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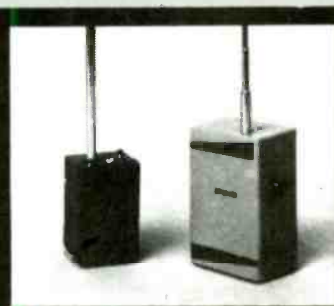

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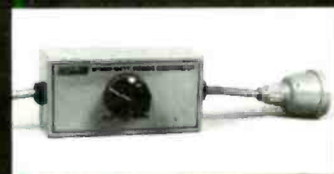

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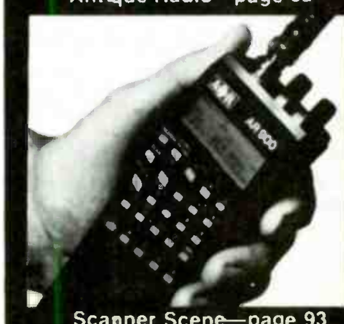

Scanner Scene—page 93

Hands-on Electronics
JANUARY 1989
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Adieu Herb Friedman. . .

Herb Friedman has passed away. Herb was the columnist for our computer column.

I first met Herb 30 years ago when we both were new to magazine publishing. I was on the job only a week or two when this huge man filled the frame of my office door. At first he startled me, but I spotted the smile on his face and a project that he held in his hands. I smiled, and that began a friendship that was never shaken, never encumbered.

I'll never know how many magazines Herb wrote for, but I can name a few: **Popular Electronics, Radio-Electronics**, Electronics Illustrated, Radio-TV News, Electronics World, Elementary Electronics, Popular Mechanics, Popular Science, Mechanics Illustrated, Science and Electronics, Photography, Hi-Fi Stereo Review, Hi-Fi Stereo Buyers Guide, and many computer magazines. I doubt that anyone has had more freelance articles purchased and published than Herb.

HERB FRIEDMAN

One of Herb's greatest loves was to sit at his workbench and produce one- and two-transistor projects that anyone can build in a single evening. As the state of the art advanced, Herb would build single-chip projects as a concession to current trends, but he kept the projects simple. Herb always envisioned a "kid" (as he would call a teenager) building one of his projects. Thus he was concerned that the cost was low, the parts were easily obtainable, and that the circuit was not critical—the project had to work when powered up.

Herb acquired test equipment to build an extensive consumer-electronics testing laboratory. He did considerable product testing in the seventies and became well known to U.S., European, and Japanese audio manufacturers. Many years ago when it was popular to quote extremely small intermodulation figures, Herb ceased doing so because he knew once the numbers fell below a few percent, they were meaningless. The audio industry followed suit a year later.

His private testing laboratory was the first to be capable of testing citizen-band radios for magazine reviews. He began in 1968 and was ready for the CB boom he predicted in the early seventies. Herb made it a practice to test products for magazine reviews only; manufacturers made offers for his service but he turned them down for fear of compromising his reputation for being impartial.

For many years Herb was in the radio and television industry. He started out as the technician who lit the fuse to ignite a pyrotechnic device in an ascending rocket for the Captain Midnight show in the early fifties. He then went to Station WNYE at Brooklyn Technical High School where he spent most of his time at the FM station as an engineer. Herb enjoyed the inquisitive mind of the students at the high school, and thus began his freelance writing career so that he could reach out to the many others who shared the hunger for electronics project building ideas. When he retired from the radio station, Herb went to work for **Radio-Electronics**, our sister publication, as an associate editor. He was more than what his title indicated: Herb was an inspiration to the entire company, especially to the editors of both magazines. He set up our photographic studio so that project and product photos would be of the quality required for our publications.

Herb leaves behind a magnificent family. Nancy, his wife, is a beautiful person, whose comments from time to time contributed to the contents of his articles and this magazine. She is blessed with an uncanny hearing ability that assisted Herb in rating high-fidelity headphones for many years. Celia, his eldest child in an accomplished author. Her science-fiction book is a winner. Larry is first entering the business world after an outstanding college career. He is a superb computer programmer and has had articles published in several consumer magazines.

I will miss Herb. The entire staff will miss Herb. Our readers, especially the emerging experimenters, will miss Herb.

Adieu, Herb Friedman.

Julian Martin

Julian S. Martin

Letters

GIVING CREDIT

As many readers know, the authors of the majority of the articles that appear in **Popular Electronics/Hands-on Electronics** *are not employees of the magazine. Instead, they are freelance authors who do the work on a contractual basis. As part of that contract, the author warrantees that the work is original, and that nothing contained in the article violates copyright laws, or any rights of third parties.*

The point of all of that is that in August, 1988 we published an article "50 Years of Car Antennas" bylined by Edward Janicki. Mr. Janicki signed our standard contract, therefore promising that the work was original, and accepted payment for the article.

We have since received word from SAE, The Society of Automotive Engineers, Inc., that the article was taken nearly verbatim from an SAE paper written by Carlos Altgelt, Ken Duffy, and Clem Rowan of the Ford Motor Company. The paper was presented at the SAE International Congress and Exposition, and was part of an SAE publication titled "Audio Systems for the Automobile." The book and paper were published and copyrighted on February 29, 1988.

We regret that the rightful authors of that excellent article were denied the credit they deserved, and deeply apologize to them and to the SAE for this unfortunate incident.—Editor

SORRY, WRONG NUMBER

We have learned that the toll-free number given in the review of the "Digital Voice Record/Playback Module" in the October 1988 issue was incorrect. The correct number for the kit's distributor, the Tapto Corporation, is 1-800-876-8001.—Editor

CASIO CLARIFICATION

In the September 1988 installment of "Gizmo," the review of the *Casio JE-3* desk-top calculator contains some terms—"RND," "F," "5/4," and "CUT"—which were foreign to me at first. Casio is my favorite manufacturer, and I wish I still had my old *FX-21* with the blue nixie-tube display. I'll buy the batteries rather than strain my eyes on most LCD displays.

In any case, if I understand Casio correctly, the "RND" rounding-off works like this: "F" merely gives you answers without any rounding off, up to 12 digits; "5/4" should give rounded-off answers; and "CUT" should enable you to select how many digits you want behind the decimal point—it shouldn't just limit the user to two, as stated in the article.

S.G.
Caseyville, IL

ANTIQUE RADIO REVAMP

I enjoy reading your column "Ellis on Antique Radio." Last year, I came across an old table-model *Emerson 149*. The unit was in good condition, and contained tubes—6A7, 6D6, 6Q7, 25L6, and 25Z5—and a ballast tube in a metal case. After cleaning it up, I switched it on. The tubes lit up and there was a low hum coming from the electromagnetic speaker.

When I replaced the can filters with two 47-µF, 150-volt tubular capacitors, the hum disappeared; tuning across the band, I got loud whistles. I replaced the screen and AGC-bypass caps and—joy!—at half volume the radio came alive with stations. With the tuning at 620 kHz, I adjusted the IF can trimmers, and the antenna trimmer on the tuning condenser at 1400 kHz.

At that point, the radio was just about perfect. There was a slight distortion that I checked with a VOM; I found + 12.5 volts on pin 5, the control grid of the 25L6. Changing the coupling capacitor—a .022µF unit that was also leaking—cured that fault, and the B+ voltage went up by 10 volts.

Now I'm picking up stations from all over the place with a 9-foot antenna. My advice to fellow restorers is to change all the paper and electrolytic capacitors—they always dry out, leak, or short out.

Can anyone tell me just how old my radio is? Were they making consumer goods *too* good in those days?

H.L.G.
Palm Bay, FL

SNIFFING AROUND

I would like to thank you for providing a great magazine geared toward the hobbyist. I particularly enjoyed building the "RF Sniffer" in the August issue. However, there are some errors in it. LED 1 should be labeled as LED 2, and vice versa; L2 is correctly stated in the parts list to be a 2-mH choke, but the schematic shows it as a 2-µH choke.

Speaking of RF chokes, I would like to see some information on how to read the molded kind. Are they color coded and read the same as resistors? They seem to have more color bands than resistors do. Are they read as microhenry or millihenry?

Incidently, to make the "RF Sniffer" more sensitive, replace the telescoping antenna; cut an 8-inch length of 75-ohm coax; and remove the vinyl sleeve, the outer braid, and the center conductor wire so that all that is

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Volume 6, No. 1

January 1989

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Cover photography by
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Advertising Sales Offices listed on page 106.

Hands-on Electronics including **Popular Electronics**, (ISSN 0743-2968) Published monthly by Gernsback Publications, Inc., 500-B Bi-County Boulevard, Farmingdale, NY 11735. Second-Class postage paid at Farmingdale, NY and at additional mailing offices. One-year, twelve issues, subscription rate U.S. and possessions $21.95, Canada $26.95, all other countries $29.45. Subscription orders payable in U.S. funds only, International Postal Money Order or check drawn on a U.S. bank. U.S. single copy price $2.50.

left is the dielectric material. Wind the entire length with No.26 wire, close wound, and solder it to a male pin connector attached on one end. Cover the length with heat-shrink tubing. You now have a flexible antenna that is much more sensitive than the telescoping kind. Attach the female pin connector to the case, and it becomes removable.

M.B.
Van Nuys, CA

Molded chokes do share their color-code scheme with resistors, although there are some differences in the way the two are read. For exact information on how to read molded chokes, see the ARRL Handbook's *chapter on Construction Practices and Data Tables; if you don't own a copy of the* Handbook, *one is available at most local libraries. Also, a FactCard on inductors, including RF chokes, is planned for later in the year.*

HAVES AND NEEDS

I recently purchased a used Bearcat 300 scanner. The instruction manual was missing. Can anyone advise me on where to find one?.

Ron Fite
1205 East 25th St.
San Bernardino, CA 92404

I have a Dumont handheld FM radio receiver; it is a type DH300, Model N33H, from Hammarlund Mfg. Co., Inc. in Marshill, NC. I've written to that company, but I didn't get an answer. Can anyone help me find a schematic diagram and any other information on that receiver?

Ernest Wurfer
741 San Diego Ave.
Sunnyvale, CA 94086

Perhaps you can help me. I just recently got my hands on a Lewytt RC77/GRC9 U.S. Army Corps Field Radio with no manual. It's a transceiver tube-type radio; I'm not sure how old it is. I'm looking for the correct operating voltage, and, of course, a manual for it.

Andrew Bowlby
4700 Highland Ave.
Downers Grove, IL 60515

CHECK YOUR FACTS

Having just purchased my first copy of **Popular Electronics**, I can truthfully say that it seems to be a good publication for anyone who enjoys working or playing in electronics.

I'm writing to point out some information that is inaccurate due to the omission of some data. "FactCard 85," concerning the 4514 IC, states in "Features" that the 4514 is a "Plug-in replacement for MC14514, MC14515." That is far from the truth. To make the data complete and true, it should include the 4515. That is because, according to specs, when the chip is selected the output of the 4514 goes HIGH and when the 4515 is selected the output goes LOW. It's something like saying that they are the same breed, but different sexes.

C.R.D.
Aurora, CO

A SIZABLE MISTAKE

While building the "Speech Processor" from the October 1988 issue of **Hands-on Electronics**, I discovered that the board size is wrong. First, I made a transparent copy at $5^{3}/_{4}$-inches as the article said. Following the parts-placement diagram, I aligned each chip over the corresponding chip diagrams. But my copy—that complied with the directions in the article—was too big! I reduced the size from $5^{3}/_{4}$-inches to $4^{5}/_{8}$-inches, and everything lined up correctly.

