device, we were not able to obtain anywhere near that much battery life. The batteries in the Zoomer are still going strong.

Both devices offer adequate personal organizer functions, neither significantly better than the other. However, the Newton is "smarter" when it comes to using the information contained in its organizer database. The Newton is also far smarter when it comes to recognizing handwriting, but still not smart enough. The errors made by Newton were more frustrating and usually more difficult to correct than those of the Zoomer. That's because Zoomer recognizes (and mistakes) single letters, while Newton works on full words, allowing for bigger goof-ups.

Both units need a better display with higher resolution and back-lighting. We realize that's incompatible with the low prices and long battery life required of a PDA, but hope that subsequent generations of PDA's come up with a solution.

There is virtually no difference between the street price and the portability of the Zoomer and Newton. We found ourselves using the Zoomer more because it had more built-in applications. We are somewhat addicted to playing solitaire, and are big fans of Pocket Quicken. But there are more potentially impressive applications being developed for the Newton, including a Fodor's travel guide to major cities and a Dell Crossword Puzzle application. No third-party applications have been announced for the Zoomer as we go to print.

Neither device has sufficient communications capabilities—wireless communications are required for full PDA functionality. We give the Zoomer the edge because it has a built-in RS-232 port which can be used to hook up to a modem. Because we didn't receive a special modem card for the Newton, and because we don't have any RS-422 devices, we were unable to use its communications features.

plication that Zoomer provides is Pocket Quicken from Intuit, which allows you to keep track of your day-to-day expenses. Although we are big fans of Quicken's desktop version (which was reviewed in the November, 1993 issue), we often find ourselves losing track of expenditures over a long weekend, when traveling, or whenever we're away from our PC's for a few days. Pocket Quicken remedies that problem by going where our PC can't.

Pocket Quicken uses three basic images: a wallet icon for recording expenses; a bank icon for deposits, withdrawals, and transfers; and a file-cabinet icon for saving and categorizing your records. Those categories are represented by other icons: a knife and fork for dining, a car for transportation, a shopping cart for groceries, and the like. There are different expense categories under the headings business, personal, home, auto, and other.

Pocket Quicken provides instant access to account data for each of your accounts. You can set it up to handle one or several accounts under the general headings cash, credit, and bank. A separate connectivity pack—not available at the time of our review—will allow users to merge their on-the-road data with their desktop Quicken data.

Pocket Quicken, which lets you keep tabs on all your financial transactions, is one of the most practical applications built into the Z-PDA.

The rest of the Z-PDA's built-in applications are not quite as practical. They range from convenient to just plain silly. Let's take a look at them, in that order.

It's always handy to have a dictionary around. The Zoomer's contains 100,000 words for checking your spelling, 50,000 definitions, and a 660,000 synonyms. You can enter a word using handwriting recognition or with the pop-up keyboard. Two on-screen keys labeled FLASH and JUMBLE allow you to play games. Flash calls up words at random, and you can guess their meanings before you look up the correct answer. Or you can try to make as many words possible by scrambling the letters in that flash word and then hit the JUMBLE button to find out how many Zoomer came up with.

The forms calculator is used to perform currency conversions, financial calculations, and unit conversions. Financial calculations include loan-payment schedules, margins, balloon payments, and—particularly useful for those who often lunch with office pals—a "bill splitter." If you input the amount of the tab at a restaurant, the percentage you'd like to leave as a tip, and the number of people, Zoomer

(Continued on page 92)

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AT&T EO PERSONAL COMMUNICATOR. From: EO, Inc., 800A Middlefield Rd., Mountain View, CA 94043. Phone: 800-458-0880, 415-903-8100. Price: $2000–$4000 ($3200 as configured here).

In its recent "you will" commercials, *AT&T* presumes that, among other things, people want to be able to send and receive faxes while at the beach. Well, that's the *last* thing we want—the sound of the surf and a good book are good enough for us.

We know from experience, however, that we would appreciate being able to send or receive a fax while on the way to the airport. Furthermore, we often wish that we had a more effective way to stay in touch with the office while we're on the road. The *EO 440 Personal Communicator* promises to do it all.

The EO 440 Personal Communicator is an impressive, one-of-a-kind device. It's not a laptop computer, and it's not truly a PDA, although it performs many similar functions. A note from EO's Vice President of Marketing that accompanied our review unit warned us not to compare it to a computer, saying that "you might just as well compare the EO 440 to a fax machine or a cellular telephone. Whereas the EO 440 contains elements of each of these systems, it is not designed to be an alternative to any *one* of them. The EO 440 is a new category of system that fills a needs profile that cannot be filled by a notebook, a fax machine, a pocket information organizer, or a cellular phone."

The EO 440 measures about 10.8×7.1×0.9 inches, but two "ears" stick out from either side of the unit, adding about three inches to its width. The ears contain a microphone, a speaker, and connectors for a printer, keyboard, and a personal computer. The screen is a 7½ inch diagonal LCD, with a resolution of 110 dots per inch. (That's 640×480 pixels, which is standard VGA resolution.) It is recessed slightly to help prevent scratches.

The EO 440 is targeted at business professionals. It focuses on communications, combining voice, data, and fax capabilities with organizer functions and more. A total of nine productivity and communications applications are built-in.

The EO 440 runs on the PenPoint operating system, which was developed by GO Corporation. The operating system was built from the ground up specifically for pen input. The applications included with the EO 440 are: GO Mail—for sending and receiving E-mail. GO Fax—for sending and receiving faxes. EO Phone—for phone dialing voice calls. Personal Perspective—an appointment calendar, address book, and information manager. EO Sound—for voice notes to documents. MiniText—a simple en-based word processor. MniNote—for producing simple graphics and handwritten notes. EO Calc—a calculator. EO Lock—for password-protecting the EO 440. PenTOPS and PenCentral—for linking the Communicator to an IBM-standard PC.

PenPoint is based on a notebook metaphor—tables of contents and page-edge tabs allow users to navigate through the various applications. The pages listed in the table of contents represent documents. Documents can be organized into sections. The page tabs on the notebook provide easy access to the documents or sections; tapping a page number is another way to open an existing document. Several auxiliary notebooks and accessories are organized on a "bookshelf" below the notebook.

The notebook metaphor took a little getting used to, but it was reasonably easy to learn, and once we were familiar with it, the Personal Communicator was easy to use. The system was also easy to remember. We think that is important because we would assume that many potential users would require the Communicator only on out-of-town trips.

Our EO 440 was almost fully equipped with available options. It contained a 20 megabyte hard disk drive, a 8 megabytes of RAM, an extended-life (7-hour) battery pack, and an internal V.42, V.42bis, 14,400-bps data/9600-bps group 3 fax modem. We did not have the cellular-phone option, but we saw it demonstrated. We were able to hook the Communicator to a standard phone line.

With the cellular option, it would be possible to receive a fax while on the road (or on the beach), display it on the screen, annotate it with the pen, and send it on to someone else—perhaps to someone with an EO. The phone list and address book make it easy to send and receive faxes. However, fax isn't the only way to stay in touch. The EO comes with a subscription to AT&T Mail, which is the largest E-mail system in the U.S. and offers gateways to such systems as CompuServe, MCI Mail, and the Internet.

The EO can connect to more than jus phone lines. It has a printer port (but wit drivers only for HP LaserJet and Epso don-matrix printers), and a serial port fc connection to personal computers. A PS/2-compatible keyboard can also b connected—a great convenience whe adding such data as names and addresses

The EO's handwriting recognition is fa from perfect. It recognizes only printe text. After we practiced a little, we foun that it could achieve a recognition rate c about 90 percent. It is possible t customize the recognizer if you can't wri a letter the way it wants you to. Recogn tion need not be done on the fly. Instead you can translate the electronic ink to te at a later time.

One very nice feature of the EO is th the handwriting-recognition software contained in a removable module. As be ter recognition algorithms are developec

(Continued on page 9.

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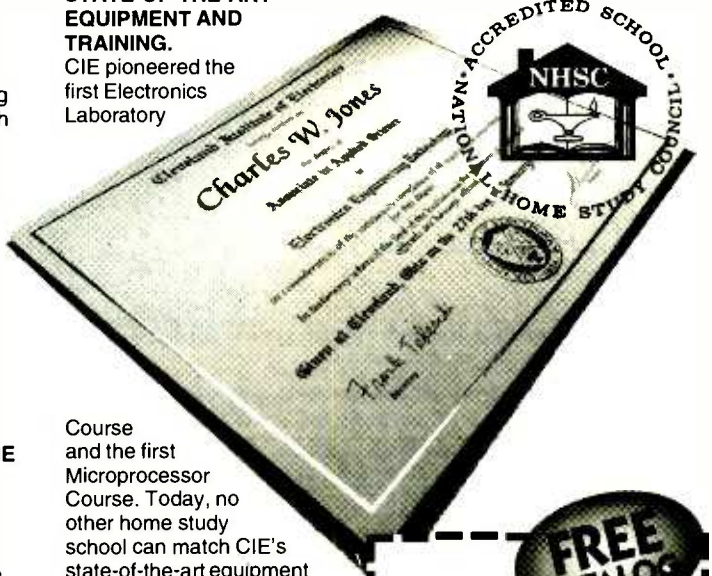

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BY ANTHONY J. CARISTI

In these times of rising costs and diminishing *real* income, every driver knows how very costly vehicle maintenance can be, even for relatively minor repairs. For most problems, a driver has no alternative but to take the vehicle to a service technician. Sooner or later all vehicles require repairs to the battery and charging system, and if the problem is not diagnosed properly, you could spend a fortune replacing perfectly good parts. But there is one area—the vehicle's battery and starting and charging systems—that can be monitored and diagnosed for possible problems using a simple electronic circuit.

Although modern automotive batteries and their charging systems can be somewhat complex, diagnosing them is relatively simple. And diagnosing electrical-system problems is just what the *Automotive Electrical Diagnostic System* described in this article is designed to do.

Some Background. The Automotive Electrical Diagnostic System monitors the battery's terminal voltage to determine the condition of the vehicle's electrical system under various operating conditions—including standing idle prior to starting, cranking, idling, and running with various electrical accessories in operation. It keeps tabs on your vehicle's battery, alternator, regulator, and cranking voltage through a set of 5 LED's.

Under normal conditions, a green LED lights and remains lit as long as the battery voltage is normal prior to starting the engine. The other 4 LED's light only when a malfunction occurs. The circuit is powered from the vehicle's electrical system, so it does not require a separate power source. It can be permanently installed in the vehicle (to continuously monitor electrical system status) or assembled as a portable unit and connected to any vehicle with a 12-volt electrical system.

All vehicles that use a 12.6-volt lead-acid battery as the power source will fall within certain voltage constraints as the vehicle is operated. For example, a battery in good condition will have a terminal voltage of about 12.6 volts when the engine has not been in operation for some time. During cranking, battery voltage should not fall below 9 volts.

When the engine is operating, the voltage regulator should hold the terminal voltage between 13.5 and 15.0 volts. When all accessories are on, the alternator should be able to maintain at least 13.5 volts across the battery at about 1500 or 2000 engine RPM. Table 1 illustrates normal battery-terminal voltages under various operating conditions and specifies possible faults when any of the voltages levels falls outside of the acceptable limits.

Circuit Operation. At the heart of the Automotive Electrical Diagnostic System (see Fig. 1) is the Maxim MAX8214ACPE five-stage voltage comparator, U1, which also contains a built-in 1.25-volt precision reference. The chip also has an on-board logic circuit that allows the outputs of two of the comparators to be inverted by tying the mode-select input (MS, at pin 15) high (more on that later).

In the Automotive Electrical Diagnostic System, the non-inverting inputs of all of the comparators are tied to U2's internal 1.25-volt reference, while the MS input is tied high, causing the outputs of comparators U1-a and U1-b to be inverted. When any comparator output is driven low, its associated LED lights.

Resistors R1–R6 form a voltage-divider network that provides specific voltage levels at five junctions, ecch of which feeds the positive input of one of U1's five comparators; thus each comparator receives a known percentage of the input (battery) voltage. Since each of the five comparator circuits are similar, an explanation of one such circuit will cover all. Take U1-e (the NOT CHARGING MONITOR), for example.

When the engine is at rest, the battery voltage is 12.8 volts or more, so the voltage at the R3/R4 junction exceeds the 1.25-volt reference, causing the output of U1-e to go high, holding LED3 off and indicating that the charging system is delivering current into the battery at engine idle. Even if the battery voltage rises above 12.8 volts (which is normal during engine operation), the output of U1-e at pin 10 remains high, keeping LED3 off. But should the charging system fail, battery's terminal voltage will dip below 12.8 volts, causing LED3 to light, alerting the driver to the condition.

Comparators U1-c and U1-d operate in a similar manner, lighting their LED's if the battery voltage falls below 9.0 and 13.4 volts, respectively, indicating WEAK BATTERY (insufficient cranking voltage) or INSUFFICIENT CHARGING (defective alternator operation).

TABLE 1—AUTOMOTIVE ELECTRICAL FAULTS

Condition	Normal Voltage	Possible Fault
Vehicle at rest	12.6 volts	<12.4 volts: bad cell or severely undercharged battery
Cranking	>9 volts	<9 volts: Weak battery
Idling	>12.8 volts	<12.8 volts: Not charging; bad alternator or wiring
Running minimum load	>13.4 volts	<13.4 volts: defective alternator or voltage regulator
Running minimum load	<15.2 volts	>15.2 volts: Overcharging; defective regulator
Running maximum load	>13.4 volts	<13.4 volts: alternator defective or belt slipping

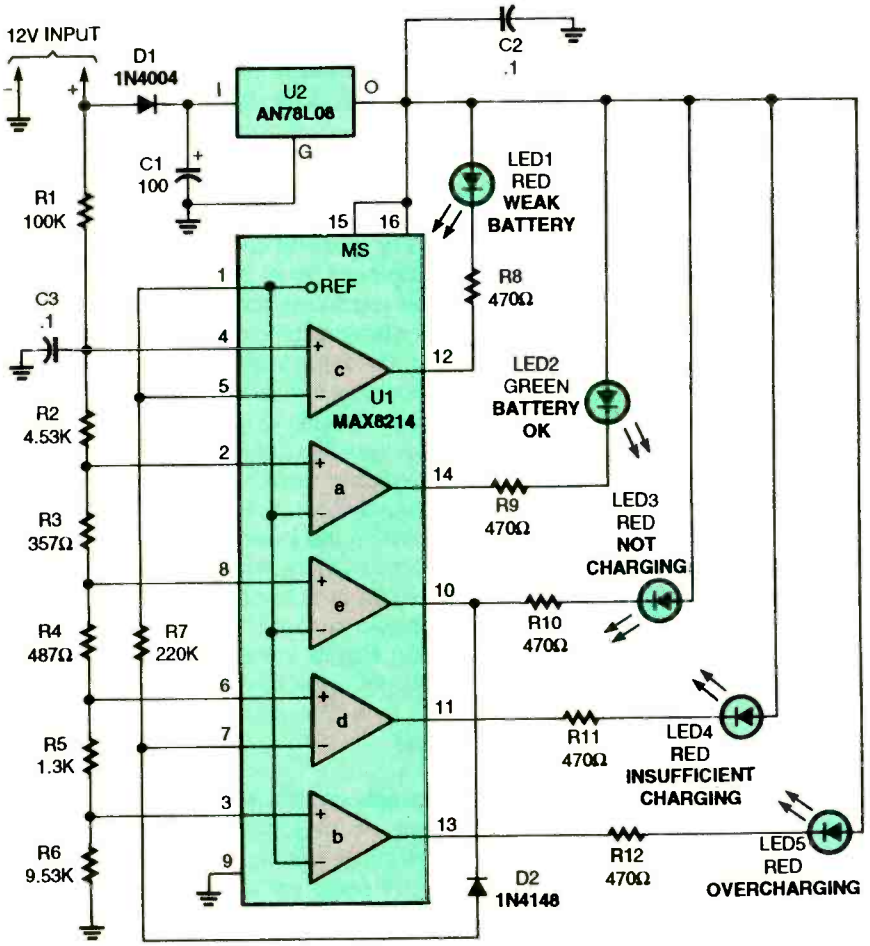


Fig. 1. The Automotive Electrical Diagnostic System is built around a Maxim MAX8214ACPE five-stage voltage comparator, which contains a built-in 1.25-volt precision reference, and on-board logic that allows the outputs of two of the comparators to be inverted.

Comparators U1-a and U1-b have to sense voltage levels higher than 12.4 and 15.2 volts, respectively to light their LED's. To accomplish that, the mode-select input of U1 is connected to V_{cc}, thereby inverting the outputs of those two comparators, and causing their respective LED's to light when the battery voltage rises above 12.8 volts prior to starting (a normal condition), and above 15.2 volts (OVERCHARGING).

In order to prevent ambiguity between a NOT CHARGING and INSUFFICIENT CHARGING situation, which would cause two normally off LED's to simultaneously light, R7 and D2 are placed into the circuit. A low output from U1-e (NOT CHARGING) pulls down the reference input of U1-d (INSUFFICIENT CHARGING) to prevent LED4 from lighting. Thus, when the vehicle charging system is not working at all, LED3 (NOT CHARGING) will light and LED4 (INSUFFICIENT CHARGING) will not.

Integrated circuit U2, a fixed 8-volt voltage regulator, maintains a constant supply voltage for U1. Diode D1 has been placed in the circuit to prevent component damage in case the lead polarity is accidentally reversed when connecting the Automotive Electrical Diagnostic System to the vehicle's electrical system.

Construction. Although circuit wiring is not critical, and could have been done on perfboard, the author's prototype was assembled on a small printed-circuit board measuring about 2 by 2½ inches. A template of that printed-circuit pattern is shown in Fig. 2. A printed-circuit board is available from the source specified in the Parts List.

A parts-placement diagram for the printed-circuit board is shown in Fig. 3. Regardless of which method of construction you choose, it is strongly recommended that you use a socket for U1. That makes testing and troubleshooting the circuit easier should it ever be necessary.

When installing the parts, be very careful to properly orient the polarized components. Just one component inadvertently installed backwards will prevent the circuit from operating and may cause damage to itself and/or other components. So, as always, double-check the position of the parts before soldering them in place.

When connecting the LED's to the circuit board, use flexible insulated

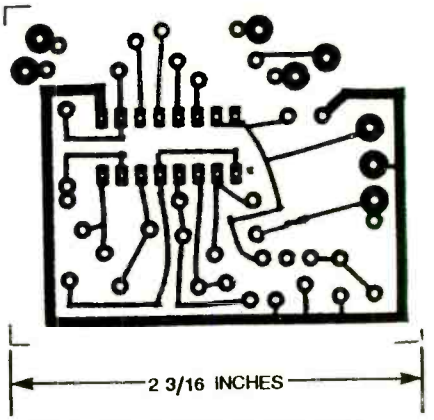


Fig. 2. The project was assembled on a small printed-circuit board measuring about 2 by 2 ½ inches. A printed-circuit board is available from the source specified in the Parts List.

PARTS LIST FOR THE AUTOMOTIVE ELECTRICAL DIAGNOSTIC SYSTEM

SEMICONDUCTORS

U1—MAX8214ACPE voltage-comparator, integrated circuit (Maxim)
U2—AN7808 8-volt, 100-mA voltage regulator, integrated circuit
D1—1N4004 1-amp 400-PIV silicon rectifier diode
D2—1N4148 general-purpose silicon diode
LED1, LED3–LED5—Red light-emitting diode
LED2—Green light-emitting diode

RESISTORS

(All resistors are ¼-watt, 1%, metal-film units, unless otherwise noted.)
R1—100,000-ohm
R2—4530-ohm
R3—357-ohm
R4—487-ohm
R5—1300-ohm
R6—9530-ohm
R7—220,000-ohm, ¼-watt, 5%, carbon
R8–R12—470-ohm, ¼-watt, 5%, carbon

CAPACITORS

C1—100-µF, 25-WVDC, radial-lead electrolytic
C2, C3—0.1-µF, ceramic-disc

ADDITIONAL PARTS AND MATERIALS

Printed-circuit materials, IC socket, enclosure, test leads, alligator clips, solder, hardware, etc.

Note: The following parts are available from A. Caristi, 69 White Pond Road, Waldwick, N.J. 07463: printed-circuit board, $11.95; a set of 6 metal-film resistors, $4.50; U1, 12.50; U2, $2.50. Please add $3.00 postage/handling. New Jersey residents please add appropriate sales tax.

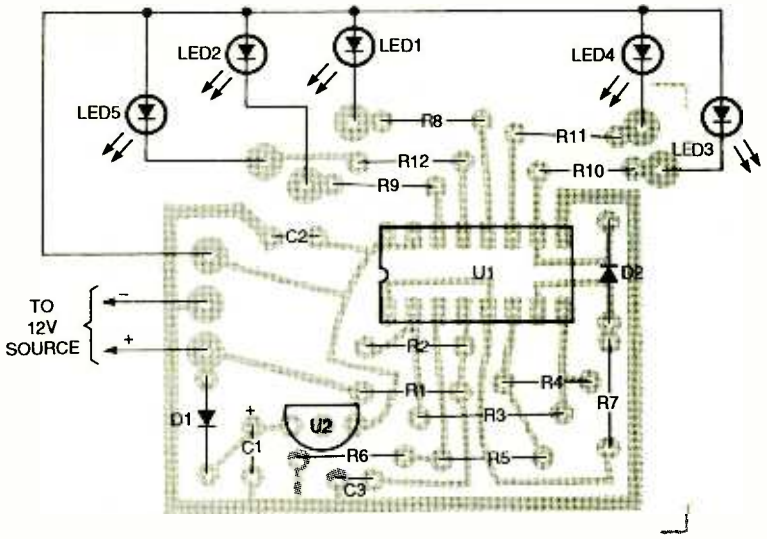


Fig. 3. Assemble your printed-circuit board acording to this parts-placement diagram. It is strongly recommended that a socket be provided for U1.

wire; solid wire is not recommended since it has a tendency to break. It is also important to use 1% metal-film resistors where specified. The accuracy of the circuit depends on the 1% tolerance of those resistors. The tolerance of ordinary carbon resistors is simply not sufficiently accurate or stable for that part of the circuit.

The circuit board can be housed in almost any a small plastic or metal enclosure. If you house the circuit in a metal enclosure, be sure that no part of the wiring touches any metal surface, and use a rubber grommet where the input leads of the instrument pass through the enclosure. The LED's should be mounted to the front panel of the enclosure and each should be labeled to indicate its meaning. Use a green LED for LED2 (BATTERY OK) and a red unit for all others.

If you wish to permanently install the project into a vehicle, connect the negative input wire to any metal part of the chassis. It is best to connect the positive input lead directly to one of the wires of the ignition switch, which is powered only when the ignition is turned on. That avoids unnecessary battery drain when the vehicle is not in use.

Note: To maintain the Automotive Electrical Diagnostic System's accuracy, it is not recommended that the positive lead of the circuit be connected to any part of the vehicle's electrical system in which a significant voltage drop from the battery positive terminal occurs, especially with accessories turned on. To measure the voltage drop in the vehicle wiring, connect a DC voltmeter between the positive battery terminal and the point at which the Automotive Electrical Diagnostic System is to be connected. A voltage drop of more than 0.05 volts with accessories operating indicates that some other point in the wiring should be chosen for the circuit.

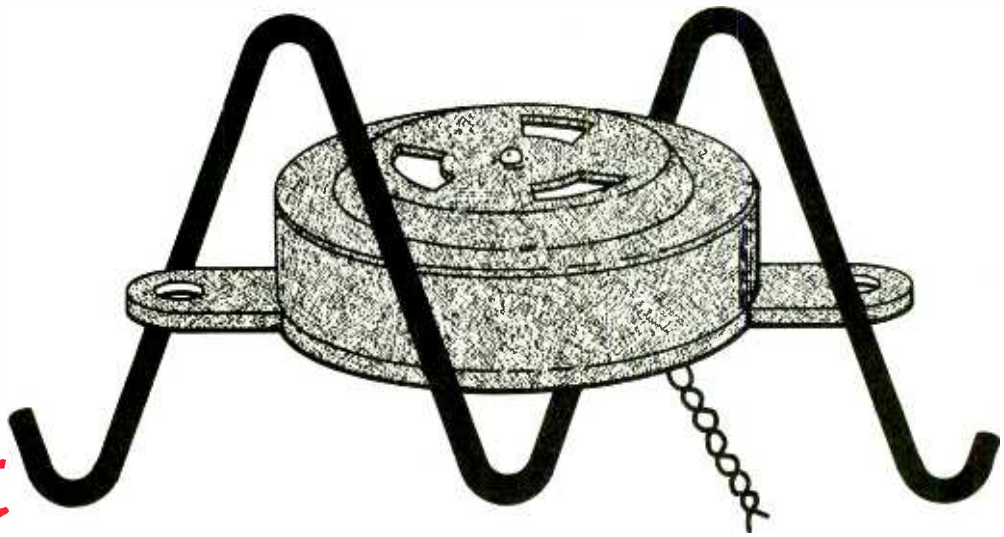
For a stand-alone unit connect lengths of 18- or 20-gauge flexible or test-lead wire (color-coded red for positive and black for negative) to the circuit for the input leads. Those wires should be terminated in alligator clips large enough to grip the terminals of the vehicle's battery. Such clips are available from most auto-parts or electronics-supply outlets.

When the assembly phase is complete, examine the project very carefully for cold solder joints (which may appear as dull or rough blobs of solder). Also, examine the board for short circuits, especially between adjacent IC pins. Correct any errors that you find.

Checkout. It is important to bench test the project before installing or using it on a vehicle. To test the project you'll need an well-filtered variable, DC power supply with an adjustment range of at least 8 to 16 volts, and an accurate DC voltmeter. Connect the voltmeter and project input leads to the output of the power supply, while observing the proper polarity of both sets of wires.

Start with the supply set to its minimum voltage and slowly raise the output until it reaches 8 volts. At that point, both LED1 and LED3 (WEAK BATTERY and NOT CHARGING) should light. The project's display is indicating that the battery voltage is below 9 volts, and also that there is no charging current. Note further that LED2 (BATTERY OK) is ex-

(Continued on page 93)



All About Piezoelectric Elements

We work through the basic principles of piezoelectric-transducer operation and examine ways of using them in circuits.

BY A. SINGMIN

Piezoelectric-acoustic elements are found in solid-state self-oscillating buzzers, beepers, telephone ringers and receivers, vibration sensors, smoke detectors, computer keyboards, games, toys, telephones, calculators, cameras, burglar alarms, and more. They are all very reliable and robust, which explains their broad appeal.

The elements are typically incorporated in miniature custom-molded cases (generally cylindrical in shape) and used whenever there is a need to generate an audio tone. Although, externally, they appear remarkably similar, these devices come in a number of distinctly different formats. In this article, the basic characteristics of each format will be examined, and examples of how to use these versatile devices will be shown.

Operation. The basic component for all the formats—an element—consists of a thin circular section of ceramic piezoelectric material mounted on a metal diaphragm. The ceramic material used depends on the manufacturer's preference. Barium titanate and titanate zirconate are two popular materials.

Typically, the metal diaphragm is less than 0.5mm thick and made of brass or stainless steel. It's thinness ensures that the metal diaphragm can be easily energized into a state of resonant mechanical vibration.

Applying an AC voltage across the electrodes of the piezoelectric material causes it to expand and contract in sync with the applied voltage. So, the metal diaphragm bends in unison with the ceramic material, thereby producing sound waves. Note that the element's resonant mechanical frequency must match the driving-voltage frequency for maximum efficiency.

Structural Characteristics. Piezoelectric elements are available in two different styles: two terminal and three terminal. Figure 1, shows the physical differences between the two types of elements. In the two-terminal type (see Fig. 1A), the AC signal is applied across the metal diaphragm (acting as one electrode) and the piezoelectric element, onto which a conductive material (the second electrode) has been applied.

In the three-terminal type (see Fig. 1B), the piezoelectric element contains a split electrode. A phase-shifted signal is generated between the split electrode and the metal electrode when an AC signal is applied to the main terminals. The phase-shifted signal is used to provide feedback to the

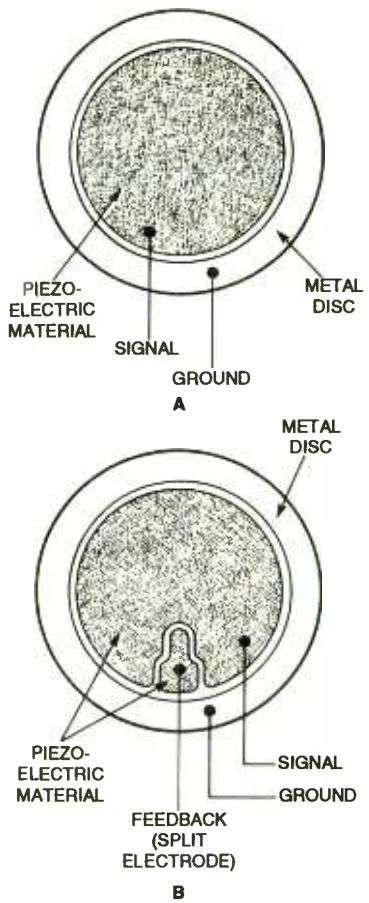


Fig. 1. The differences between two- (A) and three- (B) terminal piezoelectric devices is made obvious here. Note that there are two separate elements in the three-terminal unit.

oscillator/driver circuit to cause it to resonate at the natural frequency of the element.

When a piezoelectric element resonates, nodes (points where no vibration takes place) form around its circumference. The nodes are shown in the cross-section view in Fig. 2, where the dashed lines represent the extremes of the disc's motion. Exactly where the nodes occur is important for properly mounting the disc, which we'll examine next.

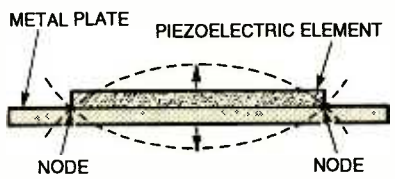


Fig. 2. Two nodes created as a piezoelectric element flexes up and down are indicated here.

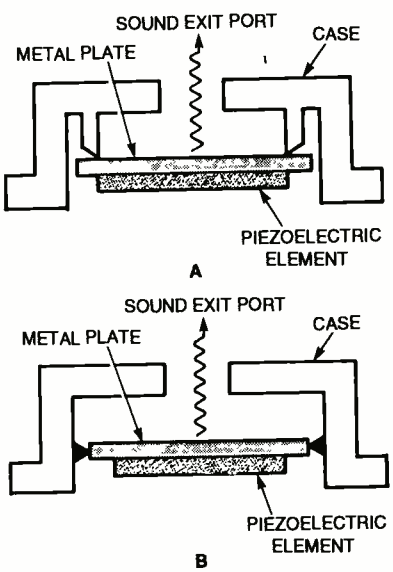


Fig. 3. One of two mounting options are typically used for piezoelectric elements: Node support (A) and edge support (B).

Mounting Methods. Mounting the piezoelectric element at the node locations (called "node support"). causes the least interference to the induced mechanical vibrations (see Fig. 3A). Consequently the greatest sound pressure output and the most stable mode of oscillation is obtained with that method of mounting. However, the sound pressure drops off rapidly when the frequency shifts away from resonance. Therefore, this mounting is mostly used for integral drive-circuit/three-terminal-element units, which use the element's feedback signal for frequency accuracy.

Mounting the piezoelectric elements at the edges (called "edge support"), offers the benefit of a wide frequency response. Figure 3B illustrates that mounting method. It is used to greatest advantage in situations where a feedback signal cannot be used. For example, when using two-terminal elements and/or simple external drive circuits.

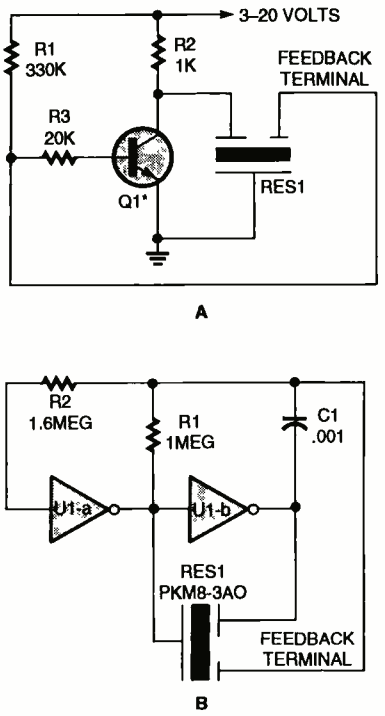


Fig. 4. Three-terminal piezoelectric elements are typically driven by transistor circuits (A), or logic gates (B).

Oscillation Methods. The schematic in Fig. 4A, represents a typical "self-drive" circuit used to produce oscillations. That oscillator has the piezoelectric element taking the place of the usual inductor and capacitor in a Hartley circuit. Typical component values are given in the figure. Depending upon the exact element and transistor used, the operating voltage can range from 3 to 20 volts, and the resonant frequency from 2 to 6 kHz.

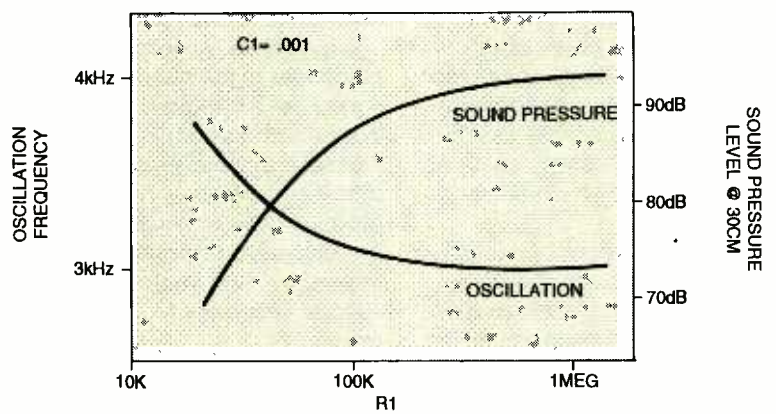


Fig. 5. Note the variation in both the output frequency and sound-pressure level with changes in the value of R1. This graph is specifically for the PKM8-3A0, but is generally representative of other elements, too.

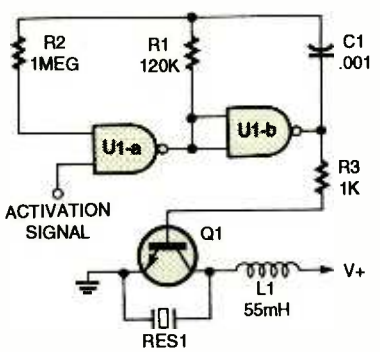


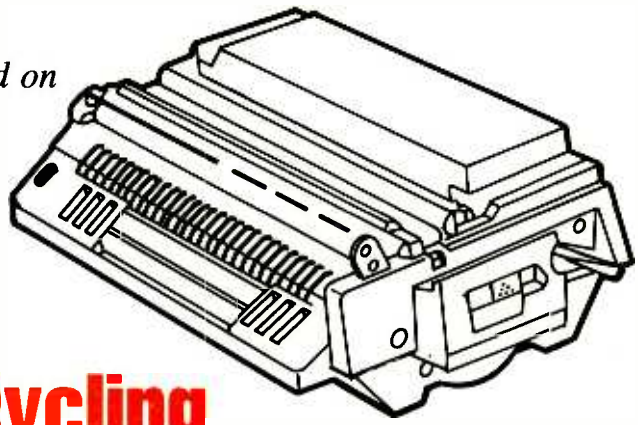
Fig. 6. Two-terminal devices can be driven by two NAND gates. A booster coil is used to compensate for the sound-pressure attenuation caused by the case.

An IC-drive version containing two CMOS-inverters is shown in Figure 4B. A good sound-pressure level is achieved by routing the feedback electrode through resistor R1 to form a positive feedback loop. With the component values shown, the frequency of oscillation is just above 3 kHz with a maximum sound-pressure level of over 90dB at 30cm. Figure 5, shows the variation in output frequency with R1 and the corresponding change in sound-pressure level for the Murata PKM8-3AO.

(Continued on page 96)

Recharging an old toner cartridge can provide excellent results while saving you money—read on and learn more!

BY FRED BLECHMAN



Save a Bundle with Toner-Cartridge Recycling

If you have a copier, laser printer, or plain-paper fax that uses a replaceable toner cartridge, you'll need a fresh cartridge after a few thousand copies. However, new cartridges are expensive. But there's an alternative and this article will give you the facts about toner cartridge "recycling," often called "refilling," "recharging," "remanufacturing," "rebuilding," and sometimes even "refurbishing."

Background. About nine years ago, when they first became available, I bought a Canon PC-10 Personal Copier. It has been one of the most useful tools I've ever purchased! As a writer, it is used to make copies of reference material and manuscripts. As an Amway distributor, I use it to copy invoices, orders, bonus records, correspondence, and all manner of paperwork. As a software producer, I use the PC-10 to copy the documentation for my $49 "AMBIZ-PAK" of computer programs for Amway distributors.

The PC-10 is probably the second smartest purchase I ever made. (The smartest was a Casablanca-type ceiling fan for our upstairs master bedroom. It gets hot in California!) I was delighted with the performance of the original replaceable cartridge, and all new subsequent Canon cartridges. But it was painful to throw away what appeared to be a perfectly "good" used cartridge, since it appeared that all it needed was some new toner. Little did I know.

Toner Cartridge Refilling. After going through a half-dozen new Canon cartridges, I noticed a magazine ad offering "toner cartridge refilling" for $30—about half of what I was paying for a new cartridge at that time—so I went for it. This was a new service, and they were eager to create business. They actually came over and personally picked-up the used cartridge at my home, and then hand-delivered the refilled one, even though their place of business (a garage?) was 150 miles from my location!

I was under the impression that all they did was add new toner, but they didn't want to get into any detailed discussion. The cartridges worked okay, and actually gave me some extra copies, since they purposely provide more toner than Canon put in the original cartridge. Sometimes I'd get streaked prints and would have to clean the corona wires in the cartridge and machine, and the copies were not quite as dark as the original cartridges produced, but I was generally satisfied.

From Good to Bad. However, as their business grew, things changed. Now I was required to send in my used cartridge (at my expense), and the price went up to $35. They sent the cartridge back with a big hole in it, and a plastic bottle filled with toner that I had to add myself! The explanation was that they could not ship the cartridge with toner in it, since it would leak. That was why they formerly hand-delivered the refilled cartridges!

It seems that once the cartridge is filled, unless it is sealed with an internal plastic strip like the original cartridge, toner leaks out if the cartridge if it is not held in a level position. As a matter of fact, Canon clearly points out that a cartridge should never be placed on end after removing the plastic strip.

This do-it-yourself method turned out to be an unsatisfactory arrangement. The toner is a very fine black powder, and it is virtually impossible to squeeze the toner out of the plastic bottle into the hole in the cartridge without some of the toner flying around. It was messy. Furthermore, I suspect this company found a cheaper and less effective toner, since the cartridge I filled with their toner produced very gray copy, even with the darkness control on the copier turned up.

A decal was provided to cover the hole, but the hole was so poorly made, with rough edges, that the decal would not cover the hole properly. Toner leaked out whenever the cartridge was handled. This process, still available today, has become known as the "drill-fill-and-spill" method. It is certainly the least expensive way to get many more copies from a used cartridge, and you can purchase the toner by itself from various sources. However, unless you are a hardware mavin with the proper hole-making tools, and willing to develop some special techniques, I don't recommend this method.

Out of the Woodwork. Laser printers have since become very popular because of their superior performance and significant price decreases. Most of the early laser printers used the Canon engine with a toner cartridge almost (but not quite) identical to that used in the PC-10 series of personal copiers. However, the original laser printers cost $2000 or more, and the printer cartridges were considerably more expensive than the copier cartridges. That made the low cost of refilling cartridges even more attractive for printers than copiers.