S.P.
Chicago, IL

You are correct. Due to a reproduction error, the board that was prepared for publication, and measured for the article, was roughly 20% oversized. The proper dimension is indeed $4^{5}/_{8}$ inches. ■

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LM301	.34	TL494	4.20	MC3470	1.95
LM309K	1.25	TL497	3.25	MC3480	8.95
LM310	1.75	NE555	.29	MC3487	2.95
LM311	.59	NE556	.49	LM3900	.49
LM311H	.89	NE558	.79	LM3909	.98
LM311K	3.49	NE564	1.95	LM3911	2.25
LM312H	1.75	LM565	.95	LM3914	1.89
LM317T	.69	LM566	1.49	LM3915	1.89
LM318	1.49	LM567	.79	MC4024	3.49
LM319	1.25	NE570	2.95	MC4044	3.99
LM323K	3.49	NE590	2.50	RC4136	1.25
LM324	.34	NE592	.98	RC4558	.69
LM331	3.95	LM723	.49	LM1360	1.49
LM334	1.19	LM733	.98	75107	1.49
LM335	1.79	LM741	.29	75108	1.49
LM336	1.75	LM747	.69	75110	1.95
LM338K	4.49	MC1330	1.69	75150	1.95
LM339	.59	MC1350	1.19	75154	1.95
LF347	2.19	LM1458	.35	75188	1.25
LF353	.59	LM1488	.49	75189	1.25
LF356	.99	LM1489	.49	75451	.39
LF357	.99	LM1496	.85	75452	.39
LM358	.59	ULN2003	.79	75477	1.29

HIGH SPEED CMOS LOGIC

74HC00	.21	74HC244	.85	74HCT138	.35
74HC04	.25	74HC245	.85	74HCT139	.55
74HC08	.25	74HC273	.69	74HCT157	.59
74HC14	.35	74HC367	.69	74HCT161	.79
74HC32	.35	74HC373	.69	74HCT240	.89
74HC74	.35	74HC390	.79	74HCT244	.89
74HC138	.45	74HC374	.69	74HCT245	.99
74HC139	.45	74HC4040	.89	74HCT273	.99
74HC154	1.09	74HCT00	.25	74HCT373	.99
74HC157	.55	74HCT04	.27	74HCT374	.99
74HC161	.65	74HCT08	.25	74HCT393	.99
74HC164	.65	74HCT32	.27	74HCT4040	.99
74HC175	.59	74HCT74	.45	74HCT4060	1.49

STANOARO CMOS LOGIC

4001	.19	4028	.65	4069	.19
4011	.19	4040	.69	4070	.29
4013	.35	4042	.59	4081	.22
4015	.29	4044	.69	4093	.49
4016	.29	4046	.69	14411	9.95
4017	.49	4047	.69	14433	14.95
4018	.69	4049	.29	14497	6.95
4020	.59	4050	.29	4503	.49
4021	.69	4051	.69	4511	.69
4023	.25	4052	.69	4518	.85
4024	.49	4053	.69	4528	.79
4025	.25	4060	.69	4538	.95
4027	.39	4066	.29	4702	9.95

7400 SERIES LOGIC

7400					
		74121	.29	74F240	1.29
7400	.19	74123	.49	74S00	.29
7402	.19	74125	.45	74S02	.29
7404	.19	74150	1.35	74S04	.29
7406	.29	74151	.55	74S08	.35
7407	.29	74153	.55	74S10	.29
7408	.24	74154	1.49	74S32	.35
7410	.19	74157	.55	74S74	.49
7411	.25	74159	1.65	74S86	.35
7414	.49	74161	.69	74S112	.50
7416	.25	74164	.85	74S124	2.75
7417	.25	74166	1.00	74S138	.79
7420	.19	74175	.89	74S153	.79
7430	.19	74367	.65	74S157	.79
7432	.29			74S158	.95
7438	.29	**74F/74S**		74S163	1.29
7442	.49	74F00	.35	74S175	.79
7445	.69	74F02	.35	74S195	1.49
7447	.89	74F04	.35	74S240	1.49
7473	.34	74F08	.35	74S241	1.49
7474	.33	74F10	.35	74S244	1.49
7475	.45	74F32	.35	74S280	1.95
7476	.35	74F64	.55	74S287	1.69
7483	.50	74F74	.39	74S288	1.69
7485	.59	74F86	.55	74S299	2.95
7586	.35	74F138	.79	74S373	1.69
7489	2.15	74F139	.79	74S374	1.69
7490	.39	74F253	.89	74S471	4.95
7493	.35	74F157	.89	74S571	2.95

CIRCLE 12 ON FREE INFORMATION CARD

CIRCLE 13 ON FREE INFORMATION CARD

Electronics Library

To obtain additional information on the books and publications covered in this section from the publisher, please circle the item's code number on the Free Information Card

AUTOLISP IN PLAIN ENGLISH: A Practical Guide for Non-Programmers

by George O. Head

This book introduces readers to the fundamentals of AutoLISP, AutoCAD's powerful internal programming language. A basic knowledge of AutoCAD is assumed. The book is designed as a learning tool, to be read and used in front of a computer. After reading it, even beginners should be able to create simple AutoLISP programs to modify AutoCAD drawing commands, access and revise drawing entities, create simple geometric constructions, and curtail repetitive drawing tasks.

Essential AutoLISP commands, functions, and programs are taught, and tips and tricks for basic programming, testing, and debugging are presented. Readers learn to use AutoLISP effectively, to solve everyday drawing problems. AutoLISP programs, accompanied by line-by-line explanations of each command, are featured throughout the book, and illustrate the lessons taught in the text. The last chapter contains 12 routines designed to dramatically increase productivity when using the AutoLISP language. Those routines are also available on an optional diskette.

AutoLISP in Plain English: A Practical Guide for Non-Programmers is available for $27.95 from Ventana Press, P.O. Box 2468, Chapel Hill, NC 27514.

CIRCLE 80 ON FREE INFORMATION CARD

COMPLETE GUIDE TO RS232 AND PARALLEL CONNECTIONS

by Martin D. Seyer

This guide presents a unique approach to connecting computers and peripherals. It uses tutorial "modules" that are designed to illustrate virtually any possible connection using serial and parallel interfaces. The reader learns to connect scores of devices together; computers, modems, terminals, and printers are covered.

The book's methodical approach offers the reader a "profile" that can be used to analyze a port on a device and determine its compatibility with other devices. The reader can easily and quickly connect any number of different devices together by simply filling out the "port profiles" for those devices and following the straightforward steps and tools provided in the book.

Pinouts for over 300 serial computers and peripherals, supplied by the vendors, are included in one appendix. Cable diagrams for serial connectors, printer- and terminal-escape sequences, connection symptoms and solutions, steps for connection, rules for cable design, and intelligent modem commands are included in some of the other useful appendices.

Complete Guide to RS232 and Parallel Connections is available for $27.95 in softcover, or $42.00 in hardcover, from Prentice-Hall, Inc., College Division, Englewood Cliffs, NJ 07632.

CIRCLE 99 ON FREE INFORMATION CARD

USING MS-DOS

by Kris Jamsa

Time is a limited and valuable commodity these days. With that in mind, this guide to MS-DOS aims to quickly teach the most effective—thus, time-saving—use of computers. Rather than getting bogged down with long words in even-longer chapters, the book is arranged in individual lesson plans that can be easily completed in 15 minutes at the computer.

That is not to say that the complexities of MS-DOS are neglected. However, by the time the reader reaches the advanced sessions—covering such topics as DOS I/O redirection, customizing the system, and using advanced system commands—he will have enough background knowledge of the basics—DOS commands, Edlin, file management, batch processing, and backup—to grasp the concepts presented.

That step-by-step learning process is designed to build the user's confidence with each concept that is mastered. Each session concisely explains a fundamental concept, and gives examples, illustrations, and hands-on exercises as well. There is also a chapter summary and a glossary of any new terms that have been presented. Finally, the book offers a comprehensive command-reference section with definitions of functions accompanied by specific examples.

Using MS-DOS is available for $22.95 from Osborne McGraw-Hill, 2600 Tenth Street, Berkeley, CA 94710.

CIRCLE 96 ON FREE INFORMATION CARD

THE COMPLETE COMMUNICATIONS HANDBOOK

by John C. Sans Jr.

Telecommunications is the fastest-growing area of personal computing today. It gives the user access to world-wide information at his fingertips, in his home. It all but removes the "information float"—the time it takes for information to travel from source to end-user; stock-market quotes, for example, can be obtained immediately via telecommunications.

This guide to telecommunications shows readers how to use their computers, modems, and telephones for at-home shopping and research; and to get up-to-the-minute financial, travel, and entertainment information. It traces the development of telecommunications from the telegraph to

the high speed digital equipment in use today. Communications technology, including micro-to-mainframe links, local-area networks, multi-user systems, telephone-switching techniques, and error detection and correction, is explained in clear text and with numerous illustrations. The book details the basic components comprising personal-computer communications systems—terminals, modems, serial-interface cables, and telephones.

(Continued on page 12)

Electronics Library

(Continued from page 8)

This practical guide shows readers what to look for in communications software and hardware. It includes prices, special features, and the names and addresses of manufacturers of each product. It also gives all the necessary information for accessing on-line information services such as bulletin-board systems, information utilities including CompuServe and The Source, and many electronic-mail services.

The Complete Communications Handbook is available for $12.95 from Wordware Publishing, Inc., 1506 Capital Avenue, Plano, TX 75074.

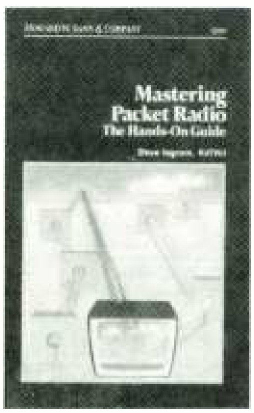
CIRCLE 81 ON FREE INFORMATION CARD

MASTERING PACKET RADIO: The Hands-on Guide

by Dave Ingram, K4TWJ

Packet radio—the technique of breaking down information into small pieces ("packets") and transmitting them over amateur radio—is a rapidly expanding field. This easy-to-understand guide to packeting is intended to put amateur-radio enthusiasts on the cutting edge of the digital-communications revolution.

The book examines packet-radio technology and capabilities, from simple concepts to more technical subjects. It offers precise explanations of what packet is, how it works, why it is used, and the hardware involved. Readers will learn about the roles of home computers and data-communications terminals, and how to set up their own packet stations.



Information is included on packet networks, bulletin boards, HF-linking concepts, Oscar satellites, and electronic mail. There is a survey of amateur equipment for packet radio, and tips for newcomers and veteran amateur-radio enthusiasts alike on being a good "packeteer." Finally, the author looks ahead to the future of packet radio, including digital audio and video, and the evolution of the amateur-satellite program.

Mastering Packet Radio: The Hands-on Guide costs $12.95, and is available at bookstores, computer stores, electronics distributors, or from Howard W. Sams & Company, 4300 West 62nd St., Indianapolis, IN 46268; Tel. 800-428-SAMS.

CIRCLE 95 ON FREE INFORMATION CARD

BOB MIDDLETON'S HANDBOOK OF ELECTRONIC TIME-SAVERS AND SHORTCUTS

by Robert G. Middleton

Packed with dozens of little-known tricks of the trade, new testing techniques, and time-saving shortcuts, this 378-page handbook will make it easier to troubleshoot television, radio, CB, tape-recorder, intercom, audio, CCTV, telephone, and digitally controlled equipment.

The book explains how DC voltages can be added or subtracted with a voltmeter, how a digital-voltmeter temperature probe can be especially useful in analyzing digital-IC temperature "signatures," and how a DC voltmeter can be converted into a high-performance dynamic ohmmeter that automatically measures the internal resistance of "live" circuits. It describes how to use a DC voltage monitor as a DC current monitor, make a sensitive test for amplifier distortion with a DC voltmeter, and measure DC voltages in very-high impedance circuitry using a two-DVM method that draws no current from the circuitry under test.

There are instructions for building a simple voltage-controlled audio oscillator that permits the use of a tape recorder as a DC voltage monitor, automatic internal-resistance ohmmeters, and modified-emitter followers with zero-insertion loss. The book discusses controlled-timbre tests and digital-logic troubleshooting ground rules, with examples of oscilloscope applications. It describes a simple arrangement for using a tape recorder as a digital data-memory storage unit, and cites the causes of circuit loading when a meter is applied in a comparatively high-resistance circuit.

With step-by-step instructions and detailed illustrations, the handbook is easy to use. It presents quick tests and testing tips, professional advice on how to get the most from new electronic test equipment, and new ways to use conventional test equipment. Many new servicing techniques were specially developed for this book.

Bob Middleton's Handbook of Electronic Time-Savers and Shortcuts is available for $16.95 from Prentice Hall, Business and Professional Publishing, Englewood Cliffs, NJ 07632.

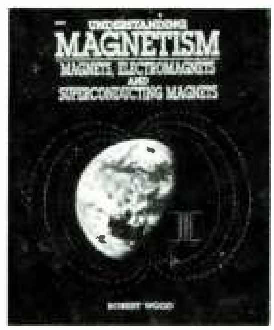
CIRCLE 99 ON FREE INFORMATION CARD

UNDERSTANDING MAGNETISM: Magnets, Electromagnets, and Superconducting Magnets

by Robert Wood

While scientists try to decipher its mysteries, people are using magnetism every day, unaware of the scope of its influence on their lives. That invisible force of attraction is one of the fundamental forces in the universe. This book examines magnetic phenomena, and the relationship between magnetism and electricity.

The history of magnetism—from the discovery of the loadstone, to scientific pioneers ranging from Hyppolyte Pixii through Joseph Henry, Wilhelm Weber, James Clerk Maxwell, and Nikola Tesla—is covered. The book defines magnetism and geomagnetism. It explains natural magnetic phenomena such as the Northern Lights and magnetic effects on the weather. It covers ferromagnetic, paramagnetic, and diamagnetic materials, and how they are used.



The book also describes the ways magnetism is used in homes and industry. It illustrates DC circuits and introduces basic semiconductors, coils, and electromagnets; basic AC circuits and transformers are covered as well. The book discusses how magnetism is used in everything from doorbells to particle accelerators.

Some simple experiments will underscore the principles learned from the text. Those include a compass, an electromagnetic relay, a galvanometer, a transformer, and an electric lock. The projects presented—an electric motor, a steam engine, and an electromagnetic-repulsion coil—are fully illustrated and contain complete parts lists.

Understanding Magnetism: Magnets, Electromagnets and Superconducting Magnets is available for $10.95 from Tab Books Inc., Blue Ridge Summit, PA 17294-0850; Tel. 1-800-233-1128.

CIRCLE 98 ON FREE INFORMATION CARD

HANDBOOK OF VIDEO CAMERA SERVICING AND TROUBLESHOOTING TECHNIQUES

by Frank Heverly

By the end of this book, readers will be expert in the repair and alignment of today's single-tube video cameras, and in how to build a profitable TV-camera service business. Complete operational data details the inner workings of video cameras. The step-by-step techniques needed to troubleshoot and service a wide range of video cameras are accompanied by over 400 charts, diagrams, illustrations and photographs.