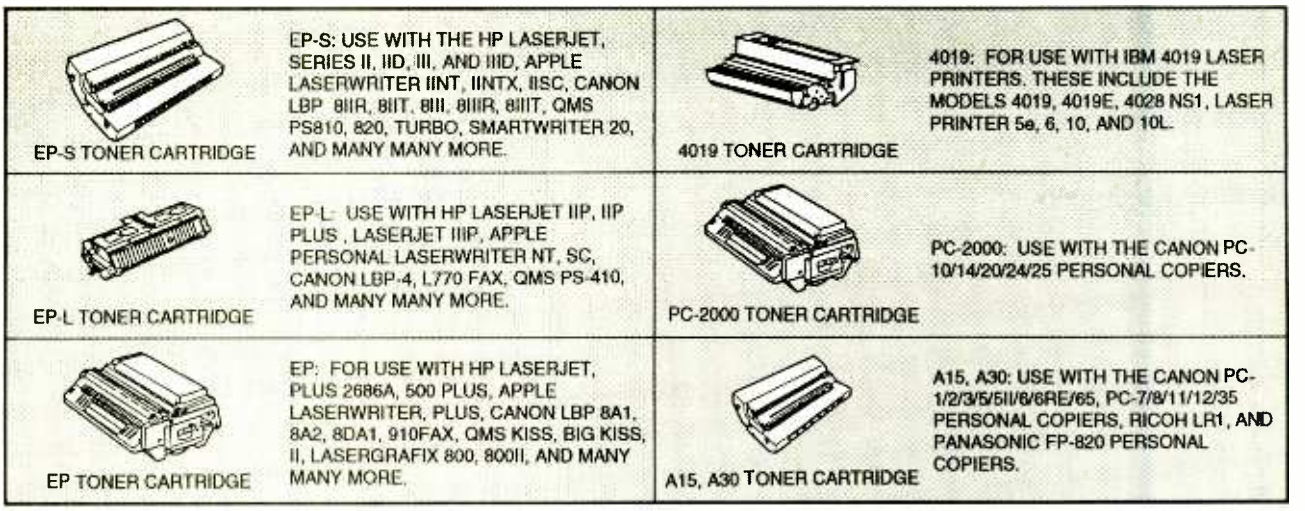


Fig. 1. These are just a few of the many toner cartridges around along with listings of some of the printer engines that use them. You'd be surprised at how many there really are.

As copiers and laser printers began to proliferate, and the drill-fill-and-spill method deservedly fell into disfavor, vendors began to appear that offered to "recharge" your used cartridges. They actually disassembled the cartridge, replaced bad parts (except the drum), vacuumed out the old toner, put in new toner, and then reassembled the cartridge. They even included a plastic strip to prevent toner leakage during shipping.

Rechargers began taking ads in computer magazines, offering to recharge both copier- and printer-toner cartridges. Many of them were mom-and-pop operations catering to local businesses. It seemed that they were virtually popping out of the woodwork as more people who were using Canon Personal Copiers and laser printers began looking for alternatives to the high cost of new toner cartridges.

Since I had lost faith in the refilling service I had been using, I started calling around to see what the other companies had to offer. I spoke several times with Tony Stramondo, at that time the President of Laser's Edge, and got a real education about the fact and fiction of toner cartridge "remanufacturing," as the process was by then called. (Laser's Edge has since been sold to Woodenfrog Printer Products.)

To bring me up to date with the current state of the art in this field, I recently interviewed Laser Cartridge Services, a local recycler (the popular term now used, since it implies both reuse and ecology mindedness). The owners, Renee Spinak and her son Larry, are typical of the smaller recyclers common around major metropolitan areas that provide personal service with local pickup and delivery.

Which is Which? According to Stramondo, the Canon Personal Copier was the first machine to be designed using a throw-away toner cartridge. This cartridge, which contained several elements involved in the copying process, was not designed to be reused. Canon clearly did not intended for users to recycle their toner cartridges, despite the fact that most of the items in the cartridge had life expectancies well beyond 2000 copies.

In the days when everything was simple, the EP cartridge used for early laser printers, and the PC cartridge used for Canon Personal Copiers, looked virtually identical, even though they were definitely not interchangeable. A label to the left of the counter window said EP Cartridge or PC Cartridge.

As copier and laser printer designs continued to reflect the rapid progress in technology, toner cartridges took the form of many designs. Some machines now use toner-only cartridges (no photoconductor drum, gears, counter or other parts), such as the Okidata 400/800 series of LED Page Printers. However, advancements not withstanding, there are cartridges that still contain many of the elements necessary to image the master document using a xerographic process (which will be explained later). Also, many different toners are now used.

In fact, toner cartridges today come in over 20 different types and sizes, reflecting the variety of laser engines on the market. Looking at Fig. 1, you'll see six toner-cartridge types and a list of the machines that use each one. That illustration is by no means all-inclusive. There are many other engines besides Canon's, and few of them use Canon cartridges, and new designs keep coming out. To add to the confusion, recyclers tend to refer to toner cartridges by the engine with which they're used. Some examples: the Canon CX engine uses an EP cartridge; the SX engine uses an EP-S cartridge; the LX engine uses an EP-L cartridge; the PC-Mini copier engine uses an A15 or A30 cartridge; the NX engine uses a IIIsi cartridge; and there are many others.

Fortunately, Chenesko Products publishes a free 36-page catalog that devotes 6 pages to listing hundreds of models of printers, copiers, faxes, and the engines they use. Since there are so many different toner cartridges, with many looking alike, be sure when you order a replacement or recycled cartridge that you get the correct one.

The Xerographic Process. Electrophotography (or the "copying") of an image onto paper is generally referred to as xerography. It is a complex process, and here we are only going to offer a simplified expla-

Sources

Aspect, Inc.
57 Eisenhower Lane South
Lombard, IL 60148-5409
Tel. 800-331-8009, or 708-627-9600
Fax: 708-627-9601

Catapult Clip Art
PO. Box 1297
Round Rock, TX 78680
Tel. 512-244-4338
Fax: 512-255-2692

Chenesko Products, Inc.
2221 Fifth Ave., Suite 4
Ronkonkoma, NY 11779
Tel. 800-221-3516, or 516-467-3205
Fax: 516-467-3223

Diversified Technigraphics, Inc.
23072 Lake Center Drive, Suite 100
Lake Forest, CA 92630
Tel. 800-457-5776
Fax: 714-855-3959

Laser Cartridge Services (LCS)
Street address intentionally omitted-
Northridge, California
Tel. 818-349-8243
Fax: 818-349-8254

Woodenfrog Printer Products
201 S. 23rd St.
Fairfield, IA 52556
Tel. 800-635-8088, or 515-472-7850
Fax: 515-472-4789

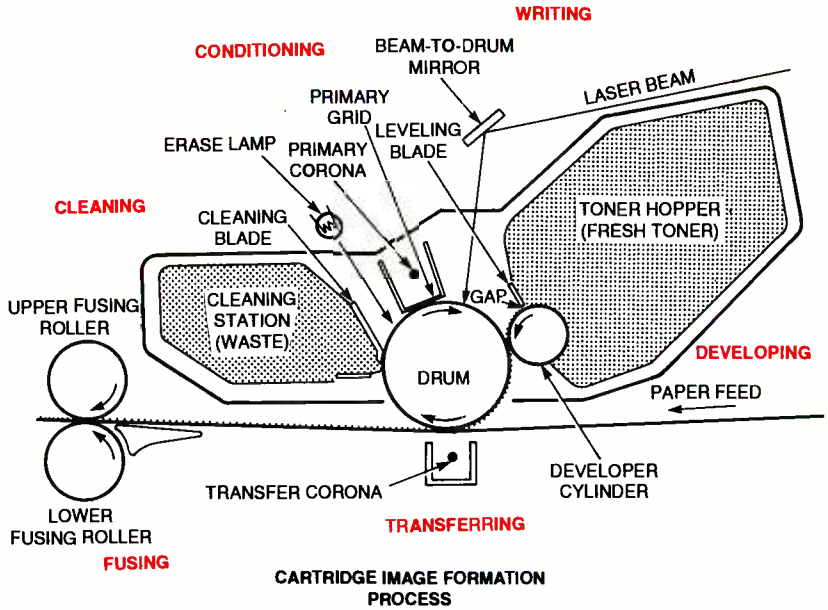


Fig. 2. In a laser printer or copier, the paper has toner deposited on it by a special charged cylinder. Then the toner is thermally fused to the paper.

nation of it. For a more detailed explanation, see the article, "Understanding Toner Cartridge Technology," by Don Thompson (*Recharger Magazine*, May 1992.)

Figure 2 (courtesy of Don Thompson) shows the interior parts of a typical laser engine. The cartridge drum is a rotating cylinder covered with a special organic-photoconductor coating (OPC) that is sensitive to both electrical charge and light. In the older cartridges, the coating was charged by a primary corona wire, which is a small-diameter wire in a shield. In the newer cartridges, a corona roller is used for that purpose. A high voltage is applied to the corona wire or roller, ionizing the air around it to produce a shower of electrically charged particles. The particles impinge onto the surface of the photoconductor, which acts as a receptor and becomes negatively charged.

A switched laser beam then passes through a lens and mirror which scans it across the slowly rotating drum. Wherever light strikes the photoconductor surface, it is discharged, and any area where no light strikes remains charged. Since the beam is turned on and off according to the light and dark areas of what is being copied or printed, it is said to leave a latent image on the drum—an electrostatic duplicate of the original.

The exposed surface of the drum then passes a developer cylinder, a rotating magnetic roller that is constantly refreshed with toner from a toner hopper or reservoir. An applied bias voltage pushes the toner from the magnetic roller onto the drum, where the toner adheres to the more-positive partially discharged, latent image.

As the OPC drum continues to rotate, now with toner covering the latent image, it passes over a transfer area outside of the cartridge. That is where the copy paper, as it is passing through the machine, comes in contact with the drum surface. On the opposite side of the paper is a transfer corona wire that has a very high charge. This charge attracts the toner off the drum onto the paper. Then the paper passes through fuser rollers. The upper roller is heated. Through a combination of heat and pressure, the toner melts and is bound to the paper surface. On older machines, a cleaning rod with a felt pad is used to clean and lubricate the fuser rollers. The finished copy is then ejected from the machine.

Meanwhile, back inside the cartridge, there's a cleaning station. This uses a polyurethane or styrene type of blade with a knife-edge that rubs up against the photoconductive drum to remove any left-over toner, since not all toner is transferred. The used toner that is scraped off the drum goes into a hopper inside the cartridge and is not used again. Therefore, the new toner gets used up two ways; it is either transferred to the copy paper, or scraped off the photoconductor drum and left in the cleaning station.

Next the photoconductor goes through a relaxation cycle. For that, a quartz/halogen erase lamp in the printer (not in the cartridge) generates white light that passes through a shutter to neutralize (discharge) the OPC surface so that it has no memory of the previous cycle.

On older cartridges, a turn-counter in the cartridge advances a colored disk, a portion of which is seen through a small window in the side of the cartridge. The color advances from green to yellow to red as the cartridge is used. It takes about 3000 turns of the drum before the counter hits an internal notch that prevents further counter rotation into the green area, but does not stop the copier or printer.

Incidentally, because some copies use more toner than others (the denser the black areas on the printed output, the more toner is used) there is

no way to determine how many copies can be made before the toner is used up. The counter, therefore, gives you only a rough indication of how much toner remains. Modern laser printers and copiers use cartridges with an internal sensor that lets you know, by either a light or display message, that your remaining toner is actually low.

The Recycling Process. Proper cartridge recycling is an 8-step process: pre-testing; disassembly; cleaning; photoconductive-drum-cleaning; sealing the supply chamber; adding new high-quality super black toner (with colors available for additional cost); inspection; final assembly, and testing. Many recyclers now also treat the photoconductive drum with a life-extending chemical compound. Also, long-life replacement drums have become available for many cartridges.

Many toner cartridges are originally assembled by robots, so parts fit together only one way and in a certain order. So it takes special tools and techniques to properly disassemble and reassemble toner cartridges.

The cleaning station toner is removed with a special vacuum cleaner. That's because the toner dust is so fine that it can penetrate normal vacuum bags and get into—and ruin—the vacuum-cleaner motor, causing an explosion in extreme cases.

The photoconductor is inspected for nicks, scratches, dents, or discoloration. The counter (if there is one) is reset. New toner is used (often more than the original amount, thus yielding more copies), a plastic sealing strip (if used) is installed, and the cartridge is reassembled with all its parts in the proper position and in sequence.

How Many Times? According to Renee Spinak of Laser Cartridge Services (LCS), many of the parts are good long beyond the normal 2000 or 3000 copies produced by a typical cartridge. Cartridges can be recycled an indefinite number of times if parts are replaced. The newer long-life photoconductive drums are typically good for 25,000–50,000 copies. The gears are nylon, good for 100,000 copies. The wiper blade is good for a year or more, after which it can get brittle and groove the drum. That's why LCS changes wipers with each drum change or sooner.

Also, LCS has found sources for compatible toners for laser cartridges that are blacker than the original. Their ultra-black toner offerings are especially good for graphics with laser printers. Their copier black is equivalent to Canon's, but gives greater yield for mostly-text use.

LCS, like most cartridge recyclers, provides an unconditional warranty, and will buy used cartridges from their customers.

Dirty Machine? Just because you're getting marks on the output of your copier or laser it doesn't necessarily mean your cartridge needs to be replaced; your machine might just be dirty. Sprays, wipes and swabs used in manual cleaning might not even reach the dirty parts.

A product called Scrubex from Aspect, Inc. can correct many problems associated with toner powder, label adhesives, paper, and dust. You simply place a Scrubex sheet in your feed tray and run it through your machine, with no equipment downtime and no service calls.

Scrubex's unique bristles, folds, and built-in isopropyl-alcohol cleaning solution reach parts and areas not otherwise cleanable without disassembly. The bristles pick up and remove foreign matter instead of moving it around or blowing it into internal parts.

Incidentally, a similar Aspect product, Printex, is used with dot-matrix and daisy-wheel printers. In the time it takes to print a page, the rollers, feed guides, and print head are cleaned and ready to run.

Do It Yourself? None of the manufacturers of toner cartridges recommend or perform recycling of their cartridges, although Hewlett-Packard will buy used cartridges with the stated purpose of keeping them from ending up in landfills. (They do not remanufacture them, however.) Plainly and simply, the manufacturers

(Continued on page 96)

Recharger Magazine

Recharger Magazine offers technical information on remanufacturing various laser-printer and copier cartridges, laser printer maintenance and repair, ink-jet filling, and ribbon recycling. It provides sources and information covering toners, photoreceptor drums, and other supplies needed in the process of remanufacturing cartridges.

Published monthly, the roughly 140-page glossy magazine is circulated worldwide to 33 countries, and offers a free referral service to help end users locate a cartridge recycler in their area.

The Subscription rate is $45 per year in the USA. Contact C&R Publications, 3340 Sunrise Ave., Suite 101, Las Vegas, NV 89101. Tel. 702-438-5557. Fax: 702-438-4025. ■

A Business of Your Own

Recycling offers so many advantages that it has become the focus for many entrepreneurs wishing to start a cottage business of their own with a relatively small investment. If this sounds attractive to you, you'll definitely want to get a copy of *Recharger Magazine* and check the companies listed in the Sources sidebar to get more familiar with the field. You'll be amazed at what's going on!

One of the more aggressive firms in setting you up in your own cartridge-recycling business for less than $500 is Chenesko Products. Call and ask for their Dealer Literature. It includes a 32-page Authorized Dealer Catalog, a 6-page letter telling you about the business and how to get started, and material about their dealer Fax-On-Demand automated document-retrieval service to allow you to receive disassembly instructions and other technical material on your fax machine 24-hours a day. Chenesko also offers User Literature for do-it-yourselfers who are not Chenesko dealers, with higher parts prices.

Don Thompson is well known in the recycling field, and his company, Diversified Technigraphics, Inc., is a source for quality hands-on training, support and technical information in this field.

Woodenfrog Printer Products offers new and remanufactured cartridges, toners, and various parts and supplies.

To aid you in creating advertising flyers, brochures, display ads, and catalogs, Catapult offers "CAT-201 Toner Cartridge Recycling" clip art, 26 pages of over 130 custom made illustrations ($88.) If you have an IBM PC or Macintosh computer, you can get the same illustrations as graphic files on disk for $96. They also offer *CAT-301 Catalog It!* for $22, which consists of 12 pages of templates, category titles, symbols, bullets, lines, and instructions for creating your own professional catalog. ■

ANTIQUE RADIO

By Marc Ellis

The Mother of All Radio Museums

Last month, I stopped the presses on the "Quaker Oats" crystal-set project so that we could cover the annual Antique Wireless Association Conference in Rochester, NY (which had just concluded at the time the column was being put together in late September). However, there was no space left to talk about A.W.A.'s permanent museum in nearby Bloomfield, NY—which is a "must-see" attraction for all conference-goers. I'm going to remedy that in this issue, after which we can get back to the crystal set!

Popular receivers dating from the beginning of radio broadcasting (about 1921) to just before the introduction of AC-powered sets (about 1929) are displayed in this reproduction of a period radio store. The showcases contain parts for the many folks who preferred to put together their own hook-ups.

The A.W.A. museum defies description. During a recent half-hour phone conversation with Bruce Kelley, the institution's charismatic and dedicated curator, I tried to probe for statistics about the size and scope of the collections. Bruce simply said that he felt the museum owned almost everything it might be possible to acquire in every major area of radio collect-

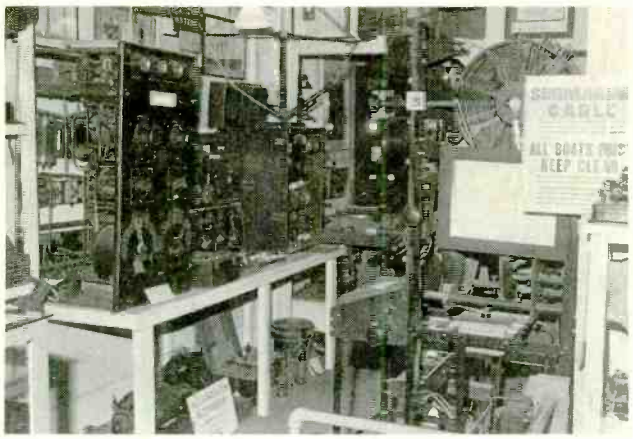
A 50-watt amateur "phone" station of the early 1920's. Note the carbon hand microphone hanging from table top at right, and the array of chemical rectifier jars on the center shelf.

A complete, and very rare, 1908 Marconi ship station exactly like that carried on the ill-fated Titanic.

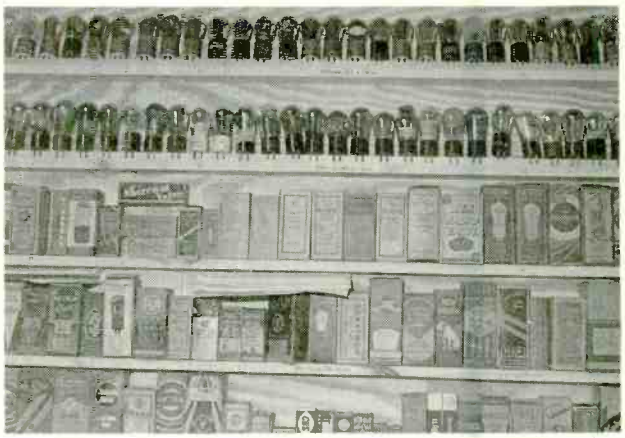
Among the sets representing the behemoth consoles of the 1930's are a McMurdo Silver "Masterpiece Series" (left) and a Stromberg-Carlson in an unusual corner cabinet.

Would you believe that the first wire recorder (known as the Telegraphone) was invented about 1907? Here it is, a product of the fertile mind of legendary radio inventor Valdemar Poulsen.

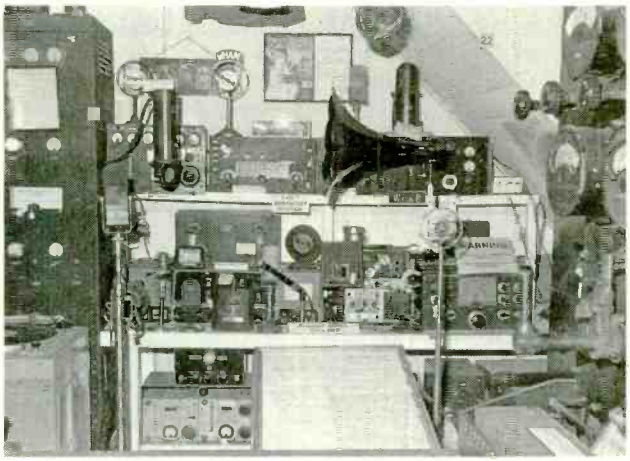
The "television corner" featured a selection of early TV receivers. At the left is a very rare Jenkins 60-hole mechanical scanner; at the right, on the same counter (just below the big RCA "Little Nipper"), are a couple of small screen sets, including a working 3-inch Pilot. Note the projection receiver above the Jenkins.



At the far left, on the counter, is a 1927 ship's radio transmitter; just to the right of that sits a display of early 1920's "Wireless Specialties" receivers. Part of the submarine cable display is visible at far right.

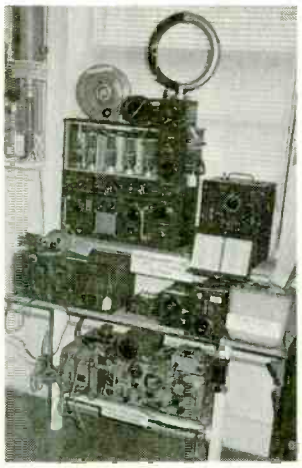


The separate "annex" building contains a large exhibit room featuring part of the museum's 50,000-item vacuum-tube collection. Here's part of a display containing 180 tube boxes, all different, as well as 148 different brands of type 201-A's.



A grouping of mid 1920's-mid 1930's broadcast station equipment nestles under the stairs leading to the museum's upper floor. See how many vintage mikes you can spot!

In the museum's separate storage facility, a 3,000-square-foot building known as "the annex," equipment is packed solid and stacked to the 10-foot ceilings. As in most institutions of this kind, the public exhibits represent just a fraction of the permanent holdings.



Echoes of World War II. On the windowsill and the shelf below it is radio equipment typical of that installed on the B17 "Flying Fortress" and other large U.S. military aircraft. A Russian-tank transceiver rests on the lower shelf.

Museum curator Bruce Kelley demonstrates a 250-watt late 1910's or early 20's amateur-radio transmitter, a non-sync rotary spark job. Partly visible on the wall at the upper right is a portrait of Zenith Radio founder R.H.G. Matthews. The brand name was derived from his ham call letters, 9ZN.

ing. A boastful statement? Maybe. But, as the accompanying photos show, it would be pretty hard to prove that statement wrong.

If you'd like to visit the museum yourself to view the wonders on display, Bloomfield is located about 25 miles southeast of Rochester and about ten miles west of Canandaigua, NY. The museum is housed in the restored 150-year-old East Bloomfield Academy building, which is also the headquarters of the East Bloomfield Historical Society. For more information, write Bruce Kelley, 59 Main St., Bloomfield, NY 14469—or call (716) 657-7489 or (716) 657-6260.

In order to do the museum as much justice as possible in the space available, I'm going to discard my usual text-based format and present this column as an album of the photos I shot at Bloomfield. So I'll conclude my formal comments now in order to leave room for as many captioned pictures as possible. Even so, remember that this is but a small sampling of what is on display. ■

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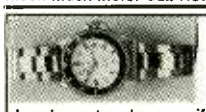

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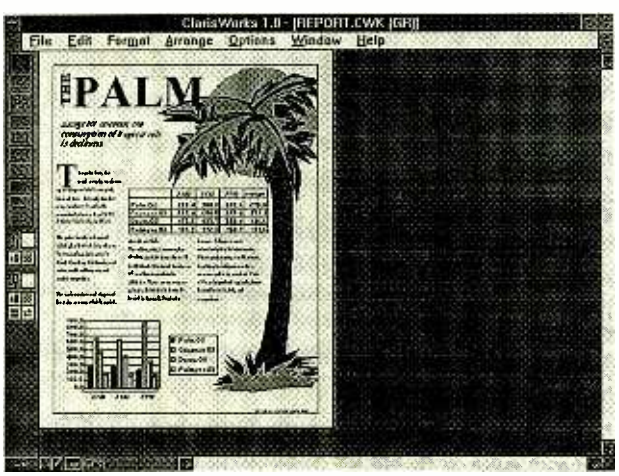
COMPUTER BITS

By Jeff Holtzman

ClarisWorks for Windows

Okay, I admit it. When it comes to computer application software, I tend to go for the biggest and most powerful. Fifteen-megabyte word processor? No problem. Forty-megabyte operating system? Fine with me. But occasionally reason prevails, and I realize that not everyone wants, needs, or can afford that kind of power. For that reason, I've recently developed some interest in "works" programs. These programs typically combine word processor, spreadsheet, database, and graphics modules under a more or less unified user interface.



You can create complex documents containing text, graphics, spreadsheets, and charts using ClarisWorks, an integrated package that has beem ported from the Macintosh environment. The program provides surprising Windows-based power in an easy-to-use package that requires less than 4MB of disk space.

Works programs usually have lighter demands on both your system resources and your pocketbook than the massive, stand-alone applications that are becoming the rule for business automation. Lotus, Microsoft, Spinnaker, and others all make works programs. But I had heard really good things about ClarisWorks for Windows, so I decided to investigate the package.

In a word, I'm impressed. Claris is the software subsidiary of Apple, formerly producing Macintosh-only software, but now doing both Mac and Windows wares. Mac software is known for ease of use; with ClarisWorks the company has done a fine job of bringing the concepts over to the Windows environment. Impressively, Claris has done so by building a package that requires less than 4MB of disk space, and that runs acceptably on a 25-MHz 386.

FEATURES

Here's a quick overview of ClarisWorks product features. It includes integrated word processing, spreadsheet, charting, graphics, and database modules. The absolutely coolest thing about ClarisWorks is its seamless integration among the word processor, spreadsheet, and graphics modules. To embed a spreadsheet or graphic image in a document, you just click on a different tool button and start drawing or entering data. So-called "integrated" software has been around for a decade or more, but never has any package achieved the smooth integration of ClarisWorks.

ClarisWorks has a surprisingly powerful feature set. It can open multiple documents (where "document" can refer to a text document, or a separate spreadsheet, graphics, or database file) simultaneously, and multiple windows into the same document. The program does not distinguish between draft and print modes; what you see is always what you get. ClarisWorks provides a robust set of input and output filters, so you can exchange spreadsheets with 1-2-3 and Excel, text files with Word and Word Perfect, databases with dBASE, etc.

The word processor supports PostScript and TrueType fonts in sizes from 4 to 255 points. You can also apply bold, italic, and underline attributes to text; you can enter subscripts and superscripts; and paragraphs can have left, center, and right alignment, and indents and tabs. A document may have several columns, with automatic text flow among them. In addition, ClarisWorks supports frames that may be placed on a page independently, and text that may flow from frame to frame to frame. There is also a spelling checker and a thesaurus.

On the minus side, the word processor does not show font and size information on the ruler line. Instead, you must refer to nested menus and dialog boxes. Another limitation is the inability to search and replace formatting.

The most serious limitation, however, is the exclusion of named styles. In most modern word processors and desktop publishing programs, a named style stands for a collection of formatting information (*e.g.*, font, size, attribute, paragraph align-

ment, underlines, borders, and the like). ClarisWorks' lack of styles means that all formatting must be applied manually, and because it is not possible to search and replace formatting, all changes of this nature must be done by a visual search-and-replace operation.

VENDOR INFORMATION

ClarisWorks for Windows
Claris Corporation
P.O. Box 58168
Santa Clara, CA 95052-8168
Tel. 408-727-8227

The spreadsheet provides a surprisingly powerful set of functions, including business and financial (fv, npv, pmt), date and time (date, datetotext, etc.), information (alert, beep, macro, row, hlookup, vlookup, etc.), logical (and, or, not, etc.), numeric (abs, exp, int, ln, log, mod, pi, round, sign, etc.), statistical (average, count, max, min, sum, stdev, var, etc.), text (char, code, concat, left, lower, mid, etc.), and trigonometric (acos, asin, atan, cos, sin, tan, etc.).

The database is a flat-file affair; it provides six data types: text, number, date, time, calculated, and summary. You can do mail merges with data from the database; you can also print address labels and the like. You can also create highly attractive forms for entering and searching for data, and reports with several levels of summaries.

All in all, ClarisWorks is a heck of a program. It has just about everything a student would need for writing technical and nontechnical reports. For traveling users, the 4MB of disk-space usage is highly attractive, as is the ability to import and export files in standard formats. I've seen the program offered at a street price of under $100. ■

CIRCUIT CIRCUS

By Charles D. Rakes

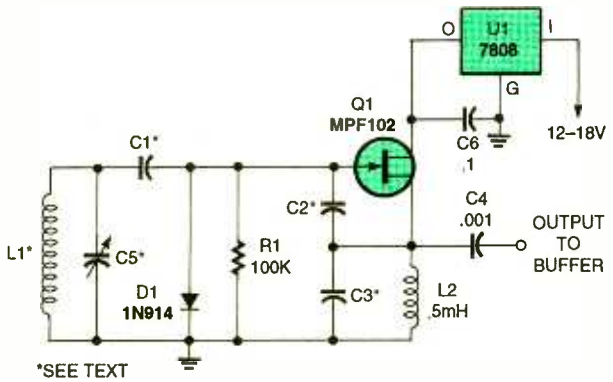
Oscillator and Bridge Circuits

Last month, we devoted this space to a discussion of oscillator circuits. We'll continue that topic now by presenting two more oscillator circuits, and then move on to a new topic—bridge circuits.

VFO

Our first oscillator circuit is a simple JFET-based, variable-frequency oscillator that can be used in receiver or transmitter circuits. The circuit (see Fig. 1) is very stable, hence, if good quality components and appropriate construction techniques are used, there will be very little drift in frequency.

The component values



f_OMHZ	L1 (TURNS)	C2 AND C3 (pF)	C1 (pF)	VARIABLE C5(pF)
2–6	36	680	150	100
5–8	25	470	100	100
7–14	20	470	100	50

Fig. 1. This simple JFET-based, variable-frequency oscillator can be used in receiver or transmitter circuits.

listed in the table at the bottom of Fig. 1 will give you a starting point to setup the oscillator to cover a desired frequency range. Inductor L1 is a homespun coil wound on a Amidon Associates, Inc. (2216 East Gladwick St., Dominguez Hills, CA 90220; Tel. 301-763-5770) T50-6 toroidal core using #26 or #28 enamel-coated copper wire. The oscillator's frequency can be increased a small amount by removing a turn from the coil's winding; by the same token, the frequency can be decreased by adding a turn or two. After you have achieved the desire frequency range, cover the coil with a clear plastic coating or coil dope to keep the coil wires from moving around and causing the oscillator's frequency to shift.

The fixed-frequency oscillator shown can easily be converted into a tunable oscillator by substituting a dual-gang linear potentiometer for R1 and R2. Different frequency ranges can be covered by using other matched values for C1 and C2. Larger values produce lower frequencies and *vice versa* for smaller values.

WHEATSTONE RESISTANCE BRIDGE

Our next circuit, see Fig. 3, is a basic Wheatstone resistance bridge. The bridge consists of four resistors connected in such a way that when the circuit is balanced, the voltage at points A and B are equal. That balanced condition produces a null that can be detected by ear. The switched resistors (R1–R5) allow resistor values of 10 ohms to 1 megohm to be measured. Resistor values can be matched by connecting the desired resistor

PARTS LIST FOR THE VFO

SEMICONDUCTORS

U1—7808 8-volt, 1-amp voltage regulator, integrated circuit
Q1—MPF102 N-channel JFET
D1—1N914 general-purpose silicon diode

CAPACITORS

C1–C3, C5—See text
C4—0.001-µF, ceramic-disc
C6—0.1-µF, ceramic-disc

ADDITIONAL PARTS AND MATERIALS

R1—100,000-ohm, ¼-watt, 5% resistor
L1—See text
L2—0.5-mH choke
Perfboard materials, enclosure, 12–18-volt DC power source, wire, solder, hardware, etc.

WIEN-BRIDGE OSCILLATOR

Our next and final oscillator is also our first bridge circuit. In Fig. 2, a 741 op-amp is connected in a Wien-bridge, audio-sinewave oscillator configuration with C1, C2, R1, and R2 determining the circuit's operating frequency. By using NPO capacitors and metal-film resistors, the oscillator's frequency is stable enough for use in tone-control applications.

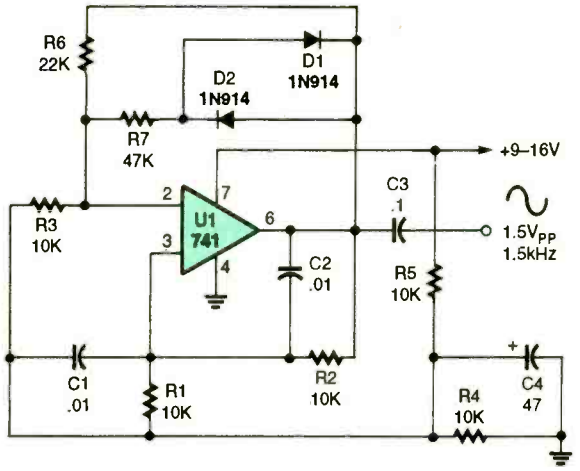


Fig. 2. The operating frequency of this Wien-bridge oscillator is determined by C1, C2, R1, and R2. It can easily be modified to act as a tunable oscillator by substituting a dual-gang linear potentiometer for R1 and R2.

PARTS LIST FOR THE WIEN-BRIDGE OSCILLATOR

SEMICONDUCTORS
U1—741 general-purpose op-amp, integrated circuit
D1, D2—1N914 general-purpose silicon diode

RESISTORS
(All fixed resistors are ¼-watt, 5% units.)
R1–R5—10,000-ohm
R6—22,000-ohm
R7—47,000-ohm

CAPACITORS
C1, C2—0.01-μF, mylar
C3—0.1-μF, ceramic-disc
C4—47-μF, 16-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS
Perfboard materials, 9–16-volt DC power source, wire, solder, hardware, etc.

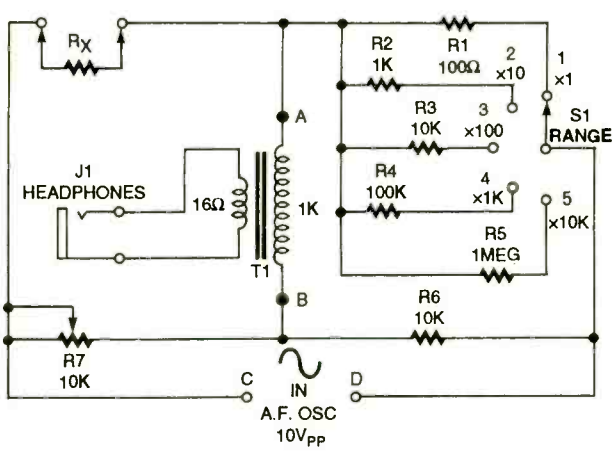


Fig. 3. When the Wheatstone Resistance Bridge is balanced, the voltage at pints A and B are equal, a null that can be detected ear is produces.

PARTS LIST FOR THE WHEATSTONE RESISTANCE BRIDGE

RESISTORS
(All fixed resistors are ¼-watt, 5% units, unless otherwise noted.)
R1—100-ohm ½-watt, 1%
R2—1000-ohm
R3, R6—10,000-ohm
R4—100,000-ohm
R5—1-megohm
R7—10,000-ohm linear potentiometer

ADDITIONAL PARTS AND MATERIALS
T1—1000-ohm to 16-ohm audio-output transformer
S1—SP5T rotary switch
Perfboard materials, headphones, binding post, phone jack, audio oscillator, enclosure, wire, solder, hardware, etc.

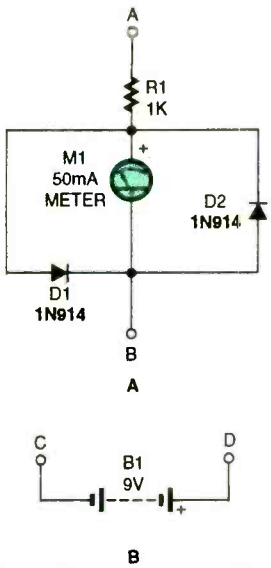


Fig. 4. By replacing the T1 and the headphones with the circuit in A and the audio oscillator with a battery (B), resistor values can be read directly from the meter.

value at R_X and bringing the circuit into balance with R7. Once that is done, remove the resistor from R_X and substitute other resistors in that position to find ones that produce a similar null.

An external audio generator supplies the signal voltage, while an audio-output transformer is used to match the circuit's output impedance to modern stereo headphones. If you happen to have an old pair of 2000-ohm headphones, leave out the transformer and connect them directly to terminals A and B.

A linear potentiometer of the best possible quality must be used for R7. A large dial can be made and marked off in a hundred equal divisions and numbered likewise. When S1 is set to position 1, resistances ranging from 0 to 100-ohms can be read directly from the dial. In all the other range positions, a multiplier is used to give the correct resistor value.

The AF oscillator, T1, and the headphones can be replaced by the circuits shown in Fig. 4 to convert the Wheatstone bridge into a DC circuit. Transformer T1 and the headphones are replaced by the circuit in Fig. 4A, while the AF oscillator is replaced by the 9-volt battery in Fig. 4B. With those changes, the zero-center reading 50-μA meter shown in Fig. 4A serves as the null indicator and a 9-volt battery supplies power for the meter.

TEMPERATURE-SHIFT METER

Our next circuit, see Fig. 5, replaces one leg of a standard Wheatstone with three small-signal silicon diodes, which are used to detect changes in temperature. That's possible because the

(Continued on page 90)

DX LISTENING

By Don Jensen

The Broadcasters SWL's Love To Hate

In the world of shortwave radio, there have always been certain stations that SWL's love to hate. There are those, of course, whose broadcasts are universally liked, or nearly so. The venerable Auntie Beeb, of the respected *British Broadcasting Corporation*, is a good example. Not only does the BBC air some of the world's best newscasts, but its entertainment programs also are first rate.

ARCO VESPASIANO AUGUSTO - ROMA

This ancient arch, one of the glories of Rome, home to Italy's shortwave voice, RAI, is illustrated on one of the station's attractive QSL cards.

However, over the years, there have been other international voices that attracted listeners, seemingly, despite their programs. For many years, Albania's *Radio Tirana* had a reputation for having some of the world's worst programs, particularly during the years when it was the most "unreconstructed" of Communist East European stations. SWL's regularly tuned Radio Tirana, if only to puzzle how it could be, simultaneously, the most vitriolic and the dullest station on the air!

Another target of SWL complaints for years was *RAI*, the acronym for Italy's shortwave operation, pronounced "wry." Most of the criticism was directed at RAI's English-language announcer, a woman whose delivery was so lifeless that she was dubbed the "Dead Lady" by American SWL's. Nonetheless, for me, RAI was, and is, a favorite broadcaster. The reason, I guess, is that some places have a special fascination for me. Rio de Janeiro is one. Tahiti is another. And Rome, the glorious and eternal city, is similarly special.

So never mind RAI's reputation—in fairness, I never felt it was really deserved—I like the Italian SW broadcaster because, well, because it's Rome! Indisputably RAI is working hard these days. Its broadcasting operations, previously scattered were centralized last year at a new radio-television center at Saxa Rubra in Rome. There are six studios there with modern and sophisticated equipment.

Rome now airs shortwave programming in 26 different languages and is contemplating adding others, including Chinese and Japanese. Since its transmitting complex at Santa Palomba, outside Rome, cannot be expanded, a new center may be built in Tuscany in the near future. In addition, and following the lead of other international broadcasters, RAI also may lease up to 3 hours of daily air time from stations elsewhere in the world in improve its overseas broadcasting coverage.

If you haven't tuned in RAI, you might want to listen for yourself to its brief, 20-minute, daily, English-language program at 0100 UTC on 9,575 or 11,800 kHz. I leave it to you. Is it thumbs up, or down, for RAI?

G-IVAN RADIO

In the September installment of *DX Listening*, I mentioned that the Australian, Belgian, and other governments are now broadcasting programs on shortwave to their military personal serving with the United Nations peacekeeping forces in Somalia and the Balkans. Now comes word of another GI radio broadcast, this one by the Russian Ministry of Defense, but directed to its troops in Tajikistan near the Afghan border.

My good friend and ace Danish DX'er, Finn Krone, who airs an SWL program for European listeners, notes that these programs to Russian soldiers are prepared in the Slavyanka Radio Studio of the Defense Ministry and are aired by *Radio Moscow* transmitters. Krone quotes the British Broadcasting Corporation's Monitoring Service as reporting those half-hour Russian GI programs are

aired Monday through Friday at 1600 UTC on a number of shortwave frequencies including 4,740, 4,940, and 11,835 kHz.

Krone notes that the 11,835-kHz frequency has been well heard in Denmark. Programs, naturally, are in Russian, but if you do hear this one, you can write to Slavyanka Radio Studio, Shaposhniknova No. 14, ulitsa Marshala, Moscow, Russia.

SENSITIVITY AND SELECTIVITY

Reader Michael Alexander, Tucson, AZ, writes to say that the simple regenerative SW receiver kit mentioned in the October 1993 *DX Listening* column "really derives its usefulness from a different operating principle than the one described."

He notes that the radio signal's "feedback energy is used to compensate for the resistive losses in the tuned circuit and the antenna, with the result of achieving a very high 'Q'. . . in the (receiver's) tuned circuit and, thus, making selectivity possible." Sensitivity, he notes, is only helped to some degree.