The handbook shows how video cameras work; how to accurately pinpoint the trouble when they malfunction; how to remove, re-install, align, and adjust the pickup tube; and how to deal with customers. Beginning with a basic description of every type of design of today's video cameras and how they work, the book goes on to describe, in full detail, the individual parts, circuits, and components that comprise video cameras. There are hundreds of shortcuts for troubleshooting, repair, and alignment. Also included are listings of sources for test equipment, special tools, and additional reference material, as well as a glossary of terms and abbreviations.

Handbook of Video Camera Servicing and Troubleshooting Techniques is available for $16.95 from Prentice-Hall, Inc., Business and Professional Division, Englewood Cliffs, NJ 07632.

CIRCLE 99 ON FREE INFORMATION CARD

HIGHER MATH FOR BEGINNERS

by Ya. B. Zeldovich and I.M. Yaglom

This introductory text book—written by a Russian mathematician and physicist, and published in the Soviet Union—presents mathematics as an integral part of the natural sciences. It concentrates on concrete mathematical solutions to scientific problems without getting mired in the formal foundations and logical subtleties that confound many beginners in higher math. In doing so, the authors intend to transform mathematics from a dry, difficult subject to one of clear and natural concepts.

While aimed at newcomers to higher mathematics—advanced high-school, vocational, and college students—the book is not simplistic. Along with traditional topics including analytic geometry and differential and integral calculus, it introduces the notions of power and trigonometric series, and examines simple differential equations. It contains hundreds of examples and calculations; some are examined from more than one angle and many are accompanied by the history of the theories presented. A discussion of the essence of higher mathematics and its possible applications in physics and engineering is followed by examples involving specific physical problems within those disciplines.

The 560-page book contains an extensive section on two mathematical trends that expand and generalize the classical differential and integral calculus—complex numbers and functions of a complex variable, and generalized functions. Finally, there is a discussion of scientific trends that use higher mathematics, intended to arouse the reader's curiosity and to encourage further study.

Higher Math for Beginners is available for $51.00 from Prentice-Hall, Inc., College Division, Englewood Cliffs, NJ 07632.

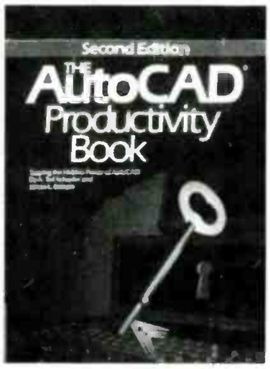
CIRCLE 99 ON FREE INFORMATION CARD

THE AUTOCAD PRODUCTIVITY BOOK (Second Edition)

by A. Ted Schaefer and James L. Brittain

"Productivity" is the key word here. Readers learn to "work smarter" by using AutoCAD as more than just an electronic drawing board—and increase their personal satisfaction, job security, and productivity in the process.

The AutoCAD Productivity Book helps professionals tap the subtleties beneath the surface of AutoCAD that can make it a powerful new tool with more speed, power, and performance. It also details how to achieve company-wide linkage, and integration of AutoCAD with engineering, sales, purchasing, manufacturing, and desktop publishing.



Beginning, intermediate, and advanced users learn how to tailor AutoCAD to their specific design needs. The tutorial section—aimed mainly at novices and intermediate users—gives step-by-step directions on using macros and the powerful AutoLISP program, creating and modifying screen and tablet menus, and automating drawings. This second edition contains two added chapters on how to customize AutoCAD Release 9's new pop-up menus, and on tips and tricks that boost speed and drawing power.

In addition, many sophisticated AutoLISP routines have been included in the "AutoCAD Productivity Library" section. The 70 carefully selected AutoLISP routines and time-saving macros that are presented in that section illustrate the features and power of customization, giving users more insight into AutoCAD's powerful programming language. Novices are strongly advised to read the tutorial section thoroughly before delving too deeply into the "AutoCAD Productivity Library."

The AutoCAD Productivity Book: Second Edition is available for $39.95 from Ventana Press, P.O. Box 2468, Chapel Hill, NC 27515.

CIRCLE 80 ON FREE INFORMATION CARD

USING THE MODELS 50 & 60

by Herbert Schildt

This guide to IBM's new machines in the Personal System/2 series contains all the information necessary to handle the Models 50 and 60 effectively.

The book's first section, though intended primarily for beginners, contains some interesting facts about the history of those machines. It goes on to discuss their basic components, define several fundamental computer terms, and to explain how to start the computer and use the Reference Diskette.

Users of the Models 50 and 60 have a choice of operating systems, and this book contains extensive sections on both the current standard, DOS, and the powerful new OS/2. There is a brief discussion of their similarities and differences, and the advantages and disadvantages of each. The DOS section has an introduction to its basic features, and proceeds to commands, system configuration, and advanced DOS features. For the OS/2 user, the book explores multitasking, the program selector, and other OS/2 features.

Hardware specifics are also covered in detail, with the emphasis on *how* things work. Memory, 80286 specifics, interrupts, disk drives, keyboard, video, and printers are described.

Using the Models 50 & 60 costs $21.95. It is available from Osborne McGraw-Hill, 2600 Tenth Street, Berkeley, CA 94710.

CIRCLE 96 ON FREE INFORMATION CARD

THE ROBOT BUILDER'S BONANZA: 99 INEXPENSIVE ROBOTICS PROJECTS

by Gordon McComb

This educational, yet fun, book takes a modular "cookbook" approach to robot building. It offers a unique collection of fully tested project modules that can be mixed and matched in countless combinations. The reader's imagination is the other ingredient required for the creation of highly intelligent, one-of-a-kind, working robots.

The projects, which include all the information needed to construct the basic building blocks of any personal robot, are geared to novice and intermediate robotics enthusiasts. Included are various modules for the body and frame, power and locomotion, appendages, "facial" features, navigation, and electronic control. The reader can combine various modules into different configurations to create rolling, walking, or talking robots—robots that can serve drinks, vacuum the floor, protect the family against fire or theft, or teach the children.

The book suggests alternate approaches and sources of electronic and mechanical components. Most of the circuits use discount-priced, surplus ICs that are easy on the builder's budget. Along with illustrations, schematics, diagrams, and parts lists for each module, the book provides a listing of necessary tools and equipment, a guide for matching up TTLs and ICs, and drill-bit and bolt chart, and computer programs that are useful in robotics.

The Robot Builder's Bonanza: 99 Inexpensive Robotics Projects costs $14.95. It is available from Tab Books Inc., Blue Ridge Summit, PA 17294-0850; Tel. 1-800-233-1128.

CIRCLE 98 ON FREE INFORMATION CARD

62 HOME REMOTE CONTROL AND AUTOMATION PROJECTS

by Delton T. Horn

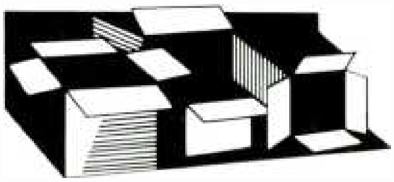
Even readers with no previous electronics experience will find useful projects that they can build and put to use at home. The devices in this book were designed to make life safer, more convenient, and more fun.

A wide array of door and window controllers, stereo and TV projects, timers, electronic-switching units, wireless controllers, telephone-related projects, and a computer controller with programming information are presented. Specific projects include an automatic guest-greeter, sensors to keep heat and air-conditioning at ideal levels, a remote-controlled "commercial killer" for the TV, and voice-activated transmitters and relays.

Before getting into project-building, there is a simple, but thorough introduction to how remote-control and automation systems actually work. Advice on safety precautions, finding parts, substitution of components, and techniques for customization is also presented in the first few chapters. Then, for each device, the author supplies complete instructions, wiring diagrams, and illustrations.

62 Home Remote Control and Automation Projects is available for $12.95 from Tab Books Inc., Blue Ridge Summit, PA 17294-0850; Tel. 1-800-233-1128. ■

CIRCLE 98 ON FREE INFORMATION CARD



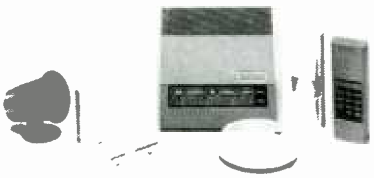
New Products

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

TALKING SECURITY SYSTEM

The *Dicon 9000* wireless security system verbally instructs the user on how to program and test the system. It also vocally reports which sensor has triggered an alarm, verifies that transmitters are within receiving range, and reports when transmitter or console-backup batteries require replacement.

Easily installed by consumers, the system fully integrates security, fire, medical, and other emergency monitoring, using a variety of sensing devices with miniature transmitters. The central console is about the size of a telephone-answering machine. It has a built-in automatic telephone dialer that is capable of calling eight local or long-distance numbers and relaying an emergency message in the user's own voice.



If an emergency occurs, the console determines whether a security, fire, or medical alarm has been triggered. It will automatically place an emergency call to the appropriate pre-programmed number or numbers. An electronic voice announces to the answering party: "Medical Emergency" or "Fire Emergency" as appropriate, then delivers the user's own message. Each message is repeated three times before the console hangs up and dials the next emergency number.

Codes, rather than conventional keys, are used to arm and disarm the software-based system. (Authorized visitors can be provided with a temporary "visitor code.") Different monitoring and alarm modes are used when the occupants are at home or away. Up to four separate security zones can be created, allowing selective monitoring of sensors. There is an instant panic alarm for emergencies.

The Dicon 9000's digital signal-coding system and sensors are made with surface-mount components resulting in compact size, and improved quality and reliability. It is designed so that even close neighbors can use it without interfering with each other's systems.

The basic Dicon 9000 package consists of the console, two magnetic window door switches with transmitters, a speaker siren with a 50-foot cord, an AC-power adapter, a modular-telephone cord, an extended-range antenna, and window decals. Optional accessories—full-function remote controls, infrared motion detectors, personal- or medical-emergency pendants, smoke alarms, additional window and door switches and indoor sirens, and a weatherproof outdoor siren—are available. Temperature sensors and propane/natural gas detectors will be available in late 1988.

The Dicon 9000 package, including all hardware and installation materials and an operator's manual with diagrams of suggested sensor placement, costs $494.00. For additional information, contact Dicon Systems Inc., 631 Executive Drive, Willowbrook, IL 60521; 1-800-387-2868.

CIRCLE 69 ON FREE INFORMATION CARD

MOVING-COIL HEADPHONES

Signet's EP400 is a moving-coil design stereo headphone that delivers peak-free response and accurate reproduction at both ends of the spectrum. A high-flux Samarium cobalt magnet and oxygen-free silver/copper wire are used for the voice-coil winding. Oxygen-free copper is used in the 10-foot audio cord to provide maximum conductivity and minimal signal loss, and to yield extended dynamics and distortion-free sound. Its frequency range is from 20 Hz to 22,000 Hz.

The headband and earpads are comfortable even during extended periods of use. The adjustable double-headband system combines strength and rigidity with even weight distribution. Mesh-covered foam earpads—mounted with a dual-swivel system—allow adjustments for individual head shape, and provide good performance with the greatest degree of comfort. Strain-relief pieces at the earpads and plug assure durability and trouble-free operation.

The EP400 headphones cost $100.00. For further information, contact Signet, 4701 Hudson Drive, Stow, OH 44224.

CIRCLE 70 ON FREE INFORMATION CARD

WORDPREFECT LEARNING TOOL

PC Template's PerfectPal version 5.0 is an updated version of their productivity tool, and is designed to make WordPerfect easy to learn and use. When used with WordPerfect versions 4.1, 4.2, or 5.0, the system of more than 375 simple-to-call, pre-coded macros allows users to greatly reduce the number of key strokes needed for even the most complex—and seldom mastered—WordPerfect functions. The package also includes 50 pre-formatted page-style setups and a guide to WordPerfect's keystrokes.

The system offers mnemonic key strokes that are named for every WordPerfect Command ("P" for print, "BOX" for box/line drawings, etc.), allowing even novices to advance quickly through word-processing commands without constantly referring to the manual. More than half of the macros feature pop-up tips, prompts, and instructions.

PerfectPal version 5.0 commands include moving/copying text in two key strokes, one-stroke tab sets, pre-set sorts and fonts, easy merge, and simplified math and desk-top publishing. All those, and more, are accomplished in one or two keystrokes instead of struggling through layers of menus. Other complex tasks—including columns, cross-references, and lists—are also pre-coded. Pop-up instructions help the user master setting up tables of contents, indexes, book chapters, and graphic images.

PerfectPal can automatically map the keyboard with special science or math signs, or foreign-language characters. With one macro, it can change the keyboard to Spanish, for example, and back to English again with another macro. Specific routines for the legal profession are also included.

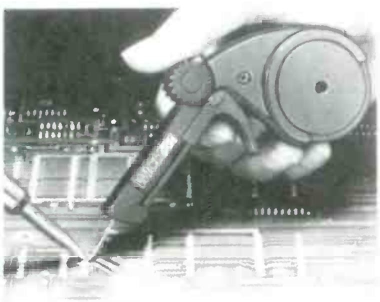
The PerfectPal package—including two system disks, two 3- by 18-inch plastic-coated templates displaying commands, and a user's manual—costs $79.00. For more information, contact PC Template, P.O. Box 9273, Glendale, CA 91206; Tel. 1-800-451-6086.