"In the days when these circuits were popular, people generally had large, outdoor, energy-gathering antennas, plus some audio amplification. Sensitivity, therefore, was not that much of a problem."

Thanks, Michael, good point. It was true in the old days, and today as well, that selectivity, rather than sensitivity, is most critical to the shortwave listener. Most receivers, even the inexpensive sort, given a suitable antenna, are sensitive enough to capture weak SW signals. But unless you are able to sort out that desired station from the babel of competing signals in a crowded band, not much will be intelligible.

"This is a basic question, I know," writes Kerry Smithton, Fresno, CA, "but I'm your basic beginner in shortwave listening. I know that there are various SW bands where stations are grouped together. Those bands are marked on my radio. But, depending on the time of day, on some of them I hear nothing at all. Where and when should I tune?"

Yes, it is basic, Kerry, but it is a useful question because we have a regular influx of brand new SW listeners among our readership. So there will always be some of you with basic questions, which I try to answer and answer again periodically.

Broadly defined, the shortwave spectrum spans the frequencies from about 2,000 to 30,000 kHz. Because of the way in which radio signals propagate—get from the transmitter to your receiver—usable frequencies fluctuate depending on the time of day. If you tune some frequencies and hear absolutely no stations, chances are you're trying the wrong bands at that hour.

When should you tune, and where? Here's a bit of help from the pages of *Passport To World Band Radio*, the annual guide to shortwave listening:

4,700–5,100 kHz—early morning and night, mainly during winter.

5,850–6,250 kHz and 7,100–7,600 kHz—night.

9,300–10,000 kHz—early morning, late afternoon, and night.

11,500–12,160 kHz—night, and to some degree, day.

13,600–13,900 kHz and 15,000–15,700 kHz—day, and to some degree, night.

17,500–17,900 kHz—day, and to a slight degree, night.

21,450–21,850 kHz—day.

DOWN THE DIAL

Your letters are always welcome! What are you hearing? Do you have a question about SWL'ing? What do you like (Italy's RAI?) and what don't you like (ditto?) on shortwave? Write me at *DX Listening*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735.

Here are some stations being reported on SW. Remember that Universal Coordinated Time (abbreviated as UTC) is equivalent to Eastern Standard Time plus 5 hours; CST + 6; MST + 7; and PST + 8.

BULGARIA—15,330 kHz. *Radio Bulgaria* in Sofia signs on its English transmission at 0000 (midnight) UTC with a newscast. It operates in parallel on 11,720 and 17,825 kHz.

CROATIA—13,830 kHz. Croatian-language programming is noted from *Croatian Radio* on this frequency. Look for a news broadcast shortly after 0500 UTC.

JAPAN—11,815 kHz. Tokyo's *Radio Japan* is audible at 0900 UTC with English news, identification, and frequency announcements.

MEXICO—6,185 kHz. *Radio Educacion* is heard with an English-language broadcast at 0800 UTC.

PAKISTAN—17,705 kHz. *Radio Pakistan* in Islamabad has a very brief English transmission, from 0227 to 0246 UTC, which includes identification, frequencies, and slowly read news. ■

*Credits: Richard D'Angelo, PA; Rufus Jordan, PA; Marie Lamb, NY; Tony Orr, VA; Doug Robertson, CA; Betsy Robinson, TN; North American SW Association, 45 Wildflower Road, Levittown, PA 19057

HAM RADIO

By Joseph J. Carr, K4IPV

Want To Operate W1AW?

The American Radio Relay League (ARRL) is the national amateur-radio operator's organization; it's headquartered at 225 Main Street, Newington, CT, 06111; not far from Hartford. If you wish to visit ARRL the next time that you are in New England, it's really easy to do—in fact they encourage visits from hams, so don't feel like you are imposing. If you write or call ARRL (Tel. 203-666-1541 and 24-hour fax 203-665-7531), they can give you exact directions from the areas interstates.

The American Radio Relay League (ARRL), headquartered at 225 Main Street, Newington, CT 06111, houses the league's administrative departments, the publications (books and the magazine QST), and a host of other services for members.

Once on Main Street Newington, it's easy to spot the ARRL HQ building with its impressive antenna farm. The HQ building houses the league's administrative departments, the publications (books and the magazine QST), the contest people, and a host of other services for members. In the lobby of the HQ building there's a fine antique-radio museum that is specially tailored to radio amateurs.

I visited the headquarters several years ago, and reported the visit in this column. But, what was missing during my last visit was the W1AW, the league's resident ham station. W1AW (originally 1AW) was the ham callsign of ARRL cofounder Hiram Percy Maxim, who passed away in the mid-1930's. The ARRL HQ station is a much deserved memorial to Maxim.

The small building located in front of the ARRL HQ building, where W1AW was located for many years, was being renovated at the time. So W1AW operations of had been transferred to a temporary site inside the HQ building. I resolved to return and see W1AW . . . which I did last summer.

When I arrived at the station, an on-duty operator showed me around. In the main transmitter room, there's a complex operating console. Behind the main operating console lies a bank of seven powerful Harris commercial transmitters (green with envy is the only way to describe my reaction to that wonderful sight!).

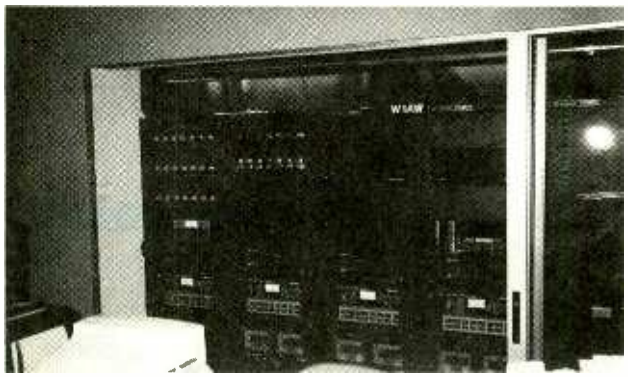
Currently, the visiting hours are from 1 PM to 1 AM Eastern Time the next morning on Mondays; from 9 AM to 1 AM Eastern Time Tuesdays through Fridays; and 3:30 PM to 1 AM Eastern Time weekends. There are some holidays off for ARRL personnel, so ask for the schedule before making the trip on a holiday. For weekend visiting, special arrangements must be made by calling or writing to the ARRL at least a week in advance.

BRING YOUR LICENSE

If you bring your FCC license (or a photocopy) with you, they'll let you operate W1AW during the scheduled guest-operator hours, from 1:00 to 4:00 PM Eastern time Monday through Fridays. Write to ARRL for a current W1AW visiting-operator schedule; the schedule changes from time to time.

The ARRL found out a long time ago that many visiting operators were a tad self-conscious about sitting at the main console under the keen scrutiny of the station chief operator. To overcome that psychological problem, they built three private glassed-en-

This complex operating console is located in W1AW's main transmitter room.



A set of seven Harris commercial HF transmitters are the main muscle of W1AW.

Our host and tour guide for the visit to W1AW was ARRL Executive Vice President David Sumner, K1ZZ. The portrait on the wall is of Hiram Percy Maxim, the original W1AW and cofounder of the ARRL.

closed, guest-operator studios. You are still under scrutiny (the ARRL, as licensee, has responsibility for what is done with their radio station, just as you are responsible for what is done with yours), but it isn't as obvious when using the three guest studios.

The ARRL is very accommodating to visiting hams. Although they can't guarantee any particular band or mode for your visit, if you call or write ahead of time with any special requests, they will at least try to accommodate you. Sometimes there are large groups touring the facility, but at other times (as when I arrived) no one other than the ARRL staff will be around.

My host and tour guide for the most recent visit was David Sumner, K1ZZ, Executive Vice President of the ARRL. I apologize to Dave for stopping in unexpectedly—ignoring my own advice to call or write first—but, as usual, the ARRL was a most excellent host.

W1AW provides a number of services, including official bulletins (in voice, CW, and teleprinter) and DX bulletins. Many hams have received their code practice off-the-air from W1AW. Code practice is sent on 1.818 MHz, 3.5185 MHz, 7.0475 MHz, 14.0475 MHz, 18.0975 MHz, 21.0675 MHz, 28.0675 MHz, and 147.555 MHz, with sessions currently scheduled for 4 PM, 7 PM, and 10 PM (all Eastern Time).

I encourage you to become an ARRL member. They are the ham's principal voice in an era when commercial interests may well begin threatening our frequencies more fiercely than at any time since the end of World War I when they put us on 200 meters and below—the supposedly useless shortwave bands. You may hear a lot of carping criticism of the ARRL. Some of it may be valid, but much of it is nonetheless little more than pure whining. In any event, they're still the only real "game in town" for amateur operators.

To overcome that psychological problem associated with sitting at the main console under the keen scrutiny of the station chief operator, the ARRL built three private, glass-enclosed "guest operator" studios.

PC BOARDS AVAILABLE

In the *Ham Radio* column for October, 1993, I discussed the Mini-Circuits MAR-1 MMIC amplifier chip; a chip that can operate from near-DC to 1000 MHz and offers 50-ohm input and output impedances. A printed-circuit pattern was shown. And while I was able to offer readers the MAR-1 chips at $4.95 each (offer still open), I could not at that time offer the printed-circuit boards. A newer and somewhat improved version of that board (see Fig. 1) is now available for $7.50. You can order it either directly from me (at P.O. Box 1099, Falls Church, VA, 22041), or from FAR Circuits (18N640 Field Court, Dundee, IL 60118). If you order from FAR Circuits, ask for the Joe Carr, K4IPV board under filename "MAR-1D.PCB."

The new board for the MAR-1 circuit is designed to accommodate either chip capacitors or ceramic disc capacitors at the inputs and outputs. In fact, there are two sets of holes at both the input and the output to accommodate smaller and larger types of disc capacitors (the key difference being the separation between the leads).

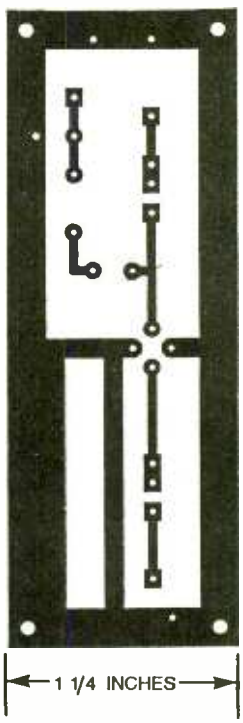


Fig. 1. The new printed-circuit board for MAR-1 amplifier that was presented in the October 1993 column is designed to accommodate either chip or ceramic-disc capacitors at the inputs and outputs.

The RF choke can be either small axial-lead molded chokes, or can be a radial-lead (vertical-mounting) 8mm standard-size choke. For 100-µH applications use Digi-Key's TK-4259; for 1 mH use Digi-Key's TK-4283 choke; and for 10 mH use Digi-Key's TK-4324 unit. ■

SCANNER SCENE

By Marc Saxon

Tracking Smokey Bear

Uniden Bearcat's *Bear Tracker BCT-2* is a pre-programmed, multi-band scanner with "Highway Patrol Warning Alert." With that feature, for every state in which you set frequencies for the BCT-2 to scan, it instantly accesses a special set of pre-programmed highway-patrol frequencies. When any transmission is detected on a highway-patrol frequency, visual and audible warnings are given.

The Bearcat Bear Tracker BCT-2 scanner sounds an alarm when it picks up signals on a highway-patrol frequency.

The warning light will flash until you are beyond a three-mile radius of the last transmission, and the audible alarm will sound for five seconds for each transmission received. The user can switch the alarm feature on or off.

The BCT-2 has a front-panel switch that can bring up all states, and is pre-programmed with low, high, UHF, UHF-T band highway patrol, local police, and Department of Transportation channels. It will also receive NOAA weather frequencies. At those times, the alarm is automatically disabled.

When scanning, specific frequencies can be locked out by the operator, or the scanning action can be temporarily stopped to allow monitoring of any active frequency of particular interest. There is also a switchable two-second scan-delay feature.

GETTING TESTY

From time to time, you find unusual things to hear on the frequencies used by aircraft manufacturers when they work on new designs. Listening to intrepid test pilots putting new and experimental aircraft through various flight tests has got to be fascinating. Those tests include speed, stress, handling, and other design factors, and often go on almost daily for extended periods of time as tests are repeated after modifications are made, and then repeated again. The tests are often conducted at high altitudes, which means that the communications from the test pilot to the ground describing what's going on can be monitored over a wide area.

Things don't always go right. I get the impression that many test pilots tend to be as blunt as they are colorful, so you get an unforgettable earful when a problem is reported to ground. This is usually while it's actually taking place.

The frequencies used for these activities occupy most of the band that runs from 123.125 to 123.575 MHz (a few frequencies in this band, such as 123.3 and 123.5 MHz, are used for other purposes). Frequencies are spaced at 25 kHz (123.125, 123.15, etc.).

Manufacturers of military equipment also use frequencies in the UHF aeronautics band. While many different UHF frequencies are in use by individual companies, several particular frequencies are commonly used by major manufacturers including Lockheed, Grumman, McDonnell-Douglas, and Sikorsky. Those frequencies are 275.2, 314.6, 345.4, and 382.6 MHz. It might be worth keeping an ear on those, too.

HANDY AND COLORFUL

Larry Johansen, of Minneapolis, Minnesota, asks what the "purple" frequency is. A friend of his said that he has a pair of handheld radios that operate there, and insists that there is no other way of identifying the operating frequency. Larry wants to monitor those radios, but doesn't believe that they are using ultraviolet frequencies.

Low-cost, over-the-counter handheld VHF and UHF radios are sold to campers, hikers, hunters, sportsmen, and for business/industrial purposes. They can operate on any of several different popular frequencies. Those

are often identified to the customer only by a color-coded designation. That makes it easy for the average person to remember in the event that they want to order additional sets for a particular channel. We guess that it's an attempt to avoid requiring members of the public to remember complicated frequencies to try not to intimidate them with techno-words like "megahertz."

But we can tell *you* that Purple is 151.955 MHz. Write down these other "secret" frequencies: Red is 151.625, Blue is 154.57, Green is 154.60, Brown is 464.55, Silver Star is 467.85, Gold Star is 467.875, Red Star is 467.90, and Blue Star is 467.925. To add to the fun, they often sell these sets for some GMRS frequencies, which they call Channel J, on 467.7624 MHz, and Channel K, at 467.8125 MHz.

Now you now where to monitor. Those frequencies will turn up all sorts of curious chatter that you won't find anywhere else on your scanner.

HIGH-FALOOTIN' CORDLESS PHONES

Several readers have asked about those new 900-MHz cordless phones, since we have mentioned the 46-MHz types here. The 900-MHz phones operate in the frequency range of 902 to 928 MHz. It appears that most of them use digital technology, spread spectrum, or other techniques to make it either difficult or altogether impossible to receive on a regular scanner. Costing a lot more than the standard 46-MHz types, the new 900-MHz phones are made for people who are willing to shell out all those extra bucks for the ability to chat without anyone hearing what they are saying.

Cobra's Intenna 900 is a 900-MHz cordless phone. Although it operates between 902 and 928 MHz, you won't hear it on your scanner!

FIRE BUFF NET

Fire Net is a paging system that transmits messages to thousands of firefighters, fire buffs, scanner fans, and news media. There are thousands of Fire Net subscribers in Boston, New York, and Chicago, and it's now being set up in southern California, including Los Angeles. Future plans call for Denver and San Francisco Fire Nets. Subscribers get information on all fires in Fire Net cities.

The information is sent via alpha-numeric radio paging, and includes the channel information used by the local firefighters working the fire. The Fire Net dispatchers are all off-duty, disabled, or retired firefighters who transmit the original response, then keep providing updates.

Persons who think that they might be qualified as dispatchers, or who are interested in the service, can phone 310-838-1436, or call CompuServe 71674,1610 or Prodigy TKXD40A.

SO LONG!

Until next time, please send along your questions, thoughts, frequencies, etc. Write to *Scanner Scene*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■

THINK TANK

(Continued from page 28)

HV PROBE

This high-voltage probe (see Fig. 7) has several strong points. For example, it's easy to build and it has two functions: it allows your DMM to take high-voltage measurements to 10,000-volts peak, and acts as a high-impedance (100-megohm) probe for high-impedance circuit testing.

The probe was designed to plug into a standard 10-megohm input DMM. If your DMM has a different input, you can change R3 and R4 to suit it. The ratio of R1 + R2 + R3 + R4 to R3 + R4 should be exactly 1000 to 1, thus, a 10.00-volt input will read 10.00 millivolts on your DMM. Keep in mind, the impedance of your DMM is in parallel with R3/R4 when you calculate new values!

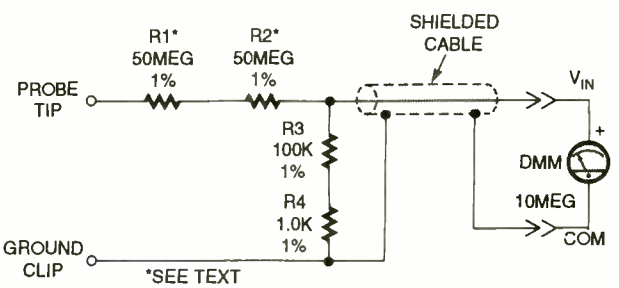


Fig. 7. Working with high-voltage or high-impedance circuits? Then you'll need this probe to extend your meter's range. It's inexpensive, simple, and, most important, could save your life!

Construction is simple: butt-joint R1 and R2 and use plenty of heat-shrink tubing over their entire length to protect against high voltage arcing. An 8- or 10-inch length of ½-inch PVC pipe with glue-on end caps makes a nice probe body, or you could use Radio Shack's No. 15-1200 wall feed-through tube, which is a ¾-inch tube of clear plastic with end fittings. Whatever you use, glue on a hilt near the handle end to keep your hand away from the "business" end! Bring out (at the handle end) a separate 18-inch wire lead with an alligator clip for the ground lead. A separate shielded cable (with appropriate plug) goes to your DMM.

To use the probe, plug it into your DMM observing proper polarity and connect the ground lead to the common of the circuit under test. Then touch the probe to the test point and multiply the DMM reading by 1000. **Always** follow that procedure to protect yourself and your DMM.

Resistors R1 and R2 are 50-megohm, 1%, 6-kV, 1.5-watt units. They cost $2.25 each from Johnson Shop Products (P.O. Box 160113, Cupertino, CA 95016; Tel. 408-257-8614) as item No. 160-CAD-50M.

—*Skip Campisi, So. Bound Brook, NJ*

Skip also noted (in his schematic) that the ground lead should be made from 18-inch long No. 24 insulated wire. The coax to the DMM should be about 24-inches. Also, R1 and R2 are Caddock No. HG716-15 units, in case you have another source of Caddock parts.

Well that's all for this month's column. If you'd like to participate in an upcoming issue, write to *Think Tank*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■

CIRCUIT CIRCUS

(Continued from page 83)

forward junction voltage of a silicon diode varies inversely with temperature; *i.e.*, as the temperature goes up, the voltage goes down, and *vice versa*.

The circuit can be calibrated so that the temperature can be read directly from the meter scale. To calibrate the circuit, place the leg of the circuit with the three diodes in a glass of ice water and adjust R4 for a 0°C or 32°F reading. Next, remove the diodes from the ice water and leave them at room temperature for about 10 minutes. Check the meter's reading at room temperature. Place the diodes in a pan of boiling water and adjust R5 for a full-scale reading. You may need to go back and forth between the two procedures to get the circuit to cover the desired temperature range.

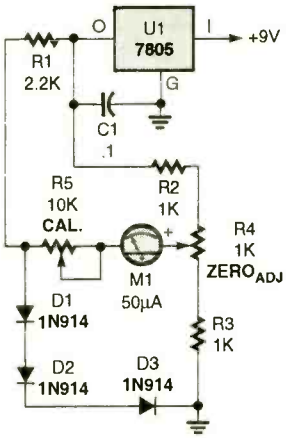


Fig. 5. The Temperature-Shift Meter meter is designed to detect small changes in temperature, rather than give exact temperature levels.

HV STATIC DETECTOR

In our next circuit, offered in Fig. 6, one leg of the Wheatstone bridge is replaced by an MPF102 N-channel JFET. The JFET's high gate-input impedance turns the simple bridge circuit into a very sensitive high-voltage static detector. The JFET's gate is tied to ground through four 22-megohm resistors. A 1- to 2-inch piece of solid-copper wire is connected directly to the JFET's gate and serves as the input sensor.