CIRCLE 71 ON FREE INFORMATION CARD

DESOLDERING GUN

Xuron's WickGun desoldering system removes solder from PC boards and other electronic devices 3 to 5 times faster than the conventional use of braid. The tool makes the dispensing, positioning, and cutting of desoldering braid a one-handed operation.

The WickGun accurately dispenses the desired length of desoldering braid. When heat is added with a soldering iron the melted solder is drawn up into the exposed braid. The solder-impregnated braid is easily cut off by squeezing the trigger. The desoldered area is left clean and free of contaminants such as finger oils. That improves future solderability. The WickGun also acts as a heat shield to prevent burned fingers.



The unit is made of static-dissipative materials, in keeping with current ESD-control practices. Easy-loading replacement-braid cartridges are available in 15-foot lengths in sizes 1 through 4. The cutting blades are also replaceable.

The WickGun has a suggested list price of $39.95. The replacement-braid cartridges cost $4.95 each for sizes 1 through 3, and $5.25 for size 4. For more information, contact Xuron Corporation, Saco Industrial Park, 60 Industrial Park Road, Saco, ME 04072.

CIRCLE 72 ON FREE INFORMATION CARD

FLOPPY-DISK FILES

Curtis' line of floppy-disk files are made of CTE acrylic copolymer—a new plastic featuring high levels of durability, resilience, and scratch and crack resistance. The files offer maximum protection for delicate floppy disks.

The Curtis 5¼-inch and 3½-inch disk files have adjustable dividers with color-coded labels, carrying handles, and anti-skid feet to anchor them securely to any desk top. They hold 50 and 40 disks, respectively. Snap-lock models and units featuring an all-steel security lock with two keys are available in each size. Every disk file has an outside shelf designed to hold two or three working diskettes.

The Curtis 3½- and 5¼-inch disk files cost $12.95 each with security lock, and

$9.95 each with snap lock. For more information, contact Curtis Manufacturing Company Inc., 30 Fitzgerald Drive, Jaffrey, NH 03452.

CIRCLE 73 ON FREE INFORMATION CARD

TWO-WAY PORTABLE RADIOS

The *Regency Plus HH Series* of die-cast two-way portable radios are durable and dependable, yet lightweight. With die-cast metal mainframes, the portables are rugged under working conditions.

The HH Series is available in three bands. In UHF, the *HH 464 D2* and *HH 464 D4* have four watts of power and two- or four-channel capability. In VHF High Band, the *HH 154* and the *HH 156* feature 4 or 6 watts of power, switchable to 1 watt, and up to six-channel capability. The series is rounded out by the *HH 505*, with 5 watts of power and four channels in Low Band.

The crystal-controlled radios are adaptable to radio common carrier and to systems with all standard-EIA subaudible (CTCSS) tones, two-tone sequential, and various other signalling formats. All models carry a 2-year limited warranty.

The suggested retail prices for models HH 464 D2 and HH 464 D4, are $569.00 and $615.00, respectively. Models HH 154 and HH 156 cost $459.00 and $550.00, respectively. Model HH 505 sells for $549.00. For further information, contact Regency Land Mobile, Inc., 7707 Records St., Indianapolis, IN 46226.

CIRCLE 74 ON FREE INFORMATION CARD

PORTABLE OSCILLOSCOPE

Tektronix' Model 2247A portable oscilloscope, aimed at the digital-design and field-service markets, features a counter/timer, automatic rise/fall-time and propagation-delay measurements, and other extended measurement capabilities. The 100-MHz, 4-channel scope provides auto setup, on-screen cursors, and up to 20 pre-programmed measurements.

The unit features 11 automatic voltage and time measurements. In addition to rise/fall-time and propagation-delay measurements, the 2246A's built-in counter/timer provides delta time, gated-counter measurements, and frequency-ratio measurements. The oscilloscope offers several gated measurements that allow the user to choose portions of the waveform for closer analysis. Users can also make measurements on

the delayed sweep; by simply positioning the scope's cursors on the expanded waveform, the numeric value appears on screen.

Operator prompts and on-screen error messages guide users through the proper setup and measurement procedures. There are prompts for proper AC or DC settings, and for proper control settings,

(Continued on page 22)

NOTHING COMES EASY

By Jack Schmidt

"M'Lord, I can't pick up not a thing on my stereo headphones in here."

"When I said that we are dealing with 'limited memory', I was not talking about the computer, I was talking about you!"

"Oh Mr. Communicator, I don't think you're putting out enough power!"

"Melvin, is it true you bought an exercise bike for your robot?"

"Byron, the computer company sent the retrofit instructions on a floppy disk."

New Products

(Continued from page 18)

such as triggering and sensitivity levels. The scope features smooth, menu-driven operation; automatic, one-button front-panel setups; and the ability to store and recall as many as 20 setups. *SmartCursors* track changes in the voltage, trigger, and ground level of the displayed waveform, shortening the setup time for single-shot triggering and peak-voltage, DC, and other measurements.

The 2247A portable oscilloscope, with a 3-year warranty on labor and parts (including CRT), has a suggested list price of $2795.00. For further information, write on company letterhead to Tektronix, Portable Test Instruments Division, P.O. Box 1700, Beaverton, OR 97077; or call 1-800-426-2200.

CIRCLE 75 ON FREE INFORMATION CARD

WRIST-STRAP CHECKER

Wrist straps often fail to provide a constant path from the wearer to ground. Such failures can be caused by a loose strap, oil or creams on the skin, open resistors in the molded cord, poor contact of snaps from the band to the cord, or poor grounding of the strap to an earth ground.

Wescorp's WSC-110 Wrist Strap Checker is designed to assure the wrist-strap wearer of continuity, from the banana plug at one end to the wearer's hand at the other. To check for continuity, the wearer

simply plugs it in at the banana jack, or clips it on the post or snap provided with the unit, and touches the contact bar on the face of the instrument. A series of indicators include a high-reading light (over 10 megohms series resistance), a low-reading light (under 1.0 megohms resistance) and a "pass" light plus audible signal to indicate satisfactory operation. A "low battery" light indicates when to change the 9-volt battery.

The WSC-110 Wrist Strap Checker costs $85.00. For more information, contact Wescorp, 144 South Whisman Rd., Mountain View, CA 94041; Tel. 800-537-7828 (415-969-7717 in California).

CIRCLE 76 ON FREE INFORMATION CARD

DIAMOND-SCRIBING TOOL

Minitool's #PV-078 Pin Vise Handle has tiny—0.5mm (.020-inch), and 0.25mm (.010-inch)—tip sizes. It can be used for repairing thin film circuits, micro circuits, and fine-line PC boards and integrated circuits. Other applications include scribing under a microscope, and precision scribing.

The high-precision pin-vise handle includes a collet adapter for use with those diamond-scribe tips. It also comes with a standard collet for use with knives and special tools from 1.5mm to 2.3mm in size. The non-roll handle offers a precision drawbar, ridged finger grip, and low-friction bronze bushing.

The #PV-078 Pin Vise Handle costs $14.95. The .5mm tip, #PV-078-U, costs $9.95, and the .25mm tip, #PV-078-U2, costs $14.45. For more information, contact Minitool, Inc., 1334/F Dell Avenue, Campbell, CA 95008.

CIRCLE 77 ON FREE INFORMATION CARD

TWO-PORT RS-422 INTERFACE

MetraByte's DUAL-422 two-channel RS-422 interface board provides high speed communications capability for IBM PC/XT/AT and compatible computers. It allows data transfers at speeds of up to 57.6 Kilobaud over distances as large as 4000 feet. The baud rate can be selected over a wide range of values between 120 baud and 57.6 Kilobaud. Through simple BASIC programming, the 9600-baud limitation of most DOS and BASIC communication routines can be overcome. Applications include interfacing the microcomputer to printers, plotters, modems, networks, and instrumentation; and communicating with signal-conditioning and control systems.

The board has two independent RS-

422A communications ports, each with its own base address- and interrupt-selection codes. Either channel can be set as COM 1:, COM 2:, or any other desired base address/interrupt level combination.

The DUAL-422's design is based around the INS 16450 UART, giving it compatibility with both the INTEL 8250 UART and IBM asynchronous card. Communications parameters—such as 5, 6, 7, or 8 data bits—and even-, odd-, or no-parity check modes are software selectable by the user.

The board plugs directly into any unused half-or full-size IBM PC XT/AT expansion-board slot. It is connected to external serial busses through the board's two 9-pin "D" connectors.

The DUAL-422 Interface Board costs $260.00; the 9-pin "D" connector costs $12.00, and RS-422 cable costs $25.00. For further information, contact MetraByte Corp., 440 Myles Standish Blvd., Taunton, MA 02780.

CIRCLE 78 ON FREE INFORMATION CARD

CAR STEREOS

Jensen's three top-of-the-line autosound receivers feature sleek styling and upgraded electronics.

Model SJS 7000, a full-featured mini chassis, has a backlit LCD display, 24 station presets (12 AM/12 FM), and separate bass and treble controls. For improved performance, it offers "Ultra Bias" tape head, "Instaloc" automatic program-control tuner, and Dolby B noise-reduction circuitry. The

unit, which produces 10-watts-per-channel into four ohms, also has a loudness control, pre-amp outputs, auto-reverse, and a power-antenna lead. The *SJS 7000* features "Flex Fader" that allows the fader to be used even with outboard amplifiers.

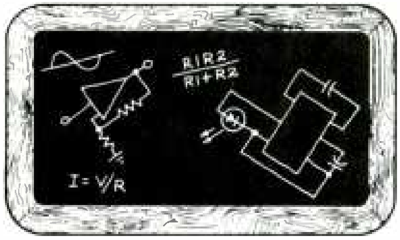
Model SJS 8000, a 3-hole universal-mount unit, allows the radio to be heard while a tape is rewinding or advancing. It has tape search, "Ultra Bias" tape head, "Flex Fader", and a CD input. The unit produces 30-watts-per-channel of output into four ohms. It also features scan tuning, Dolby B noise-reduction circuitry, auto-reverse, 24 station presets, and separate bass and treble controls.

The top-of-the-line *Model SJS 9000* is designed for theft prevention. The user can easily pull it out of the dashboard when leaving the car. In addition, it offers all the features of the *SJS 8000*, including 30-watts-per-channel of output into four ohms.

Models SJS 7000, SJS 8000, and SJS 9000 carry suggested retail prices of $239.95, $269.95, and $320.95, respectively. For more information, contact International Jensen, 4136 North United Parkway, Schiller Park, IL 60176; Tel. 800-323-0707. ■

CIRCLE 79 ON FREE INFORMATION CARD

CIRCLE 11 ON FREE INFORMATION CARD



Think Tank

By Byron G. Wels

SCR PROJECTS

Back in the early days, if you wanted to control a motor's speed, you had a "brute force" rheostat with a control wheel the size of a small car's steering wheel on it. It usually took an ape of a guy with two hands on the wheel to slow down or speed up the motor. Then solid state came along, and voltages were dropped to the point where you could actually touch a contact and not draw an arc. And the steering-wheel sized rheostat gave way to a small knob that you could operate with two fingers.

To a large extent, that was due to a device called a silicon controlled rectifier. Essentially, it was a diode with an added terminal that was used as (and was called) a gate. Thanks to the SCR, small voltages could control large voltages, and not through relays that had only two steady states. You could now control a full range of voltages. As time (and science) progressed, new applications were discovered for that versatile device, and we're glad to offer a range of them here.

SCR Tester. This handy little unit will give you a visual indication, is a one-evening project, and is easy to throw together. Once you've got it, you can check the operation of all those possible duds in your junkbox, and maybe throw some of them into the scrap heap.

Figure 1 shows a 3-amp, 50-volt SCR and a test circuit. A fixed resistor can be used for R1. Points G (gate) and K (cathode) are temporary connections so that they can easily be opened. If R1 is a fixed resistor of a few-hundred ohms, when K is closed, the lamp doesn't light. When G is also closed, the lamp lights to its full intensity. The lamp remains lit even if G is opened again. But when K is opened, even momentarily, the lamp does not light again when K is closed. It does so when G is closed. That illustrates the "on" and "off" operation of the SCR.

If R1 is of a higher value, about 50,000 ohms, you can place a meter at G to show the gate current (I_G). A small gate current flows that rises as you reduce the value of R1. At some given value of I_G, the SCR begins to conduct and the lamp lights. Using a standard 3-amp, 50-volt SCR, conduction begins at an I_G of perhaps about 0.5 mA.

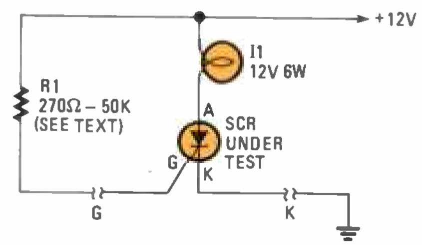


Fig. 1. The SCR Tester—which provides a visual indication—is simply a voltage source, an indicator lamp, and a resistor through which gate current is supplied.

You can make an additional test by supplying the current from an adjustable voltage source, enabling you to determine the SCR's turn-off point. Close K then temporarily close G. Reduce the anode-to-cathode supply to about 2.0 volts, return to 12 volts, and note that the lamp remains lit. Further reduce the supply to about 1.0 volt and repeat the check. You'll find a point, where if the supply is reduced under the holding level, the SCR won't conduct when full voltage is returned. It has reverted to the "off" condition.
—Brian Conklin, Enid, OK

Thanks Brian. That's a nice piece of work, and I know that you're going to enjoy the Fips book. It's on the way!

Simple Burglar Alarm. Parents usually don't have a lot of respect for the abilities of their kids. I'm in high school, and heard dad saying at the dinner table that if he'd get a burglar alarm for his store, he could cut down on the cost of his insurance premiums. Being an electronics hobbyist, I offered to build him one. I got a "That's a good boy," look and the matter was dismissed.

I worked up the enclosed circuit (See Fig. 2) but dad was too busy to go over it with me, so I built it and installed it in the store. He didn't have time for it until he heard the bell go off, and suddenly he became interested.

I figured that any crook would come through the front door, one way or another, so I put a switch mat under the carpeting just inside the front door. The alarm circuit is connected to the SCR anode and gate. Pressure on the mat closes the contacts of the mat switch, which applies current to the SCR gate, causing it to conduct.

With the SCR conducting, a path to ground is provided through BZ1 (a 6- to 12-volt bell) and SCR1, causing BZ1 to sound. The bell continues to sound, even if the crook steps off the mat. To turn the alarm off, you have to manually throw switch S1 to break the circuit. During the day, when customers are going in and out, simply open the switch and the alarm is disabled until you throw the switch on again, to arm the circuit.

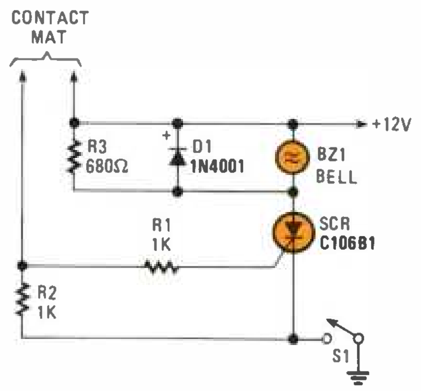


Fig. 2. This Burglar-Alarm circuit consists of a mat switch, which when stepped on, triggers SCR1.

I used diode D1 to protect the SCR from back voltage from the bell winding. As the vibrating contacts of the bell open, the circuit opens. Resistor R3 maintains a steady current through the SCR, keeping it from going back to the off state.

You really don't need R2 if leakage in the alarm circuit isn't there. Such leakage might offer sufficient current to trigger the SCR, but R2 sees to it that such leakage would have to be heavy for that to occur. When the mat is stepped on, R2 is just across the supply and has no effect. Supplies of any other voltage can also be used.

Now that the system works (and dad is convinced), I'm adding additional mats at the back door and the rear window.

I suggest that the bell be mounted high over the front door, out of reach, where neighbors and the police can easily locate it. I also used warning stickers generously, and foil-taped all the glass.

—Barry Sherman, Seattle, WA

I'll bet your dad is looking at you a little differently these days! Also, you didn't mention whether or not he got his discount from the insurance company, but never mind. You've got a copy of the Fips book.

Rain Detector. Something good has just got to come out of this. That's why I'm sending it to you. I want one of those Fips books! It all began when I put this circuit together for my wife. I told her to leave it out with the newly-hung washing, and if it started to rain, "a plate gets wet, and the alarm sounds so you'll know to take the wash in." The very-next day, I came home to find her heating the etched plate with her blow dryer, and I didn't really care for the things she was calling me. So I added a switch, S1. (See Fig. 3.) The plate is a small (2 × 3-inch perfboard etched into strips with jumpers to the alternate strips.

Rain falling on the board reduces circuit resistance until gate current triggers the SCR. That sounds the little solid-state buzzer, which remains on until the water dries or S1 is opened. Resistor

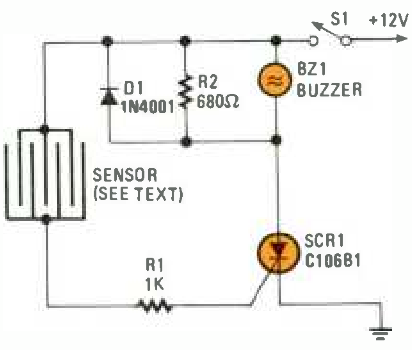


Fig. 3. A printed-circuit board, etched so as to form interweaving (but electrically separate) traces, is used as a Rain Detector sensor, which when bridged by water droplets, causes BZ1 to sound.

R2 provides sufficient current to keep SCR1 conducting. You can also use the circuit to operate a sump pump when water reaches a given level by connecting a sensitive relay to the circuit in place of the buzzer. With the same technique, you could hook it to a motor and use it for anything from closing windows automatically if it rains, to raising a convertible top on a car.

My young son, (a real smart-aleck) got a wooden spring-type clothespin and put a metal thumb tack at each of the joining surfaces, connected a wire to each, and thence to a battery and bell. He put an aspirin tablet between the tacks and accomplished just about the same thing. "After all," he explained, "aspirin manufacturers all boast about how fast their tablets dissolve!"

—John McFee, Denver, CO

Okay John, one (and only one) Fips book. Your son will just have to read yours!

(Continued on page 26)

Battery Charger. It's a cold one out there. You get into your car, and you can't wait to warm the old bus up and get the heater working. You pump the gas peddle a couple of times, turn on the ignition key, and the most you get is a "click." The battery is as dead as a doornail.

Figure 4 is a trickle charger whose output falls as the battery voltage rises. Nice, huh? As the charge on the battery approaches the maximum, the charging rate is automatically reduced. Connect it up, and go back inside where it's nice and warm and have another cup of coffee.

The line transformer, T1; the full-wave rectifier; a bridge circuit; and SCR1 are rated for the maximum current and voltage needed. Use a 12.6-volt transformer, capable of delivering three to five amps. During maximum charge, resistor R1 and diode D1 triggers SCR1 so the full rate is there. The voltage across R6 and R3 is relatively low, so D2 doesn't conduct; that keeps SCR2 off. The voltage at which SCR2 conducts is set by potentiometer R6.

When D2 starts passing gate current to SCR2, the SCR turns on, moving diode D1 negative. The voltage for D1, drawn through R1, drops almost to zero. That keeps SCR1 from triggering. The effect is slow and the triggering angle of SCR1 is reduced as voltage rises. You can put a limiting resistor, meter, or fuse at R2.

—Frank Zabo, Palo Alto, CA

Great idea Frank, many a snowy morning I've needed just such a charger for my own car. Hey! Does it really snow in Palo Alto? Keep an eye out for your copy of the Fips book. It's on the way.

Code-Practice Oscillator. I'm really not a monster, and I really got a boot out of it when my son expressed an interest in amateur radio. While I was pleased, I told my wife that "anything—even a code-practice oscillator would be better than blasting rock 'n' roll." It seems that today's kids really don't need a volume control on their amplifiers. They blast 'em 'till the windows rattle.

But my wife didn't like the constant "beep-beep-beeping," as she called it, and she often caught the kid practicing and grinning at her at the same time, and wished she knew what he was saying! This circuit, simple as it is, solved the problem.

In Fig. 5, Capacitor C1 charges through resistor R1, and when the gate level established by potentiometer R2 is high enough, the SCR is triggered. Current flows through the SCR and earphones, discharging C1. The anode voltage and current drop to a low level so the SCR stops conducting and the cycle is repeated. Resistor R2 lets the gate potential across C1 to be adjusted, which changes the frequency or tone.

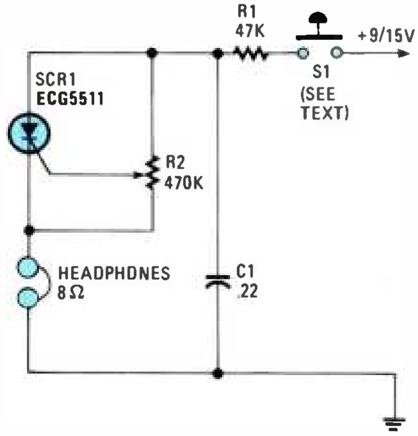


Fig. 5. Shown here is the Code-Practice Oscillator, which consists of only five components, feeding 8-ohm headphones.

Use a pair of eight-ohm earphones. The telegraph key goes right into the B+ line, a nine-volt battery.

All is quiet around the house now. Building this oscillator for my son has demonstrated that I'm a doting father, my wife now greets me at the door with a kiss instead of a scowl, and I'm saving a fortune on aspirin.

—Thomas Dickinson, Sioux Falls, SD

Okay Tom. You're also saving a fortune (a small one) on your free copy of the Fips book. Hope you enjoy it.

Automatic Lights. My family has been planning a week's vacation for several months, and didn't want to tip our being away to any unwanted visitors. We planned to stop newspaper and mail deliveries, and did all the right things. Still, the house would be completely dark at night. One of my neighbors had installed a series of timers that would automatically turn lights on and off at night, and one evening, he invited me over to check out the system. We stood across the street and watched as lights blinked on and off inside his home at random, making the place look like a pinball machine.

I didn't want that, so I built this circuit (See Fig. 6), which is controlled by a light-dependent resistor, LDR (R3), that turns on one living-room lamp when the room is dark. Period. It's enough to make a would-be burglar suspect that somebody is in the house. When the sun comes up, the light goes out. It's just enough—but not too much.

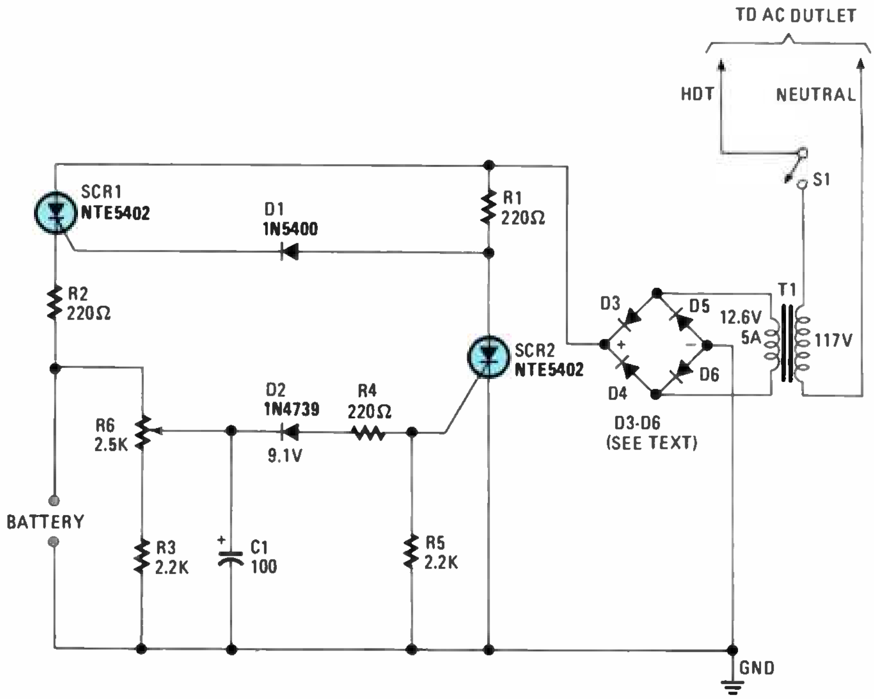


Fig. 4. This Battery Charger provides a heavy charge to depleted batteries, which diminishes as the battery advances toward full charge.

Since potentiometer R1 acts as a sensitivity control, almost any LDR is suitable for the task. The one we chose has a resistance of about 1 megohm in the dark. When light falls on it, the resistance drops to a mere few-hundred ohms.

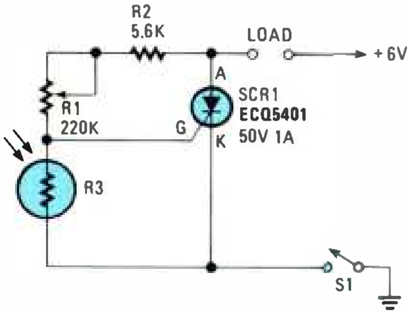


Fig. 6. The Automatic-Light circuit is controlled by an LDR, which has a high resistance in darkness, and a low resistance when exposed to light.

When light reaches the LDR, the SCR is cutoff at the gate. But when the light level striking the LDR drops, the SCR conducts, and the circuit is completed. We recommend that since the SCR is going to be controlling a lamp, it would be a good idea to use a relay to operate the lamp, rather than attempt to operate it directly from the SCR. Potentiometer R1 sets the sensitivity of the circuit.

Anyway, I hope this submission rates a copy of the Fips book. Thanks.
—Mark Salchow, Brooklyn, NY

Great idea, Mark. Hope you like the book too.

Every Home a Disco. Sure, music is nice, but by the addition of the simple circuit shown in Fig. 7, you can add a great deal of interest. In these days of TV, people want something to look at as well as listen to! The light modulator can be single channel, two channel (for treble and bass), or three channel, if you prefer. It will take your audio output and modulate it so that the lights seem to dance in time with the music. You can use any combination of colored lights as well, to make things even more interesting.

Line-voltage lamps of about 40 to 100 watts do nicely. And there's no reason why you can't use lower voltage lamps if you prefer. The required audio-driving power isn't large, and you can get it from a tape or record player, or an FM radio. You simply attach the speaker output through a 1:1 audio transformer.