With the sensor clear, adjust R8 for a zero meter reading. Run a comb through your hair and move it toward the sensor. The meter should go off scale. Place the static sensor next to your computer or any static-sensitive equipment and take special notice when the meter moves. ■

PARTS LIST FOR THE TEMPERATURE SHIFT METER

SEMICONDUCTORS
U1—7805 5-volt, 1-amp voltage regulator, integrated circuit
D1–D3—1N914 general-purpose silicon diode

RESISTORS
(All fixed resistors are ¼-watt, 5% units.)
R1—2200-ohm
R2, R3—1000-ohm
R4—1000-ohm potentiometer
R5—10,000-ohm potentiometer

ADDITIONAL PARTS AND MATERIALS
C1—0.1-µF, ceramic-disc capacitor
M1—50-mA meter
Perfboard materials, 9-volt power source, wire, solder, hardware, etc.

PARTS LIST FOR THE HV STATIC DETECTOR

RESISTORS
(All fixed resistors are ¼-watt, 5% units.)
R1–R4—22-megohm
R5, R6—1000-ohm
R7—330-ohm
R8—1000-ohm potentiometer

ADDITIONAL PARTS AND MATERIALS
Q1—MPF102 N-channel JFET
B1—9-volt transistor-radio battery
S1—SPST switch
M1—100-µA, center-zero, meter
Perfboard materials, enclosure, wire, solder, hardware, etc.

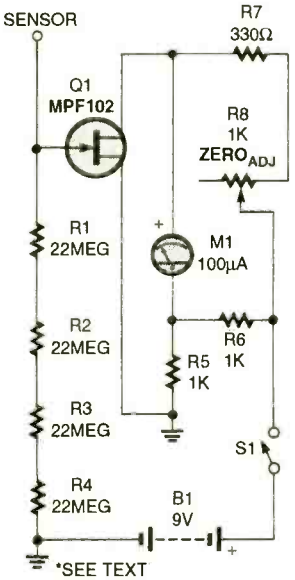


Fig. 6. The HV Static Detector uses a short length of solid-copper wire connected directly to the JFET's gate as the input sensor.

ELECTRONIC CASINO

(Continued from page 50)

the display repetitively flashes the digits "1," "2," and "3," prompting you to select a game to play. Pressing S1 selects, blackjack, S2 selects craps, and S3 selects the slot machine. After you select your game by pressing the appropriate switch, game play begins.

Blackjack. In blackjack, DISP1 shows the point total of the dealer's hand, while DISP2 shows the player's total. The circuit assumes that one "unit" of the player's bankroll is wagered on each hand. When S4 (DEAL) is pressed, two "cards" are dealt to the player, along with one to the dealer, and the display is updated to show the point totals of both hands. The player then presses either S1 to keep his hand, S2 to ask for another card, or S3 to double his wager (in which case, in accordance with standard casino rules, he gets only one additional card).

When the player finishes playing his hand, the circuit automatically plays out the dealer's hand. Cards are dealt one at a time and the display is updated until the dealer's point total reaches or exceeds 17. At that point, the hand is over and the winner is the hand with the highest total that does not exceed 21. If the totals are the same, the hand is a tie. The circuit determines who wins—player or dealer—and the player's bankroll is increased or decreased depending on the outcome of the hand.

Standard casino-blackjack rules are programmed into the circuit, including a payoff of 3 to 2 for blackjack (an initial hand containing an ace and a ten or face card). Aces are counted as eleven points unless the total for the hand exceeds 21, in which case the ace is one point. A hand that contains an ace is called a "soft" hand and is indicated by a flashing display.

Slot Machine. Each digit of the display represents one "wheel" of the slot machine. Pressing S4 "pulls the handle" to start the wheels "spinning." The displays rapidly change between five characters ("–," "E," "0," "8," and "H") and then stop one at a time, starting from the left, to display four characters. If none of the characters match, the player loses that spin and one unit is deducted from the bankroll. If some of the displays do match, various payouts are added to the bankroll depending on how many and which characters match. As in a real slot machine, the probability of occurrence is different for the different characters. The "–" is the least probable character, and the payoff is 100 to 1 if all four display digits contain a "–."

Craps. Pressing S4 "rolls the dice" and displays the result—a number between 2 and 12—in the two display digits on DISP2. An initial roll of 7 or 11 wins; a roll of 2, 3, or 12 loses; and any other roll is called the "point." When a point is established, it is shown in DISP1. Then the player keeps rolling until either a 7 is rolled (a loss) or the point is rolled again (a win). When either of those events occur, the player's bankroll is correspondingly increased or decreased by one unit and the circuit waits for the next roll.

Conclusion. Because some switches have more than one function, depending on the game being played, the Electronic Casino may take a little getting used to. But once you get over that hurdle, you have many hours of gambling fun. ■

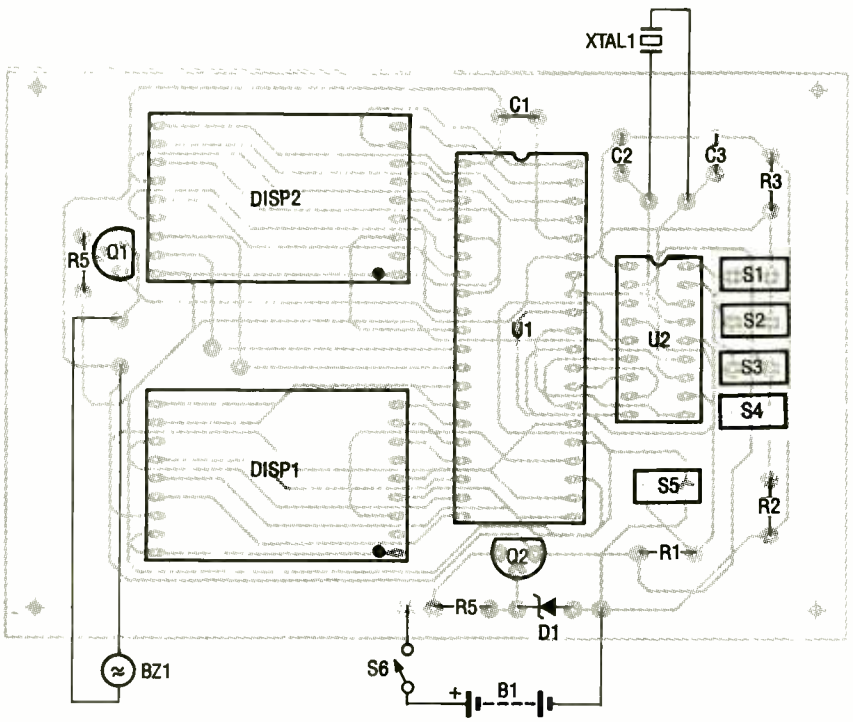


Fig. 5. Be sure to install the displays with the correct orientation (notched markings, not shown here, should be on the B1/S6 side of the board).

ZOOMING ALONG

(Continued from page 61)

will tell you each person's fair share of the bill. Zoomer can also convert between units of measurement in length, area, mass, volume, velocity, time, and temperature. Most of the units of measure used are fairly standard, (quarts and liters, feet and kilometers), but there are a few more interesting ones available. Did you know that 17.6 football fields laid end-to-end, would fit in one mile?

Zoomer's language translator translates 1000 words in 26 languages. Besides the usual English, French, Spanish, and Italian, Zoomer offers Swahili, Serb-Croatian, Yiddish, and even Esperanto. We would prefer more words and fewer languages, but then again, we don't get around much anyway.

The reference section contains a curious mix of practical data and silly trivia. Zoomer provides consumer, U.S., and world information. The first consumer category is nutrition, in which the nutritional content of various foods—including fast foods—are provided. Many diet-conscious folks would find that data to be quite practical. The other two categories—birthstone/flower and zodiac signs—have little practical value for anyone. (If you really cared, you'd already know your sign and your birthstone. Did you even know you *had* a birth flower?)

United States and World information contain a similar mix of sensible and frivolous data. Keeping in touch long distance is made easier with listings of area codes, international dialing, and state abbreviations; airport codes might help frequent travelers; and clothing conversion could come in handy if you shop abroad. But unless they were boning up for an appearance on *Jeopardy*, we're not sure who would need to carry around information about various states and cities (state song, motto, flower, bird); holidays; and the complete text of the Declaration of Independence, the U.S. Constitution, the Bill of Rights, and various Constitutional amendments.

Last, but not least, Zoomer offers three games. Games might not be practical, but they certainly are a sensible application for a handheld device that goes everywhere with its owner. What better way to while away a plane trip, or kill time waiting for 5:00 to roll around? The Z-PDA has Solitaire, another single-player card game called Pyramid (which is virtually impossible to win), and an Othello-like board game called Uki. We'll admit that there were times when we should have been trying out other applications, but goofed off with the games instead. The cursor pad and Nintendo-like buttons set below Zoomer's LCD will be used in future, third-party games.

The Zoomer does offer a well-rounded assortment of applications, making it an attractive tool/toy despite its one flaw—its limited handwriting-recognition capability. The amount of frustration caused by mis-translations is unacceptable. We hope to see that problem remedied in future generations of Zoomer products. ■

ABC'S OF PDA'S

(Continued from page 57)

average consumer will conceive a need for such a device. Impressive as they are in terms of new technology and integrated capabilities, the first-generation PDA's suffer from unreliable handwriting recognition and, worse, lack of what's known as a "killer ap"—some new application that everyone needs and no one else is offering.

The PCMCIA slot on each device can be used to add new applications, and several have been announced, including Motorola paging service (for both Newton and Zoomer); and a Fodor's travel guide to major American Cities, *Dell Crossword Puzzles & Other Games*; *Columbo's Mystery Capers*, and financial-management and business forms from *Money Magazine* (all for Newton). The control pad and fire buttons on the Zoomer's front panel suggest that add-on games can't be far behind. Apple envisions applications including maps that use global positioning technology (Rockwell has announded a GPS receiver that fits in a PCMCIA slot), Newton fax/phone, learning devices for children, specialized uses such as an architect's sketchpad that could calculate square footage, and a refrigerator-mounted Newton family message center.

If that last application ever becomes a reality, PDA's will have made it as true consumer items. Picture a busy family juggling two careers, school, extra-curricular activities, social events, etc. Now equip all family members with their own PDA's, from which they can exchange information with the main family PDA—or with their friends' PDA's. Canceled soccer practice and a re-scheduled dentist appointment would be easier to handle, and paging could keep everyone in touch. All that would be needed to make the PDA totally indispensable is the addition of cellular-phone capability. That's a picture that will surely put smiles on the faces of the folks at Apple, Sharp, Tandy, and Casio.

HOW DO THEY REALLY WORK?

That's a nice vision for the future, but how do today's first-generation Personal Digital Assistants really work? To find out, keep reading. Reviews of a Newton, a Zoomer, and the EO 440 follow. ■

EO ON THE GO

(Continued from page 62)

it will be possible to upgrade the Communicator. Another plus is that the screen is large enough so that writing on it feels natural; the resolution is high enough that what is written looks natural.

The special stylus that is supplied with the Communicator is required to operate the device. The advantage of requiring a special stylus is that you can write without worrying about the heel of your hand causing spurious input (The LCD isn't touch-sensitive, but instead responds to the pen's magnetic properties.) The disadvantage is that if you lose the stylus, you can't use the Communicator; a replacement stylus is about $35.

PenPoint understands some thirty gestures. Deleting text requires that you draw an "X" over it. Circling text calls up an editing pad. Drawing an X through a circle is an undo command that reverses the most recent action. A carat creates a new document or opens a writing pad that can be used to insert text. A check mark opens an option sheet. Pen "flicks" scroll pages up, down, or side-to-side. A question mark opens a quick-help feature. The gestures, in general, seemed sensible. As we moved back and forth between the Zoomer, Newton, and EO 440, we had no trouble remembering the EO's gestures, but sometimes got confused on the other two.

The EO offers what is called "intelligent text." For example, when you add a name to the Address Book, it becomes part of a collection of information called the ProfileBook. Whenever the name is written, it will be recognized by the EO. If, for example, your appointment calendar had a note about an appointment with Jim at his office, the name would appear in bold type, and more information about Jim could be called up with a double tap—his office address, for example. A note could also be linked with the data—perhaps a hand-drawn map showing where his office is. Six months down the road, you can find out just when the meeting was because it will still be linked to Jim, and can be found by looking at Jim's profile.

The to-do list in the Personal Perspective information manager is also intelligent in that items that are not done automatically roll over into the next day. Placing a check mark in the status box associated with an item indicates that the to-do has been done.

The communications functions of the EO are centered around an inbox and an outbox. Incoming faxes and E-mail messages are stored in the inbox. Tapping on the inbox icon opens it, presenting a list of received faxes and messages. While you are reading a document, you can zoom in

and out and scroll. You can view faxes in full size, mark it up, and send it out to someone else by placing it in the outbox. Tapping the outbox icon opens the outbox notebook, where you can enable GO Fax. A cover sheet is automatically generated, but need not be sent.

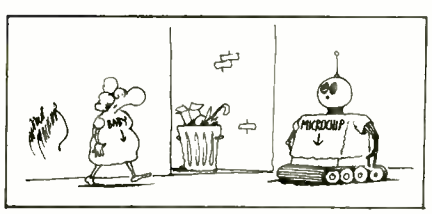
The EO Phone application can be used to make voice calls through a standard phone line or the optional cellular module. Without the module, the EO itself can't be used as a telephone.

EO Sound permits voice to be "attached" to a document. E-mail messages can be sent to other EO users—through either AT&T Mail or by phone—who can play back the voice note just by tapping on its icon.

The Personal Communicator provides several options for backing up data. If PenTOPS software is used to link the EO to a PC, data can be stored on the computer's hard disk or on a floppy diskette. An EO floppy disk drive or hard disk drive can be connected through the parallel port. A PCMCIA memory card can be used for backup, or the modem can be used to send data to a PC running TOPS software.

The EO personal communicator was introduced many months before either of the other two items reviewed in this month's Gizmo. Even so, it clearly seemed like the most mature of the products. Some of that is because our evaluation unit contained some essential "options." For example, without the modem or the 8-megabyte memory, sending and receiving faxes would not have been possible. The EO is, of course, priced considerably higher than either the Zoomer or Newton. In fact, it costs more than both put together. However, the EO has a more obvious—and well heeled—market. Ask virtually any business traveler if he could use a portable device on which he could receive faxes and E-mail, and create and edit documents. Most would say yes, we'd assume. Whether they could justify spending more than $3000 for such a device is a more difficult question.

The EO is a complete package. Personal Perspective is a good address/date book and a good personal information manager. Mini Text is powerful enough to take care of a good deal of correspondence. A spreadsheet application more powerful than the simple EO Calc would be a sensible addition, however. You never know when you might want to check the latest financial forecast while at the beach. ■



AUTOMOTIVE TESTER

(Continued from page 68)

tinguished, indicating that the battery voltage is below normal.

Now, slowly raise the supply voltage until LED1 goes out (that should occur at about 9.0 volts). Further increase the supply voltage until LED2 (BATTERY OK) lights, which should occur at 12.4 volts. Slowly increase the power-supply voltage until LED3 (NOT CHARGING) goes out and LED4 (INSUFFICIENT CHARGING) comes on simultaneously. That should occur at 12.8 volts.

Continue to raise the power-supply voltage, and when it reaches 13.4 volts only LED2 should be lit. Finally, raise the voltage until LED5 (OVER CHARGING) comes on, which should occur at 15.2 volts. **CAUTION:** Do not allow the power supply's output voltage to exceed 16 volts.

If you get the responses outlined above, the project is operating properly. The voltage levels at which the LED's change state should be within 0.1 volt of the specified voltages. If your project falls out of that tolerance, you should adjust the value of one or more of the resistors of the voltage divider (R1 through R6) by about 1% to bring the circuit into spec.

If the project does not respond properly at any one of the specified voltage levels, check pin 1 of U2 to be sure the 1.25-volt reference voltage is present. If not, check the orientation of D1, C1, U1, and the LED's. Try another chip if possible. If only one LED malfunctions, troubleshoot the comparator that drives that LED. Then measure that output voltage as the input voltage is varied about the specified triggering level. Check the orientation of the inoperative LED, and replace it with a new one. If the simultaneous switchover between LED3 and LED4 does not occur, check the orientation of D2.

Using the System. The following steps should be performed in sequence when checking an automotive electrical system. If the project is intended for stand-alone use, connect the project's input leads directly to the vehicle's battery terminals before starting the engine; be sure to observe the proper polarity. Check the vehicle's alternator belt for proper tension.

1. Before the engine is started, the BATTERY OK (LED2) should light. The NOT CHARGING indicator (LED3) should also be illuminated since the alternator is not operating at this point. Note: If the engine has just been turned off, LED4 may be illuminated instead of LED3, since the battery may have a higher than normal terminal voltage from being charged by the alternator.

2. Have an assistant start the engine while you observe the project's display. If the WEAK BATTERY indicator (LED1) comes on during cranking, the battery terminal voltage has fallen to less than 9 volts. That indicates that the battery is in a low state of charge or is near the end of its life. Recharge the battery and repeat the test.

3. With the engine idling, only LED2 (BATTERY OK) should be illuminated, indicating that everything is normal. Note that some vehicles will indicate INSUFFICIENT CHARGING (LED4 will be lit) because the battery's terminal voltage has not exceeded 13.4 volts while idling. That will be checked at the next step in the procedure. If the NOT CHARGING indicator (LED3) is lit, the charging system of the vehicle is totally inoperative. That could be caused by a defective regulator circuit, an open alternator field, or a bad connection somewhere in the electrical harness.

4. To check the charging capacity of the alternator, turn on the heater/AC fan (highest setting), rear window defroster, windshield wiper (fastest speed), and high-beam headlights. Race the engine to 1500 or 2000 RPM (moderate speed). Only LED2 should be illuminated. If LED4 (INSUFFICIENT CHARGING) lights, the alternator cannot deliver enough current to handle the accessory load. That may be caused by a shorted or open diode, or a shorted winding in the alternator itself. Since the alternator is a three-phase device that uses a 6-diode bridge circuit, it will be able to deliver some output even though one of the phases is defective.

5. To check the regulator, turn off all accessories and race the engine to about 2000 RPM. If LED 5 (OVERCHARGING) lights, the regulator is defective. That will cause the battery to have excessive water consumption and shorten its life. In many vehicles, the regulator is non-adjustable and must be replaced. ■

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PIEZOELECTRIC ELEMENTS

(Continued from page 70)

One of the commonly used external-drive circuits for two-terminal elements uses two NAND gates to produce the drive oscillations (see Fig. 6). The arrangement is fairly standard, with the output drive taken from the collector, as shown, and a small inductor used as the transistor's load in order to peak the voltage.

Proper Driving. Now let's discuss some things you should keep in mind when devising your own drive circuits. Piezoelectric elements can be driven by either a sinewave or square-wave voltage, depending upon the application. Using a sinewave drive will cause the device to operate at a frequency below its specified resonant frequency. With a square-wave drive, a higher acoustic output can be achieved, but with an increase in harmonic content.

For obtaining a maximum output, a frequency of between 500 Hz and 4 kHz is recommended. As seen in Fig. 7, the sound-pressure output level varies significantly with even small changes in drive frequency. Therefore fine tuning is quite necessary to obtain maximum output.

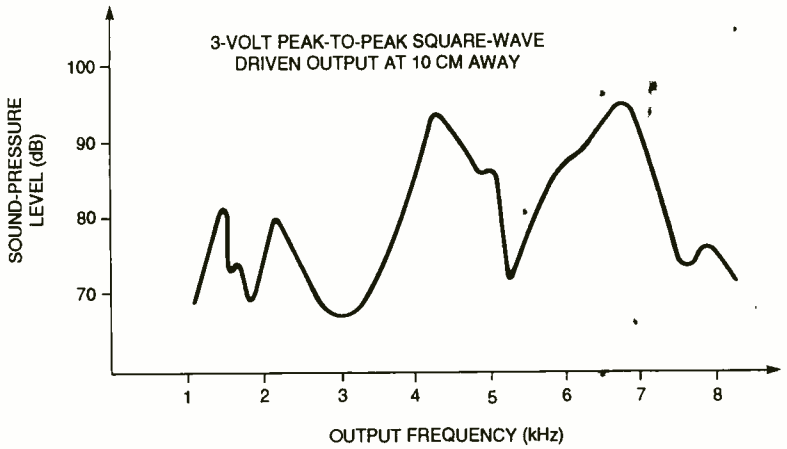

Fig. 7. Sound pressure level can vary greatly with even small changes in output frequency, as you can see from this graph.