You get the current for the lamp from an SCR. When low-level audio is present across T1, SCR1 is not triggered into conduction. A louder signal, however, triggers the SCR so that the lamp lights and follows the sounds. Since SCR1 is operated by an alternating current, the rectifier moves out of the avalanche condition when gate current is low.

If you scale the circuit down to use 12 volts, or any other lower voltage, current has to come from a line transformer. A DC supply can't be used, or SCR1 continues to conduct once it is triggered to the on condition. Variable resistor R3 lets you adjust the power reaching transformer T1 so that with normal operating volume, SCR1 triggers again and again, except during quiet passages.

When building such a circuit, safety must be kept in mind. A breakdown in T1 could slap the line voltage into your audio system; and with many of the amplifier circuits, you just cannot ground T1. A low rated fuse should be included in the live half of the line connector. A safer way to do things is with

(Continued on page 106)

ROCKET STROBE

BY ANTHONY CHARLTON

Now you can launch a model rocket on the darkest night, and find it in a flash no matter where it lands!

I shot an arrow in the air, it fell to earth I know not where. When Longfellow penned those words in the 1800's, he must have been thinking about my model rocketry career! The bane of a model rocket hobbyist is losing a carefully constructed and painstakingly finished model in shrubbery or trees. But those days are over.

Our *Rocket Strobe* sends out a highly visible S.O.S. for up to 2 hours, providing ample time to locate and recover the model. It also makes dramatic night launches a reality, with the blue-white flash of the Strobe visible throughout the flight sequence.

Seeing the Light. Invented in 1932 by Dr. Harold E. Edgerton, a Xenon flash lamp is the light-producing device for our Strobe. Flash lamps produce a short-duration, high-intensity pulse of light by converting energy stored in a capacitor to visible light. Each flash of the Strobe lasts about 500 microseconds. For that brief instant, the flash is as bright as a 4000-watt lamp!

It's the high intensity of the light pulse that produces long-range visibility—yet, the Strobe requires very little energy input.

Basic Strobe Circuit. A strobe circuit has four basic parts. (See Fig. 1). The first is the power supply, which must be capable of producing about 300 volts from a 9-volt battery. That high voltage is required to sustain the arc within the lamp after triggering.

Second, we need a capacitor to store energy. The luminescence provided by the Strobe is directly related to the value of the capacitor, or to the amount of energy that the capacitor can store.

Third, we need a triggering circuit to produce a very high voltage pulse to ignite the lamp. A typical ignition pulse has an amplitude of 4000 volts, and is several microseconds in duration. The trigger pulse is capacitively coupled to the Xenon gas inside the lamp. When enough atoms are ionized by the pulse, and if the capacitor has enough charge on it, the gas fully conducts. Light output begins after conduction, and continues until the charge on the capacitor drops to about 50 volts. The lamp shuts itself off at that point, to renew the cycle after the voltage builds up again.

Last, we need a Xenon flash lamp: one is available from the supplier given in the Parts List. There are several different shapes and designs of flash lamps. We shall use a small, straight type in our Strobe.

Size and Weight. In order to be successfully lofted, our Strobe needs to be small, efficient, and light. Weight and size saving is accomplished by miniaturizing the power supply. Surplus electronics suppliers often have camera electronic flash boards left over from manufacturing overruns. Those boards contain tiny transformers that are capable of producing hundreds of volts from a battery-powered driver circuit. Suitable transformers are also available from the supplier given in the Parts List.

To drive them with maximum efficiency, we use a hex FET, and a pulse-width modulator (PWM) circuit. That combination results in maximum power output from the smallest size and weight unit, while providing an adjustable flash rate.

Strobe-Circuit Description. Referring to Fig. 2, gate U1-a (one-sixth of a CD4584 CMOS Schmitt trigger) is configured as an oscillator. With the values shown, the oscillator operates at 6 kHz. You may need to experiment with different frequencies by using the different values of C1 and R1 to obtain maximum output if you use

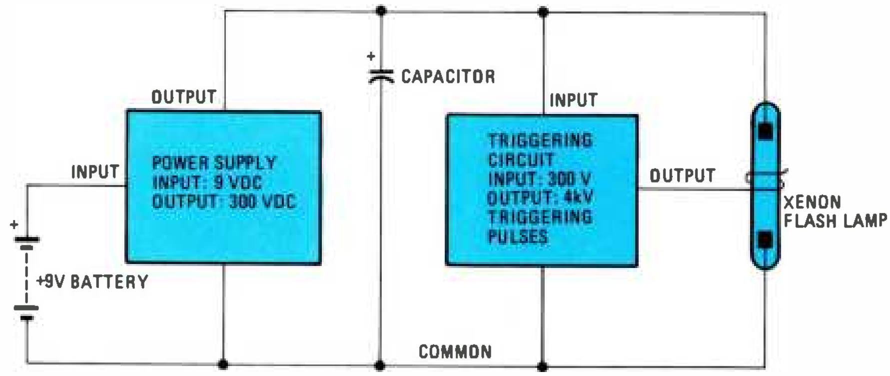


Fig. 1. Here is a block diagram of the basic strobe circuit, which consists of a power supply, storage device (the capacitor), triggering circuit, and a Xenon flash lamp.

a transformer other than the one specified in the Parts List.

Gate U1-b squares up the output of U1-a and feeds a squarewave to C2, C3, R2, R3, D1, and R4. Trimmer potentiometer R4 controls the duty cycle of the resulting pulse. When R4 is set to its maximum resistance, the maximum pulse-width and power is available from the circuit.

The remaining gates (U1-c, U1-d, U1-e, and U1-f) serve to amplify and invert the output of the PWM (pulse-width modulated) part of the circuit. The amplified pulse is fed to the IRF-Z20 hex FET, whose super low on-state resistance of only 0.07 ohm switches the primary of T1 with great force. Pull-down resistor R5 keeps the IRF-Z20 totally off during the logic-0 state of gates U1-c to U1-f. The output is rectified by D2, and is used to power the Strobe's flash-lamp circuit.

A word is needed about miniature transformers. Most units have an accessory winding used in self-oscillating circuits powered by bipolar transistors. That winding is not needed, since we have our own on-board PWM oscillator circuit. A simple test with an ohmmeter will reveal that low-resistance feedback winding. Do not confuse it with the low resistance, heavy gauge primary winding. Typical transformer configurations are shown for you in Fig. 3.

Another consideration is that lots of transformers are connected for European and Oriental active-negative circuits. (Akin to driving on the wrong side of the road to us!) That confusion is easily overcome by identifying the start of the primary and secondary windings. Connect the start of each winding as indicated in Fig. 2.

When in doubt, you may make a simple power indicator from a NE-2 neon lamp and a 220,000-ohm, half-watt resistor connected in series. Connect the lamp to the cathode of D2; and the lamp will glow much more brightly when the right combination of winding polarity is connected.

The Flash-Lamp Circuit. Previously, we mentioned that there is a relationship between lamp luminance and the size of the main capacitor. A unit rated at 33 µF will provide 2 watt/seconds (W/S) of light output. With our circuit, the flash rate is adjustable from one every 30 seconds to one every 4 seconds using R4. You may want to experiment with different capacitor values to obtain the desired light output at the desired flash rate.

For instance, a 10-µF capacitor in our circuit will produce about ⅓ of the maximum attainable light level while providing a rate of nearly one flash per second at R4's maximum setting. That rate would be better suited to night photography of the flight sequence. A slower, brighter flash is ideal for recovering the rocket in the daytime, when visibility of the flash is at its worst.

A long battery life (at a slow flash rate) is possible by setting R4 to minimum. We strongly recommend the use of a 9-volt nickel-cadmium (Ni-Cad) rechargeable battery, to save on battery costs. An alkaline battery can also be used. Regular carbon batteries work poorly because of their inability to supply the current needed for the Strobe circuit. The average current consumption of the Strobe at 9 volts was measured at 230 mA at the maximum flash rate setting, and 45 mA at the minimum setting. Nickel-cadmium batteries give a slower maximum flash rate because of their lower voltage.

The triggering circuit uses an interesting trick. (See Fig. 4). A small transformer, T2, is grounded via an SCR connected to its primary. When SCR1 switches on, the charge on C6 quickly travels through T2's primary and the SCR to ground. That induces a high-voltage pulse in T1's secondary winding, which ignites FL1. A simple and inexpensive trigger circuit kicks on SCR1 when the charge on C7 is high enough to sustain the arc inside FL1. A voltage divider, consisting of R6 and

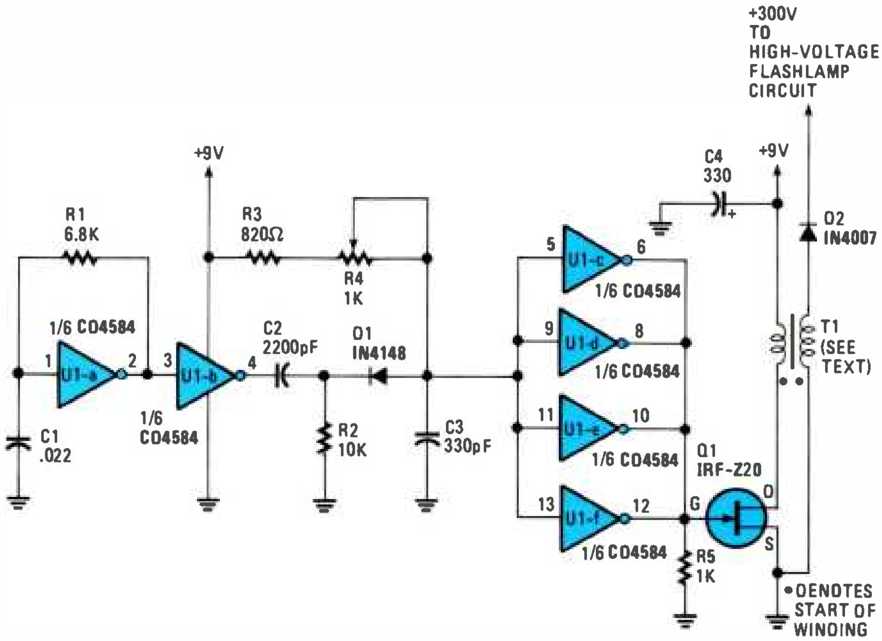


Fig. 2. Shown here is the schematic diagram of the PWM power supply for the Rocket Strobe, which produces 300 volts from a 9-volt battery.

needed for the nose-cone/electronics package. The nose cone must withstand considerable force at the apex of flight when the rocket engine activates its ejection charge. There is nothing gentle about the hefty charge of black powder that pops off the nose cone and deploys the parachute! Figure 5 shows the parts of a rocket engine, and their function. Be sure to use enough silicone for good strength.

Weight must be minimized to allow your bird to lift off, and attain maximum height. Soft grades of balsa wood are the lightest, and weight savings may be gained by careful assembly of the electronics on a small board, using a minimum of solder. All told, our Strobe added 3½ ounces to the rocket's weight. You may also save weight by not painting the model with too many coats of finish if it's to fly a Strobe.

If the electronics are ahead of the model's center of gravity (CG), the rocket should fly fine with the added weight. If, for some reason, you locate the electronics or battery behind the rocket's CG, a counterbalancing weight must be added to the nose to bring the CG back to its normal position. A rocket's CG is determined by its balance point with an unused engine installed. (See Fig. 6.)

A flash lamp may be attached to the rocket's nose, body, or fins. Be aware that the delicate flash lamp needs breakage protection. A rigid, clear piece of plastic tubing placed

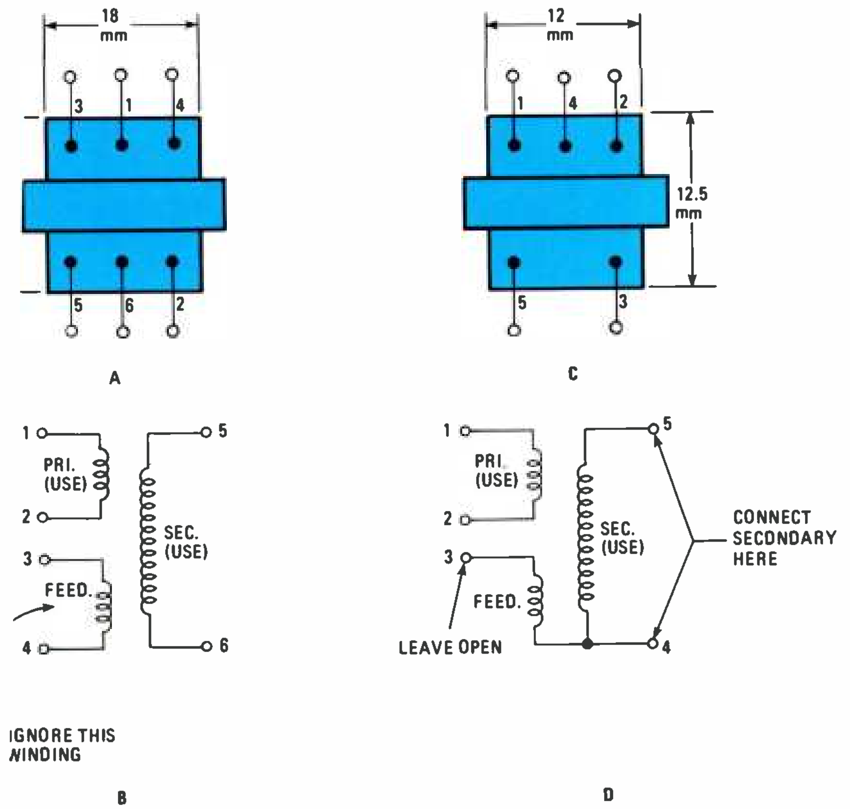


Fig. 3. If you use a miniature transformer salvaged from an old flash unit, it will be necessary to figure out the proper windings and/or connections. Shown here are two typical miniature transformer configurations.