Continuous DC bias will cause depolarization of the ceramic elements and lead to permanent damage. It is therefore necessary to capacitively couple piezoelectric devices whenever they are driven with untried homemade circuits. Also voltages higher than those recommended by the manufacturer will cause damage to the ceramic and provide no higher

With the information presented in this article you should be able to use piezoelectric elements to their fullest in your own projects and designs. Build and enjoy. ■

TONER CARTRIDGE

(Continued from page 74)

want to sell new cartridges. Special tamper-proof methods and hardware are used in assembly to keep out those without special tools, and special toners are used. In fact, when I contacted Canon for material to support this article, they refused to supply any information when I told them I would be covering recharging. They claimed they did not want to encourage a process they could not insure was being done properly.

If you want to recycle your own cartridges, supplies are available, but with the present complexity of technology and options, you are probably better off leaving recycling to those doing it as a business. On the other hand, you may want to get in the recycling business yourself. If so see the Business of Your Own sidebar.

Guarantee/Warranty?? Since the first days of cartridge refillers, the question in the minds of users has been the effect a refilled cartridge might have on their machine or warranty. Some confusion exists in the field over this, with some technicians and dealers stating that using a recharged cartridge would void a machine's warranty, while some machine manufacturers have specifically refuted that claim.

Woodenfrog Printer Products provides a Limited Warranty certificate that states in part that Woodenfrog "agrees to repair or replace any customer's printer or copier if it is damaged as a result of using a remanufactured toner cartridge which has been provided by Woodenfrog."

As you would expect, recyclers insist neither the machine nor its warranty are at risk when using recycled cartridges, while manufacturers of new cartridges are less specific. Considering the long history and common usage of recycled cartridges, it would seem that if your machine or warranty were in jeopardy, it would have become a well-known fact by now.

Who Remanufactures? Since refill, recharge, remanufacture, or recycle are the common terms used in ads, you'll have to call and ask if they completely disassemble the cartridge or just refill it. Are holes drilled, or is the cartridge reassembled rather than just refilled? My advice is to deal only with a company that actually fully disassembles the cartridge. When looking for a recycler, find out if they have significant experience, what kind of toner is used, and what guarantee is provided. Beware of those who have found an opportunity to make a few quick bucks by drilling some holes and buying cheap toner.

If the cartridge comes back to you with a plastic sealing strip that has to be pulled out of the cartridge before it can be used, that's a good sign provided it was properly installed by disassembling the cartridge. However, a stiff sealing strip can be installed without disassembly, and it may not seal properly.

When all is said and done, a remanufactured toner cartridge from an experienced recycler can provide excellent results. ■

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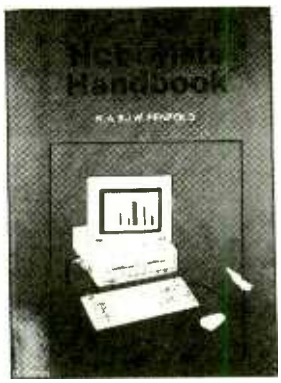

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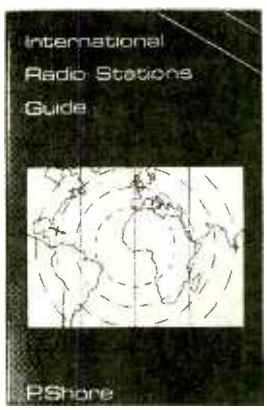

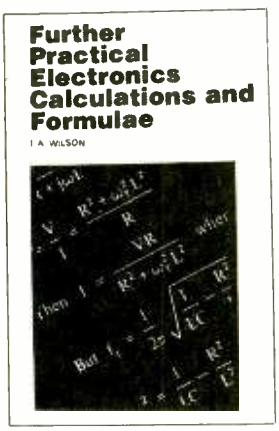

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☐ **WIRELESS & ELECTRICAL CYCLOPEDIA—ETT1—$5.75**

A slice of history. This early electronics catalog was issued in 1918. It consists of 176 pages that document the early history of electricity, radio and electronics. It was the "bible" of the electrical experimenter of the period. Take a look at history and see how far we have come. And by the way, don't try to order any of the merchandise shown, it's unlikely that it will be available. And if it is, the prices will be many times higher.

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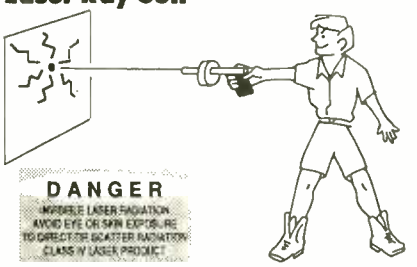

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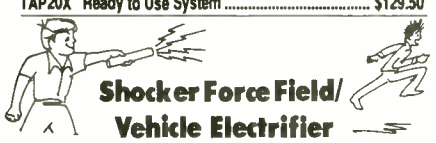
Shocker Force Field/ Vehicle Electrifier



Neat little device allows you to make hand and shock balls, shock wands and electrify objects, charge capacitors. Great payback for those wise guys who have wronged you!
SHK1KM Easy to Assemble Electronic Kit $24.50

Blaster Pulser

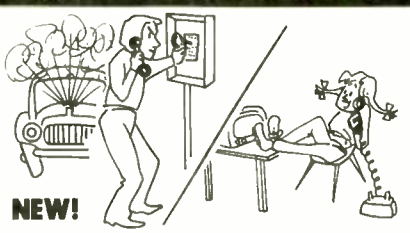
Pocket-sized wand produces 100,000 watts of power for personal defense, field and lab use, etc. BLS3 Plans $10.00
BLS3K Kit / Plans $69.50

Homing / Tracking Transmitter

Beeper device, 3 mile range.
HOD1 Plans .....$10.00 HOD1K Kit / Plans $49.50

Listen Through Walls, Floors

Highly sensitive stethoscope mike.
STETH1 Plans.....$8.00 STETH1K Kit/Plans $44.50



NEW! Telephone Line Grabber / Room Monitor

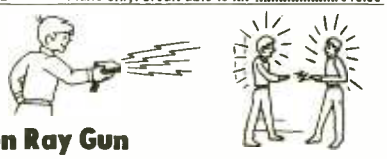
ALL NEW! The Ultimate in Home or Office Security & Safety!
Simple to Use! Call your home or office phone, push a secret tone on your telephone keypad to access either: A. On premises sounds and voices; or B. Existing telephone conversation with break in capability for emergency messages. CAUTION: Before assembly or use, check legalities with your state Attorney General's office as you may require "beepers" or other 3rd party alerts.
TELEGRAB1 Plans Only $10.00
TELEGRAB1K Kit / Plans $99.50

Ultrasonic Blaster

Laboratory source of acoustical shock waves. Blow holes in metal, produce "cold" steam, atomize liquids. Many cleaning uses for PC boards, jewelry, coins, small parts, etc.
ULB1 Plans.....$10.00 ULB1K Kit/Plans.....$69.50

100,000V Intimidator / Shock Wand Module

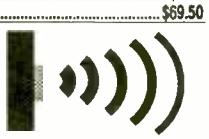
Build an electrical device that is affective up to 20 feet. May be enclosed for handheld, portable field or laboratory applications.
ITM2KM Easy-to-Assemble Electronics Kit $49.50
ITM2 Plans only, credit-able to kit $10.00



Ion Ray Gun

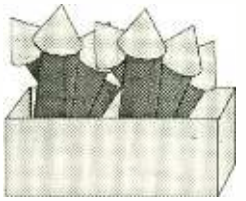
Projects charged ions that induce shocks in people and objects without any connection! Great science project as well as a high tech party prank. IOG3 Plans $8.00
IOG3K Kit/Plans $69.50

Invisible Pain Field Generator

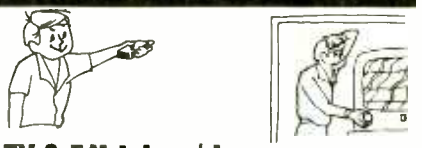


Shirt pocket size electronic device produces time variant complex shock waves of intense directional acoustic energy, capable of warding off aggressive animals, etc.
IPG7 Plans .....$8.00 IPG7K Kit/Plans ...$49.50
IPG70 Assembled $74.50

SUPER GIANT SMOKE ASSORTMENT



SPECIAL INTRODUCTORY OFFER! WOW! Over 500 items - the largest smoke assortment we have! Each super giant assortment contains at least 500 pieces - enough to last you a long time. All this at a special price - less than 12 cents per item. Guaranteed value at least 50 percent more than you pay! SMOKE 25 ..... $59.50



TV & FM Joker / Jammer

Shirt pocket device allows you to totally control and remotely disrupt TV or radio reception. Great gag to play on family or friends. Discretion required. EJK1KM Easy to Assemble Electronic Kit $24.50

Visible Beam Laser

High brightness red HeNe laser visible for miles.
Produce your own light show! Projects a visible beam of red lite clearly visible in most circumstances. Can be used to intimidate by projection of a red dot on target subject. Also may be used to "listen in" using our laser window bounce method #LLIS1 below. *Easy to build module makes A working visible laser!*
LAS1KM Kit w/1mw Laser Tube, Class II. $69.50
LAS3KM Kit w/2.5mw Laser Tube, Class IIIA $99.50

"Laser Bounce" Listener System

Allows you to hear sounds from an area via a lite beam reflected from a window or other similar objects. System uses our ready-to-use LATR1 Laser Terminator gun site as the transmitter. The receiver section is supplied as an easy-to-build kit, including our cushioned HS10 headsets. LLIST2 Plans $20.00
LLIST1K Kit of Both Transmitter and Receiver $199.50
LLIST20 Assemble with Laser Gun Site $299.50

5mw Visible Red Pocket Laser

Utilizes our touch power control!
VRL5KMX Kit / Plans $119.50

Fantastic ALL NEW pinwheel effect for auto, motorcycle, bicycle, etc. Use one per wheel. SIMPLE TO USE! LWMIRLY $9.50

Pocket Sized Night Viewer

Uses Low Level Starlight to See in the Dark!
- Low Cost
- Ultra-Hi Lite Amplification!
- Auto Brightness Control
- Limited Amount Available
- Made in USA • Night surveillance • Animal studies, etc.

Can be used to fly an airplane or drive a car!
PKV7 Plans $15.00
PKV7K Easy to Assemble Kit $1,295.00
PKV70 Ready to Use $1,595.00

3 Mile FM Wireless Microphone

Subminiature! Crystal clear, ultra sensitive pickup transmits voices and sounds to FM radio. Excellent for security, monitoring of children or invalids. Become the neighborhood disk jockey, or go "under cover" using our sunglasses FM radio (see catalog). FMV1 Plans ... $7.00
FMV1K Kit and Plans $39.50
SUGL10 Sunglasses with built in FM Radio $29.50

Telephone Transmitter - 3 Mi

Automatically transmits both sides of a telephone conversation to an FM radio. • Tunable Frequency • Undetectable on Phone • Easy to Build and Use • Up to 3 Mile Range • Only transmits during phone use.
VWPM7 Plans $7.00
VWPM7K Kit/Plans $39.50

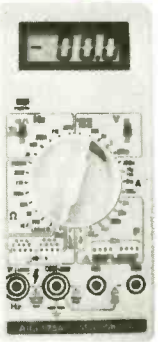
ALFA ELECTRONICS

HIGH QUALITY TEST EQUIPMENT
BEST PRICE

DMM 2360 $119.95

DMM + LCR Meter
Most Versatile DMM

Inductance: 1µH-40H
Capacitance: 1pF-40µF
Frequency: 1Hz - 4MHz
Temperature: -40 - 302 °F
TTL Logic Test: 20MHz
Diode, Continuity
Volt, Amp, Ohm
3999 count display
Peak Hold
Auto power off
Ruggerdized case.
Rubber Holster $8.00



DMM 175A $67.95

DMM with 20 MHz Frequency Counter
Most Popular DMM

Freq. Counter 1Hz-20MHz
DCV 0.1mV-1000V
ACV 0.1 mV-750V
ACA/DCA 0.1µA-10A
Resistance 0.1Ω-2000MΩ
Capacitance 1pF-20µF
TTL Logic test 20 MHz
Transistor HFE test
Diode test ,LED test
3 1/2 digit display
10 MΩ impedance
Soft case$3.00, deluxe case $5.00

Fluke Multimeter

Fluke 12	$79.95
Holster C-10	$10
Fluke 70 II	$65
Fluke 73 II	$90
Fluke 75 II	$127
Holster C-70	$15
Fluke 77 II	$147
Fluke 79 II	$167
Fluke 29II	$167
Fluke 83	$225
Fluke 85	$259
Fluke 87 True RMS	$285
Fluke 97 Scope Meter	$1750

LCR Meter 814 $199.95

The Best Handheld LCR

Inductance: 0.1µH-200H
Capacitance: 0.1pF-20,000µF
Resistance: 1mΩ-20MΩ
1% basic accuracy
Dissipation factor indicates leakage in capacitor and Q factor in inductor
Zero adjustment to reduce parasitics from test fixture
Best for high frequency RF and surface mount components.
SMD and chip component test probe $25.00. Deluxe carrying case $5.00

LCR Meter 195 $119.95

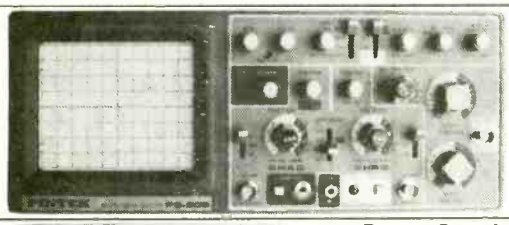
Very Popular LCR

Inductance: 1µH-200H
Capacitance:0.1pF-200 µF
Resistance:0.01Ω-20MΩ
Basic accuracy:R:1%, C:2%, L:3%
Test frequency 1 kHz
Soft carrying case $3.00
Deluxe case $5.00

Capacitance Meter 7705 $57.95

0.1 pF-20,000µF in 9 ranges
0.5% basic accuracy
Zero adjustment ± 20pF to compensate parasitics from test fixture

Also Available:
Heavy duty DMM, AC/DC clamp meter, Thermometer, Light meter pH meter,, High voltage probe Digital caliper, Anemometer Elctronic scale, Force guage Tachometer, Humidity & EMF adapter, Sound level meter Frequency counter, SWR/field strength/power meter, Dip meter



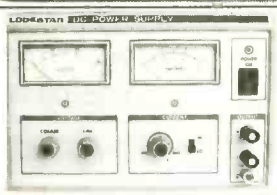
20 MHz Oscilloscope with Delay Sweep PS-205 $429.95

Dual Trace, Component test, 6" CRT, X-Y Operation, TV Sync, Z Modulation, CH2 Output, Graticule Illum, 2 probes each has x1,x10 switch. Best price with delay sweep.

PS-200 20 MHz DUAL TRACE	$339.95
PS-400 40 MHz DUAL TRACE	$494.95
PS-405 40 MHz DELAY SWEEP	$569.95
PS-605 60 MHz DELAY SWEEP	$769.95

20 MHz Digital Storage Oscilloscope DS-203 $729.95

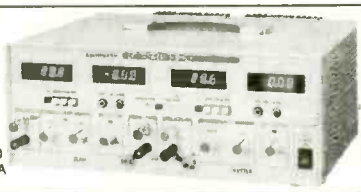
Switchable between digital and analog modes
2 K word per channel storage
Sampling rate: 10 M sample /sec
8 bit vertical resolution (25 Lerel/div)
Expanded Timebase 10ms/div - 0.5 s/div
Refresh, Roll, Save all , Save CH2, Pre-Trig
Plotter Control



DC Power Supply PS-303 $159.00

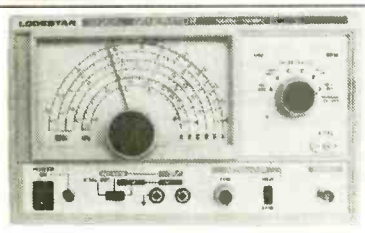
0-30 VDC , 0-3A output

0.02% + 2mV line regulation
0.02% + 3mV load regulation
1 mVrms noise and ripple
Short circuit and overload protected
PS-8200 with digital voltmeter $179.00
Also available: 30V/5A, 60V/3A, 60V/5A 16V/10A, 30V/10A



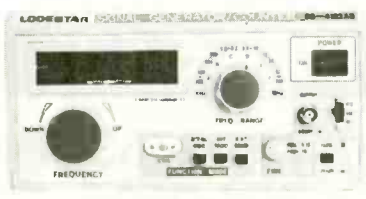
DC Power Supply Triple Output PS-8202 $499.95

Two 0-30 VDC , 0-3A outputs
One fixed 5VDC, 3A output
Capable of independent or tracking operation
Constant voltage and constant current mode
Four digital meters for volt and current display
Excellent regulation and low ripple
Short circuit and overload protected
Also available: 30V/5A triple output $549.95
60V/5A dual tracking $749.95



RF SIGNAL GENERATOR SG-4160B $119.00

100 kHz-150MHz sinewave in 6 ranges
RF Output 100mVrms to 35 MHz
Internal 1kHz, External 50Hz-20kHz AM modulation
Audio output 1 kHz, 1 Vrms



RF SIGNAL GEN./COUNTER SG-4162 AD $229.95

Generates RF signal same as SG-4160B
Frequency counter 1Hz - 150 MHz for internal and external source
Sensitivity <50mV

AUDIO GENERATOR AG-2601A $119.00

10Hz - 1MHz in 5 ranges
Output: 0-8Vrms sinewave
0-10Vp-p squarewave
Synchronization: ±3% of oscillation frequency per Vrms
Output distortion:
0.05% 500Hz - 50kHz
0.5 % 50Hz - 500kHz
Output impedance: 600 ohm

AUDIO GEN./COUNTER AG-2603AD $229.95

Generates audio signal same as AG-2601A
Frequency counter 1Hz-150MHz for internal and external sources
Sensitivity <50mV

FUNCTION GENERATOR FG-2100A $169.95

0.2 Hz -2 MHz in 7 ranges
Sine, square, triangle, pulse and ramp
Output: 5mV-20Vp-p
1% distortion, DC offset ± 10V
VCF: 0-10V control frequency to 1000:1

FUNCTION GEN/COUNTER FG-2102AD $229.95

Generates signal same as FG-2100A
Frequency counter 4 digits
Feature TTL and CMOS output

SWEEP FUNCTION GEN./COUNTER $329.95

0.5Hz to 5 MHz in 7 ranges
Sweep: Linear 10:1/Log 10:1 20ms to 2s
AM Modulation
Gated Burst, Voltage Control Generator
Generator Control Voltage & 6 digit counter
1Hz-10MHz for internal & external sources

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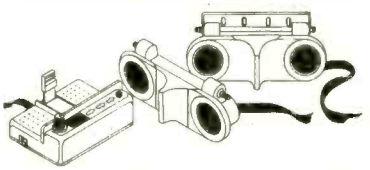
ULTRASONIC PROXIMITY DETECTOR



The ED-100 was designed for use as an auto/truck/RV back-up alarm. A digital display and audible beeper inside the vehicle inform the driver of the distance to impact beginning when the vehicle is within 14 feet of another object. Two 40 kHz ultrasonic emitter/detector modules, measuring 5.81" long X 1.9" wide, 2.05" thick, attach to the rear of the vehicle. The device operates on 12 or 24 Vdc.

These units are new, in original cartons and include instructions. The company that marketed this device is no longer in business, and no manufacturer's guarantee is in effect.

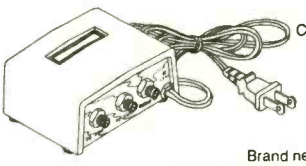
We offer these ultrasonic detectors for experimentation only, and in no way wish to promote their usefulness as a driving aid.

Originally sold for over $100.00.

CAT# ED-100

$24.95 per set

EXPERIMENTER'S DELIGHT VHF TO UHF BLOCK CONVERTER



Channel Master # 0746

This is one of those deals that's too good to be true.

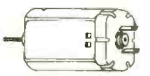
Brand new, in the box, Channel Master block converters. They used to be quite popular back in the early days of cable television, before there were a lot of cable-ready TVs. Somewhere in the world we know there is still a demand for them--especially at this price. Designed to convert television VHF channels 2 through 13 and A through W to UHF channels 36 through 76. The box alone, is a great project box. The 10 ft. AC power cord, the interior components, F connectors and AC receptacles are well worth the price.