R7, ensures that roughly 300 volts is stored in C7 before the neon lamp, NE1, fires. Neon lamps are designed to fire at different voltages. The common NE-2 lamp used in our circuit fires at about 120-volts DC. When NE1 fires, it dumps the charge stored in C5 to the gate of SCR1. That in turn, produces a trigger pulse that is applied to flashlamp FL1, causing it to ignite, which allows you to find your rocket in a flash!

Speaking of flashes, let's look at different ways to attach a flash lamp to your rocket, rocket stability, what type of engines can loft your "bird," and a few suggestions for multiple strobes to increase visibility.

In our prototype, the flash lamp is attached to the end of the rocket's nose cone with silicone glue. The electronics are handily located in the nose, and the battery is held by a snap-in holder designed to withstand the shock and vibration of parachute deployment without losing the battery. The author used a combination 9-volt battery snap connector and holder assembly (see Parts List for source).

A balsa-wood plug is held securely in place by silicone, which also seals the components inside the nose cone, as well as providing an anchor point for the parachute, and shock-absorbing rubber cord leading to the rocket's body.

Strong assembly techniques are

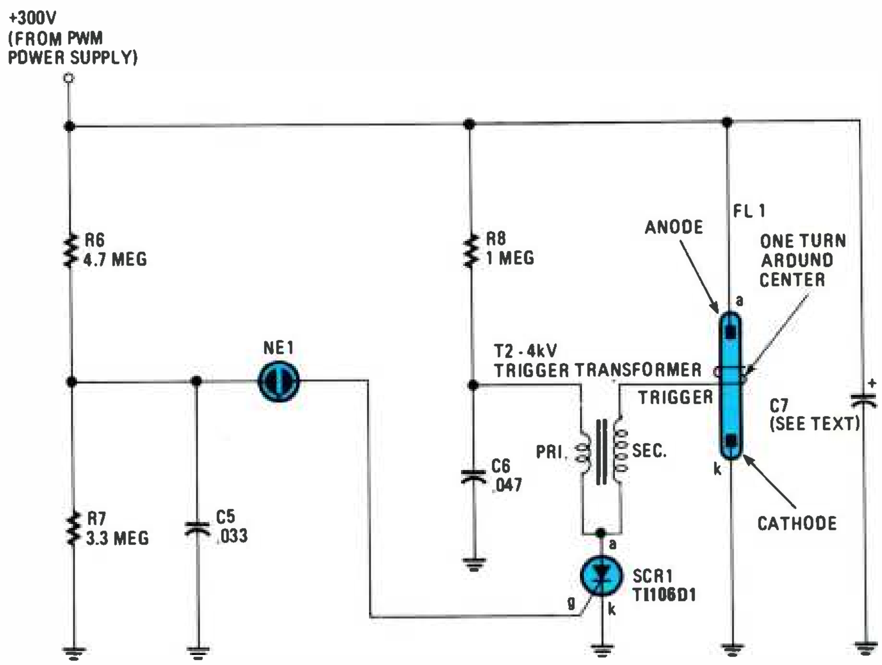


Fig. 4. The triggering circuit uses a small voltage transformer that is grounded via a SCR which, when triggered, induces the high-voltage pulse that ignites the flash lamp.

PARTS LIST FOR ROCKET STROBE

SEMICONDUCTORS

Q1—IRF-Z20 hex FET (Digi-Key IRF-Z20-ND)
D1—1N4148 or equivalent general-purpose diode
D2—1N4007, 1-A 1000-PIV, general-purpose rectifier diode
U1—CD4584 hex Schmitt trigger, integrated circuit
SCR1—TI106D1, C106D1, ECG5457 (or equivalent) 400-volt, 4-amp, sensitive gate silicon controlled rectifier

RESISTORS

(All fixed resistors are ¼-watt, 5% units, unless otherwise noted.)
R1—6800-ohm
R2—10,000-ohm
R3—820-ohm
R4—1000-ohm, trimmer potentiometer
R5—1000-ohm
R6—4.7-megohm
R7—3.3-megohm
R8—1-megohm

CAPACITORS

C1—0.022-µF ± 10% stable temperature coefficient (Digi-Key P1016 or equivalent)
C2—2200-pF ± 2% stable temperature coefficient (Digi-Key P3222 or equivalent)
C3—330-pF ceramic disc (Digi-Key P4106 or equivalent)
C4—330 to 680-µF, 16-WVDC miniature electolytic
C5—0.033-µF, 250-WVDC (Digi-Key E2333 or equivalent)
C6—.047-µF, 400-WVDC (Digi-Key E4473 or equivalent)
C7—33-µF (or value to suit, see text) 350-WVDC miniature electroytic

ADDITIONAL PARTS AND MATERIALS

FL1—Xenon flash lamp
NE1—NE-2 120-volt neon lamp
T1—See text
T2—4kV trigger transformer
Printed circuit or perfboard materials, 9-volt nickel-cadmium battery, snap-in battery holder (part number 16064, from Sintec Electronics, 28 8th St. Box 410, Frenchtown, NJ 08825 or equivalent), wire, solder, hardware, etc.

Note: The following parts are available from Allegro Electronic Systems, 3 Mine Mountain Road, Cornwall Bridge, CT 06754. A kit containing T1, T2, and FL1 with data sheets is available for $5.75 postpaid. Connecticut residents, please add appropriate sales tax.
Free technical assistance is available by writing Allegro Electronic Systems at above address or calling (203) 672-0123 weekdays from 9 AM to 1 PM in the afternoon.
Model Rockets are available from local hobby shops, or by mail-order in kit form from Estes Industries, PO Box 227, 1295 H Street, Penrose, CO 81240. Catalog: $1.

TABLE 1—ROCKET/ENGINE COMBINATIONS

Model Name	Engine Type	Weight w/Engine	MLW	Weight Margin
Phoenix™	D12-3	8.1	14	5.9
Mercury Redstone™	C5-3	3.9	8	4.1
Jupiter C™	C5-3	3.9	8	4.1
Black Brant II™	D12-5	3.8	10	6.2
Pathfinder™	D12-5	4.7	10	5.3
Mega Sizz™	D12-5	4.7	10	5.3
Ranger ™	D12-5	3.1	10	6.9
Der V-3™	D12-3	5.9	14	8.1
Der V-3™	D12-5	5.9	10	4.1
Eggspress™	C5-3	3.4	8	4.6
D.A.R.T.™	C5-3	2.7	8	4.6
Transtar Carrier™	C5-3	2.8	8	5.2

Note: All weights are given in ounces.
Courtesy of Estes Industries. Material used by permission.

around the lamp affords additional breakage protection. Plug the open end with a tapered balsa or plastic plug to preserve the rocket's aerodynamic sleekness. Use of a short, sturdy flash lamp, cushioned in Silicone, may work fine, as it did with our model.

The parachute's size must be increased to compensate for the added weight: 40 square inches of parachute area per ounce of weight is recommended. All told, our rocket weighed 13.5 ounces, so 540 square inches of chute area was needed. We replaced the 18-inch chute that came with the model with two 24-inch ones. That gave about 900 square inches, which gently delivers the model to Earth.

If you need to use more than one chute, attach each chute's shroud lines to a snap swivel (which can be found at tackle shops). Those handy little gizmos reduce the chance of the line tangling (which can lead to disaster) and enables you to clip on or remove chutes in a jiffy. More than one parachute means you will have to pack each carefully. Try not to wind the lines too tightly around the chutes, and use plenty of flame-proof recovery wadding between the chutes and engine. Dusting the chutes with plain talcum powder lets them slide out freely during the engine's ejection phase, and they unroll quicker when in the air.

The finished model's weight is an important consideration in engine selection. To launch successfully, the model must be less than the maximum lift weight (MLW) of the engine type selected. Weight can really creep up on you (as all dieter's know!). Our model, called the Phoenix, weighed 11.6 ounces, with the engine and Strobe installed. After it was painted, the paint added 1.9 ounces! That put total weight at 13.5 ounces., very close to the MLW of the engine we used.

Table 1 is a listing of some rocket/engine combinations that will lift off with the Strobe onboard. Each model was selected to provide a reasonable weight margin, and a body size large enough to hold a 9-volt battery. The weight margin is what's left over for the Strobe, paint, battery, and so forth. The rockets are sold in kit form, and manufactured by Estes Industries. Other designs may work, provided that you use lightweight batteries, and build the rocket and Strobe using minimal-weight methods.

Multiple strobes add a very interesting touch. We used up to six flash lamps, strung in parallel, all operating from the same power supply. The light output appears to be equally divided among multiple lamps if they are all of the same type. To get the same brightness per lamp, you'll have to increase the value of C7 (see Fig. 4). For instance, with 3 lamps, C7 would need to be three times larger to provide each lamp with a high brightness, but the total light output would be tripled. Increase C6 to 0.1 µF when using more than one lamp in parallel. The higher capacitance causes a greater charge to be dumped across T1's primary (and hence, a larger secondary current), which guarantees the ignition of all lamps.

Construction. Well, by now you are an expert on power supplies, strobes, rockets, and aerodynamics; so let's roll up our sleeves, and get to work!

You may make a PC board, or wire the electronics on perfboard (which we did). A universal printed-circuit board worked fine. As you assemble the circuit, be mindful of the need to minimize weight. Use just enough solder to make a good joint. Trim away excess space on your mounting board.

Wherever possible, use miniature components. A Ni-Cad battery will save you quite a bit of weight (1.25 ounces vs. almost 2 ounces for an alkaline unit). The Ni-Cad gives a good 15 minutes of flashing at high rate, and over 1 hour on slow.

The power-supply layout is not critical, but you must pay attention to the high-voltage output of the trigger transformer. That little guy puts out over 4,000 volts, and while it does not look too dangerous it packs quite a nasty wallop!

Dress the secondary leads away from other components; a half inch is recommended. The wires leading to capacitor C7 and the trigger transformer should be short, and if on the outside of the rocket, glued flat to avoid excess air drag. If you run the wires inside the body, make sure that they won't become tangled in the recovery system! Also, the ejection gases will quickly rot the insulation on wires; if they are in an exposed area, jacket and seal them in heatshrink tubing or the kind of plastic tubing sold for aquarium air lines.

Wire size is not critical; we had fine luck with #26 stranded hook-up wire. Make sure flash-lamp polarity is observed. The end with the large round electrode is the cathode, which is always connected to ground. Some flash lamps have a trigger wire already attached to one end, but on those that don't, one wrap of bare wire around the lamp's center will do the trick. Secure the wire with a tiny dab of epoxy or Crazy glue to the glass.

Make sure that the leads to the lamp are well insulated at the splices. A connector is handy to have in the circuit leading to the lamp. That way, the electronics can be quickly disconnected for testing or adjustment. Eventually, the lamp burns out and will have to be replaced, but only after many flashes. The author calculates the lamp listed in the Parts List will last around 20,000 flashes. That's over 20 hours continuous at a high flash rate, and represents many rocket flights.

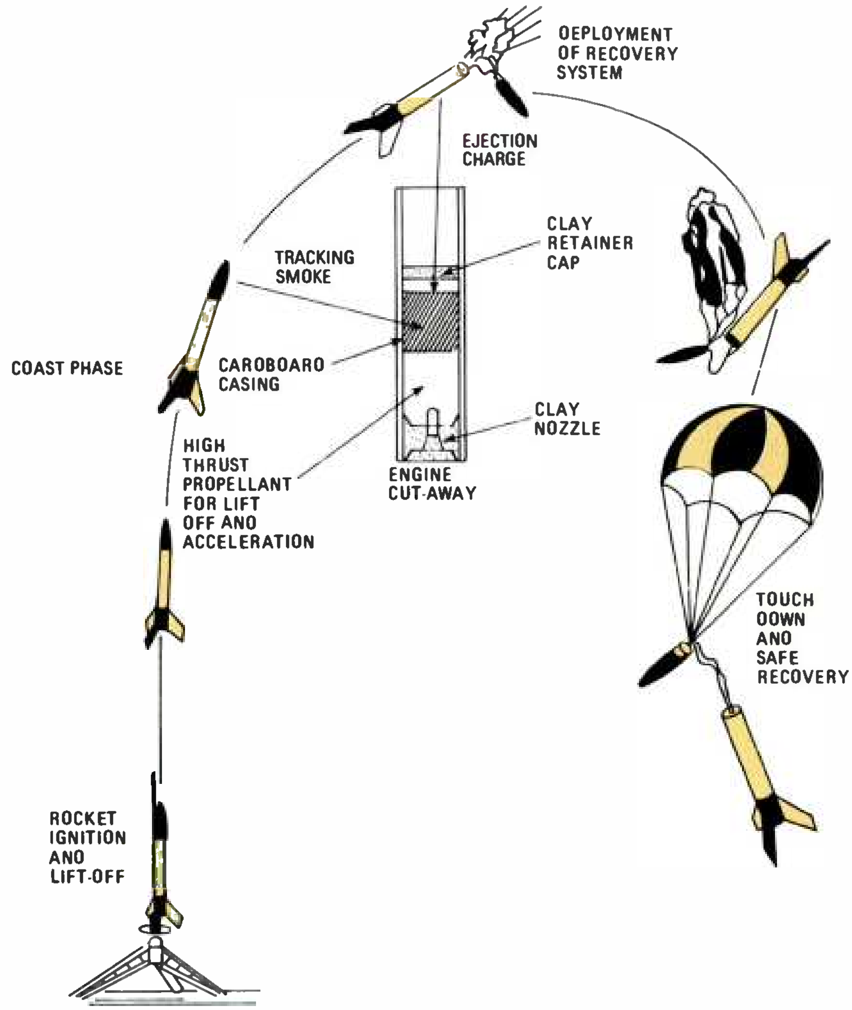


Fig. 5. Here is the flight sequence of the rocket along with a cutaway showing its engine components and their function.