CAT# CM-0746

10 pieces for $18.50

$2.00 each

3 Vdc MOTOR



Johnson Motors # MF213G-2050
DC motor operates well at 1.5 Vdc to 4.5 Vdc.
0.72" X 0.94" X 1.38" long.
0.08" (2 MM) diameter shaft is 0.25" long.

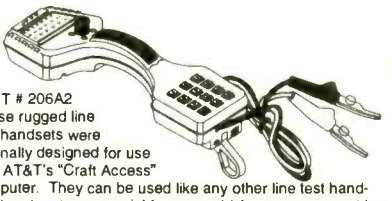
CAT# DCM-42

2 for $ 1.00

LARGE QUANTITY AVAILABLE!

150 for 40¢ each • 600 for 30¢ each

TELEPHONE LINE TEST HANDSET



AT&T # 206A2

These rugged line test handsets were originally designed for use with AT&T's "Craft Access" computer. They can be used like any other line test handset, but they have special features which may or may not be useful. In addition to the touch-tone keypad, talk/monitor switch, alligator clip leads, 4 conductor modular jack and tool belt clip, these units have a LCD screen and function button/joystick for use with AT&T's "Craft Access" computer. For the average user, the extra features mainly allow you to adjust the volume and program in phone numbers. The main drawback to these units is that they contain batteries that require recharging, and the test set should be recharged when not in use. The size of the unit is 12.5" long X 4.5" wide. Brand new, in the box. They include 2 ni-cad battery packs, a charger and instructions.

CAT # PTS-206

$60.00 per set

DIGITAL VIDEO STABILIZER

Eliminate color shifting screen flashing, jagged edges and unwanted lines copyguarding can cause. Eliminates copy guards and cleans up movies as you view them. Simple hook-up; just install 9 Vdc battery (not included) and watch crystal clear video without need for adjustment.

WARNING: This product is intended for personal use only. Not intended for pre-recorded material that might constitute copyright infringement.

CAT# RX-11

$29.95 each

ELECTROLUMINESCENT "Glow Strip"

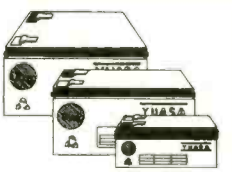
4.75" X 10.25" electroluminescent glow strip operates on 80-120 Vac.

Emits a soft pink/white glow when energized. Great for backlighting control panels and special effects. Thin and flexible, can be used on curved surfaces. 0.04" thick. 2 wire connection.

CAT# GS-510

$6.00 each

RECHARGEABLE GEL CELL BATTERIES



Maintenance free, rechargeable batteries ideal for alarm back-up or portable power of any kind. Useable in any position.

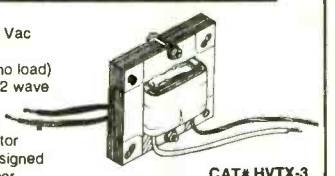
6 Volts @ 4 A/h CAT# GC-64
Panasonic # LCR6V4P or equiv.
2.75" X 1.87" X 4" high
$12.00 each

12 Volts @ 1.2 A/h CAT# GC-1212
Yuasa # NP1.2-12 or equiv.
3.8" X 1.81" X 2" high.
$ 7.50 each

12 Volts @ 7 A/h CAT# GC-127
Yuasa # NP7-12 or equiv.
5.95" X 2.53" X 3.71" high
$ 25.00 each

12 Volts @ 12 A/h CAT# GC-12
Yuasa # NP12-12 or equiv.
5.93" X 3.83" X 3.69" high
$ 35.00 each

2KV TRANSFORMER



Primary: 120 Vac
Secondary:
1,890 Vac (no load)
2,250 with 1/2 wave rectifier
@ 4 madc &
.22 uf capacitor
Originally designed for laser power supply. Measures:
3.13" X 3.75" X 2.3"

CAT# HVTX-3

$15.00 each

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New Rechargeable Sealed Lead Acid Battery

12VDC 15Ah Size: L 7" x H 6.5" x W 3" Name Brand
Leakproof - can be used in any position maintainence free - needs only charging. High power density - Long service. Will stand up to tough operating conditions such as overcharge and deep discharge. Applications - for new equipment or replacement - alarms, medical equipment, robotics, industrial equipment, UPS systems and much more!
Weight 13 lbs. *"Call For Quantity Pricing"* #LAB100 **$29.95ea.**

PLUG-IN WALL TRANSFORMERS

	Mfg	Each	10/Lot
5.6VAC @ 200MA	T.I.	$0.95	$8.00
9.0VDC @ 450MA	G.E.	$3.25	$30.00
12VDC @ 299MA	PANA.	$1.25	$10.00
14VDC @ 450MA	G.E.	$2.50	$22.00
14VDC @ 700MA	G.E.	$3.25	$30.00
20VAC @ 700MA	Import	$2.75	$25.00

Fully Enclosed 73 Watt Continuous Switching Power Supply

• 91 Watts Surge • Forced Air Output • 4 Outputs
• Full Ranging Input Voltages From 90 to 264 VAC
Will provide the necessary power and cable to run two drives one hard drive and one floppy disk drive with a microconnector. Has its own internal fan capable of cooling power supply as well as the components inside the computer to a safe operating temp.

Output Voltages	Full Load (amp)
+5V	10.0 A
+12V	1.5 A
-12V	.3 A
-5V	.3 A

UL/CSA Approved
Size: L 6.5" x W 2.8" x H 3.7"
#PSB03 **$24.95 ea.**

COOLING FANS

		Each	10/Lot
115VAC	4.7"	$5.75	$55.00
12VDC	4.7"	$4.75	$45.00
24VDC	4.7"	$3.75	$35.00
12VDC	3.5"	$4.25	$40.00
24VDC	3.5"	$3.75	$32.00
12VDC	2.25"	$4.25	$40.00
24VDC	2.25"	$3.75	$32.00
12VDC	1 5/8"	$4.25	$40.00

RARE EARTH MAGNETS

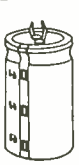
Kidney Shaped
Approx 3/4" x 1/2"
Estimated pull 1 1/2 lbs.
You won't believe the power
#REM01 **$1.49 ea., 10 Lot/$.99 ea.**

LED's

Standard Jumbo 5MM or 3MM

Red	$.06 ea.	20 piece
Yellow	$.07 ea.	minimum
Green	$.07 ea.	per item

SNAP-IN LYTICS



220MFD @ 160VDC	.60
220MFD @ 200VCC	.90
220MFD @ 400VDC	1.50
470MFD @ 200VDC	1.75
680MFD @ 200VDC	1.75
820MFD @ 250VDC	1.75
1500MFD@ 200VDC	2.25
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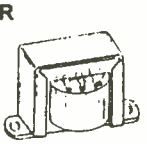

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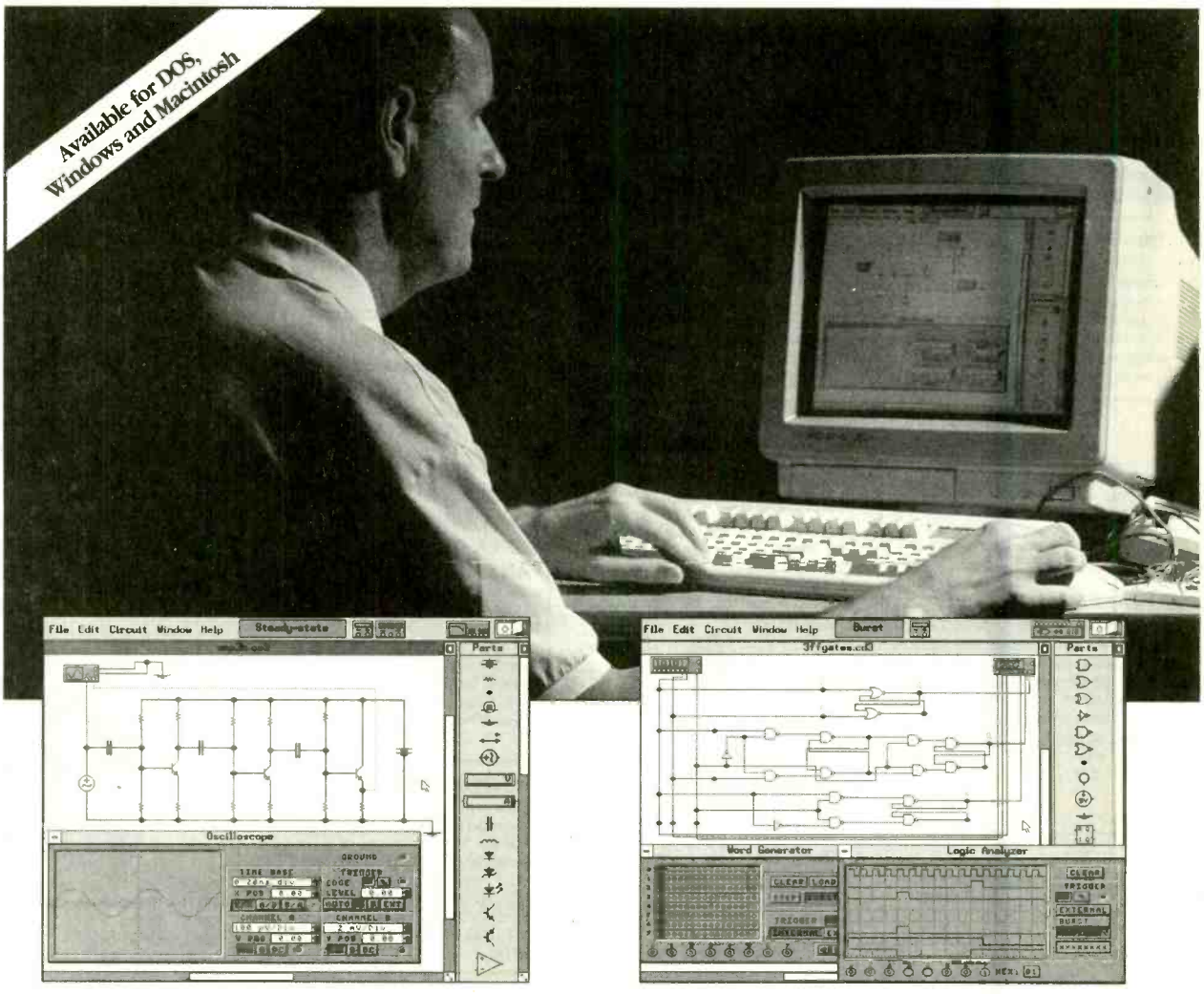

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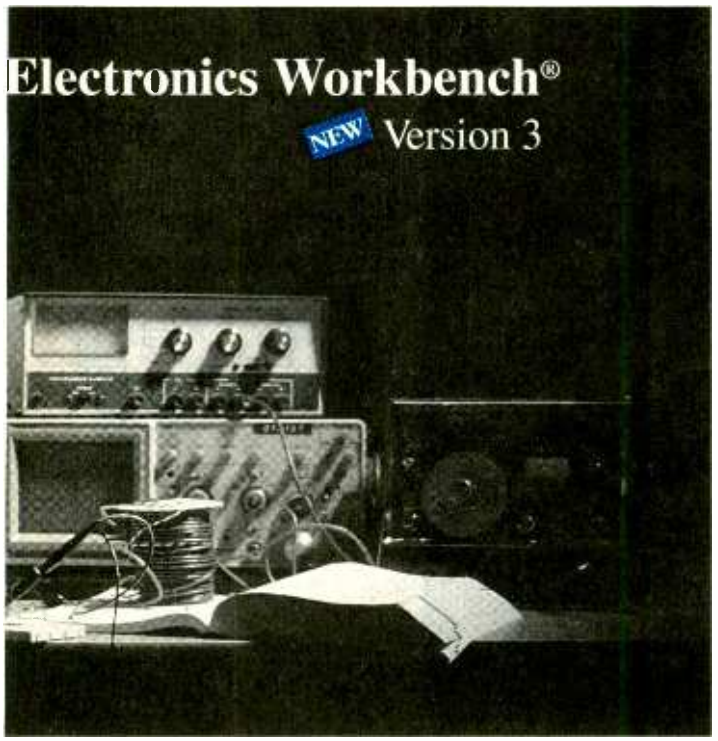

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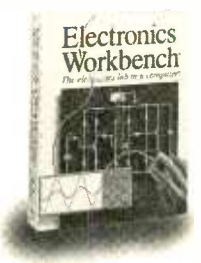

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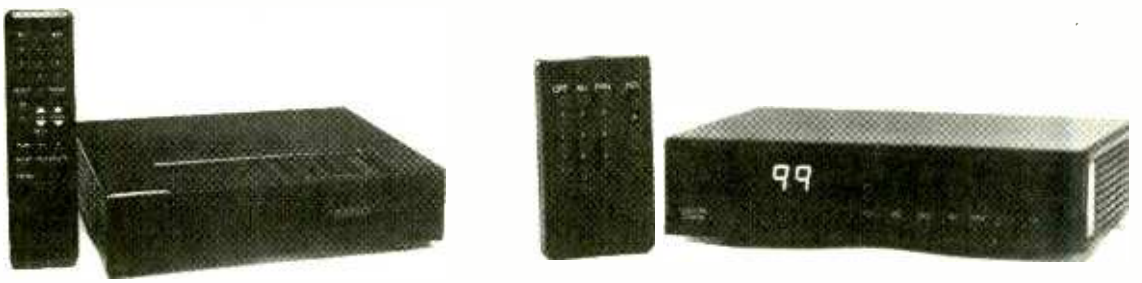

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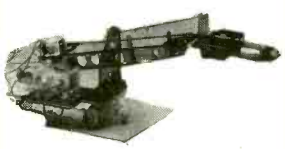

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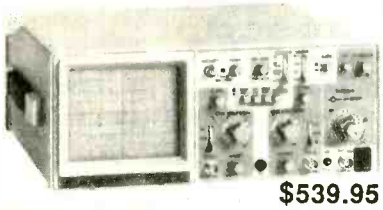

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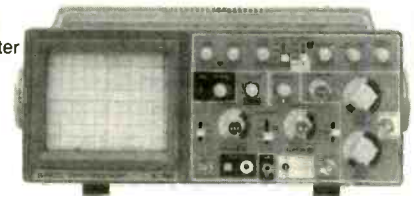

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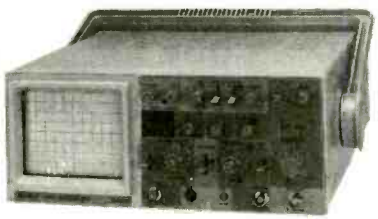

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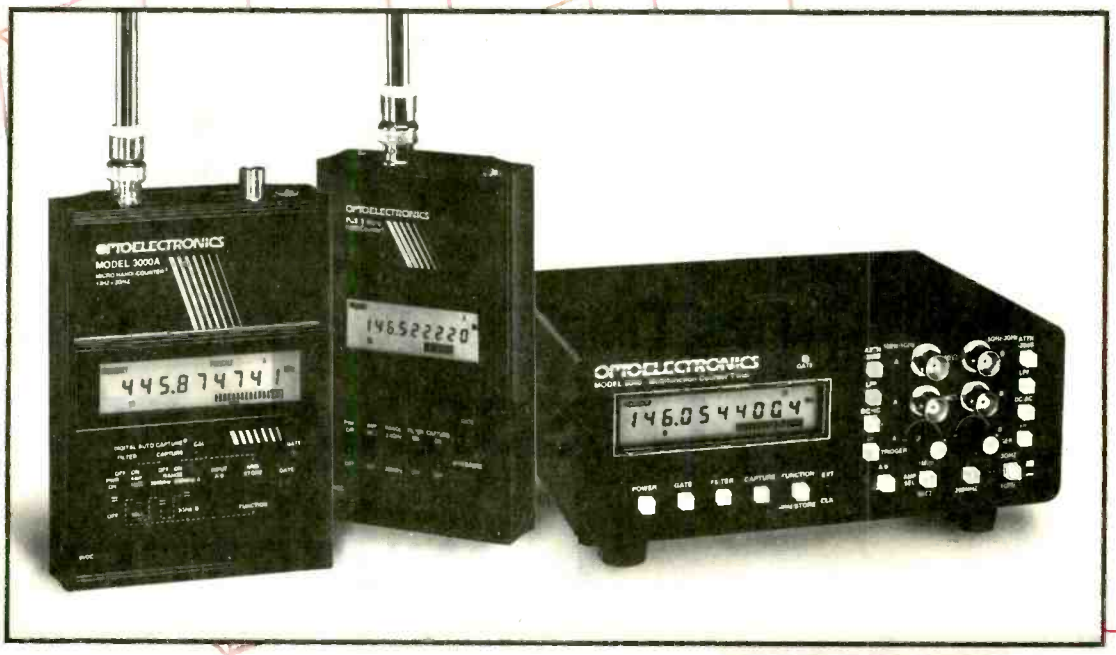

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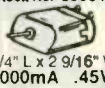

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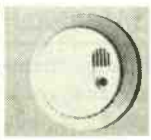

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TYPE or PRINT your classified ad copy CLEARLY (not in all capitals) using the form below. If you wish to place more than one ad, use a separate sheet for the additional ads (a photocopy of this form works well). Choose a category from the list below and write that category number into the space at the top of the order form. If you do not specify a category, we will place your ad under Miscellaneous or whatever section we deem most appropriate.

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.

RATES

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.

CONTENT

All classified advertising in the **PE Market Center** is limited to electronics items only. All ads are subject to the publisher's approval. We reserve the right to reject or edit all ads.

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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.

AD RATES: $1.00 per word, Minimum $15.00.

Send your ads with payment to:
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210 — CB-Scanners
240 — Components
270 — Computer Equipment Wanted
300 — Computer Hardware
330 — Computer Software
360 — Education
390 — FAX
420 — Ham Gear For Sale
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480 — Miscellaneous Electronics For Sale
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17 - $17.00	18 - $18.00	19 - $19.00	20 - $20.00
21 - $21.00	22 - $22.00	23 - $23.00	24 - $24.00
25 - $25.00	26 - $26.00	27 - $27.00	28 - $28.00
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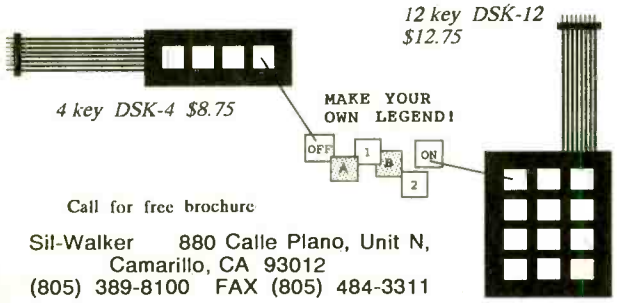

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Worlds smallest FM voice transmitter. Use with any FM broadcast receiver. Easy to assemble, all chip (SMT) parts are pre-assembled to the circuit board.

XST500(E-Z) Kit $44.95

- Smallest Phone transmitter anywhere!
- Tunes 88-108 MHz.
- No batteries required, powered by phone line.
- Up to 3/4 mile range.
- Attach to phone line anywhere in house, even inside phone.

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- 16 levels of voice masking.
- Button for normal operation.
- Complete anonymity on all calls

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STOP THOSE ANNOYING PHONE CALLS! Sound older and tougher when you want to. Not a kit, fully assembled. Single line phone operation only.

TRANSITION 2000 ..... $89.95

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- Use with any modular phone.
- Connects between handset and phone.
- 16 levels of voice masking

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STOP THOSE ANNOYING PHONE CALLS! Sound older and tougher when you want to. Use with single or multi-line phones. Not a kit, full assembled.

TRANSITION 2001 ..... $59.95

- Transmits both sides of phone conversation.
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- Works with any FM broadcast receiver.
- Up to 1 mile range.
- Turns off when phone is not in use to extend battery life.

XTT100 LONG RANGE PHONE TRANSMITTER

Similar to our very popular XSP500, the XTT100 is battery powered for maximum range. It plugs into any phone jack and transmits all calls on that line.

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- Super sensitive, hear every sound in a house!
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- Use with any FM broadcast receiver.
- Up to 1 mile range.
- Powered by 9V battery.

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- Adjustable from 88-108 MHz.
- Up to 1 mile range.
- Works with any FM broadcast receiver.
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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 Countersurveillance 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 businesses 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
P.O. Box 4099 • Farmingdale, NY 11735

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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Amount of payment $_____
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Total enclosed _____
Bill my ☐ VISA ☐ MasterCard
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All payments in U.S.A. funds. Canadians add $4.00 per VHS cassette. No foreign orders.

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.