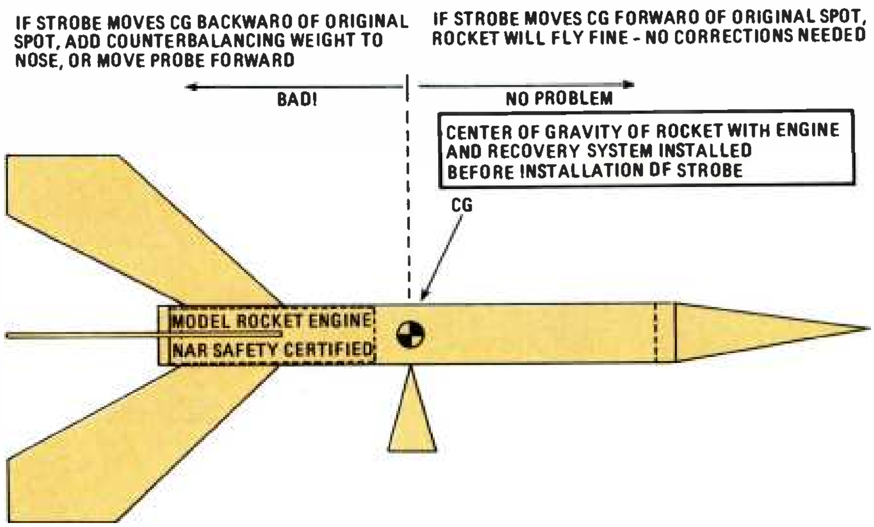
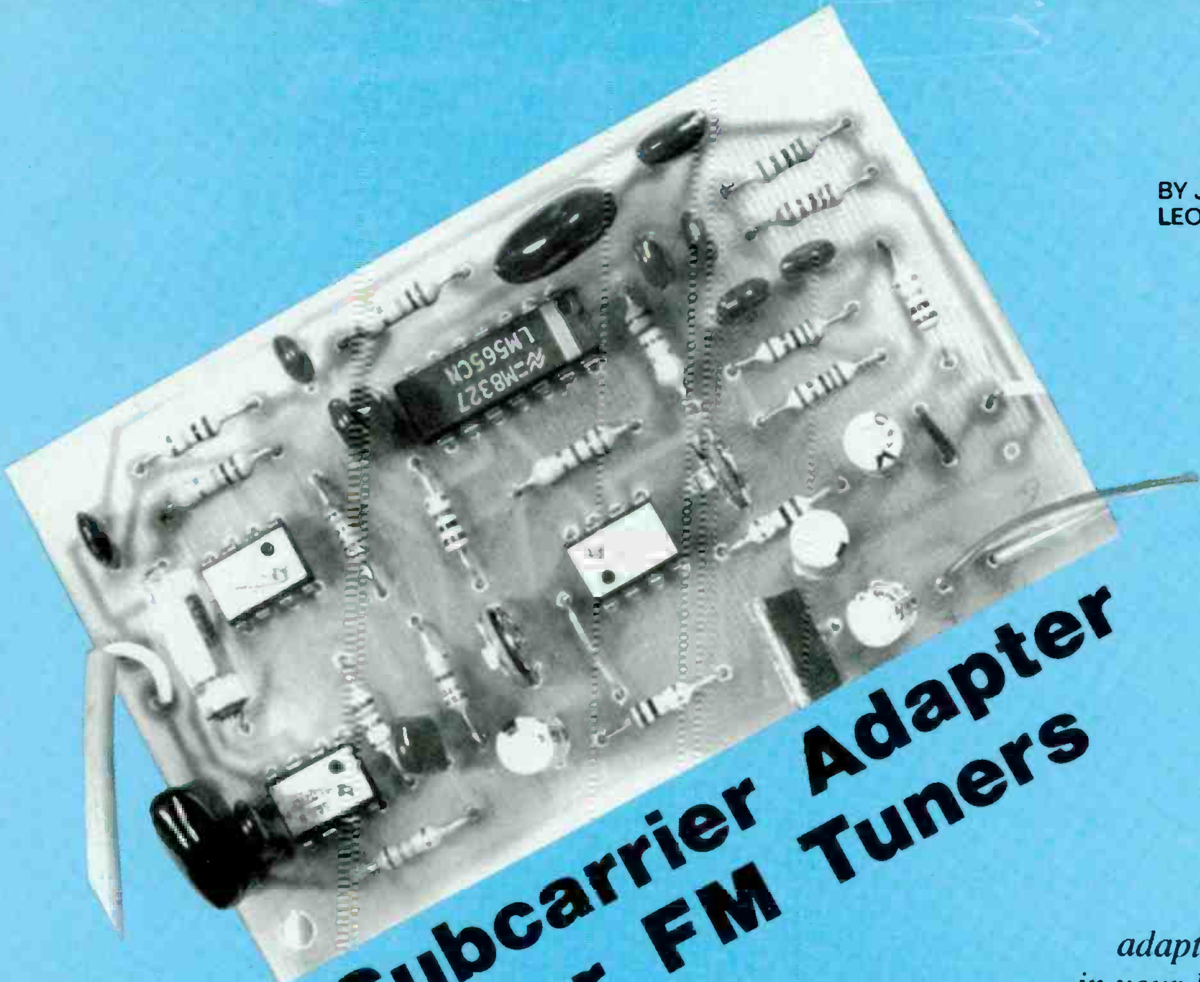


Fig. 6. If the electronics are forward of the model's center of gravity, the rocket should fly fine with the added weight.

To get the best efficiency, it's necessary to keep C4 close to Q1 (see Fig. 2). That ensures a "reservoir" of current to draw from as Q1 switches. Usually, Q1

(Continued on page 96)



BY JOHN CLARKE AND
LEO SIMPSON

Subcarrier Adapter For FM Tuners

This simple adapter circuit fits in your FM tuner and lets you tap into hidden FM transmissions

Although new to some countries, subcarrier transmissions on FM broadcasts have been made for years. They are referred to as Subsidiary Communications Authorized transmissions or SCA. They are based on a 67-kHz subcarrier that is placed on a station's main FM carrier. It's even possible to have multiple subcarriers, some carrying digital data and others carrying audio.

So you can receive such broadcasts, we present the SCA Adapter* that can be hooked into most FM tuners with a minimum of fuss. Low in cost, it uses just a few readily available integrated circuits.

Before we describe the Adapter circuit, let's briefly talk about FM-subcarrier transmissions. They have no effect on standard FM mono and stereo radios. Also, they are fully compatible with all existing FM radios, whether stereo or mono. In fact, unknown to the great mass of FM listeners, such transmissions have been going on for some time.

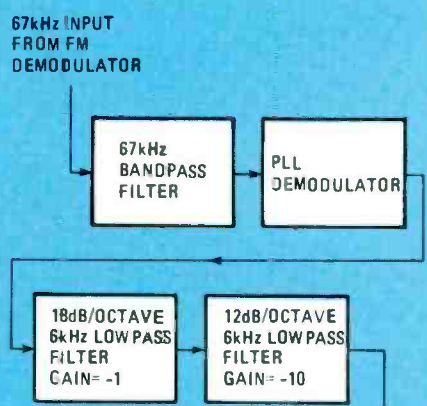


Fig. 1. This block diagram shows the four circuit functions of the SCA Adapter. The corresponding functions are also marked on the circuit diagram in Fig. 2.

But while all FM radios are presently unaffected, they are capable of picking up the subcarrier transmissions. With the addition of an adapter such as the one we'll describe here, they will be able to detect the hidden audio signals.

The SCA Adapter prototype was built on a compact printed-circuit board accommodating three low-cost op-amps, a phase-locked loop IC, a 3-terminal regulator, and a handful of resistors and capacitors.

How it Works. Figure 1 shows a block diagram of our circuit. The 67-kHz signal present at the output of the FM detecter (in the radio to be modified) is first fed to a 67-kHz bandpass filter, and then to a phase-locked loop (denoted PLL), which recovers the audio on the 67-kHz subcarrier.

The audio output of the PLL is then passed through a low-pass filter, which attenuates frequencies above 6 kHz at the rate of 18 dB/octave. Another 12-

*This story first appeared in *Silicon Chip*, Australia (January 1988); reprinted here with permission.

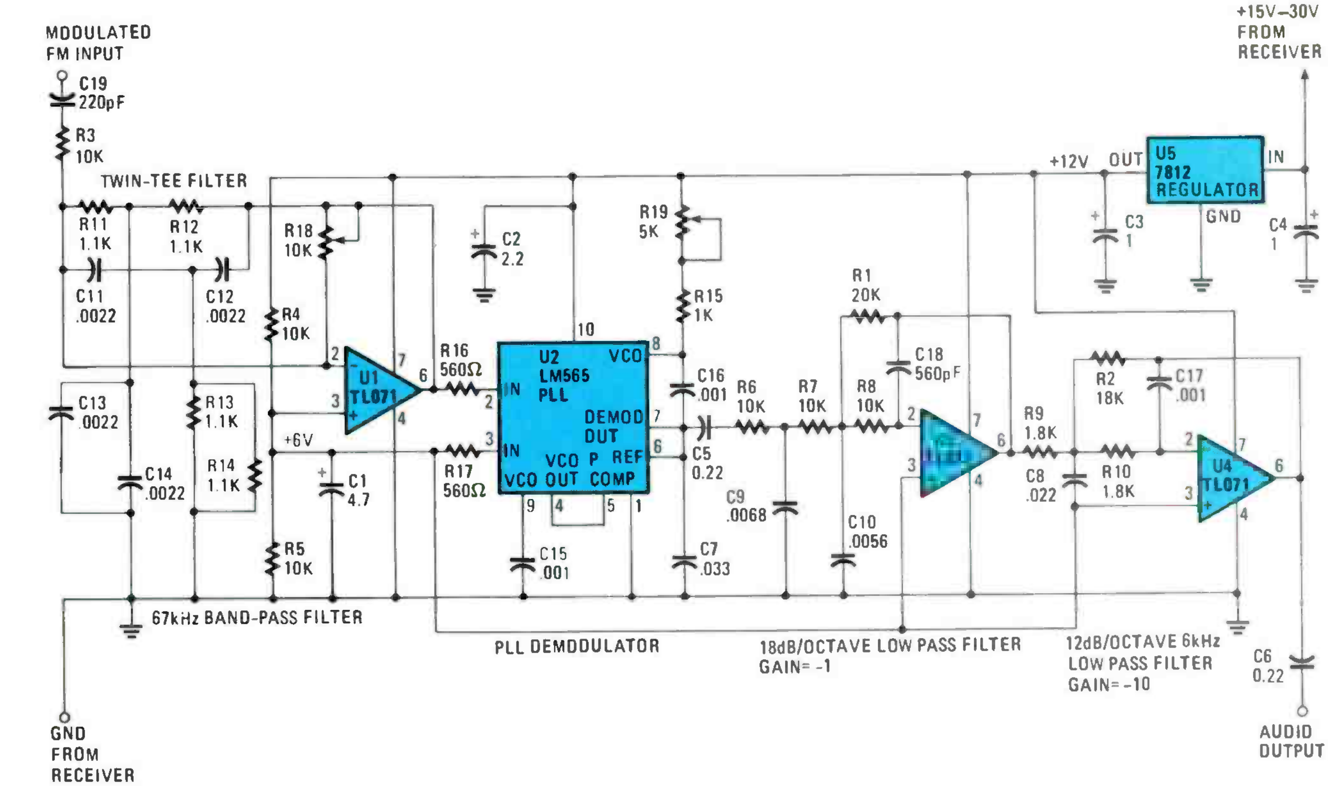


Fig. 2. The circuit for the SCA Adapter is basically a PLL with input and output filter stages.

dB/octave low-pass filter stage completes the conditioning of the signal before it is passed to an external audio amplifier.

Figure 2 shows the complete circuit. Op-amp U1 and its associated components comprise the 67-kHz bandpass filter. A twin-T network, comprised of four 1100-ohm resistors and four 0.0022-µF capacitors, is connected in the feedback network of the op-amp. That gives some gain at 67 kHz and heavy attenuation for frequencies above and below that frequency.

An additional passive filter at the input to the twin-T network (containing a 220-pF capacitor and a 10,000-ohm resistor) provides some additional roll-off for frequencies below 67 kHz.

In practice, the bandpass-filter action covers a frequency range of about 10 kHz above and below the 67-kHz center frequency. Resistor R18 sets the gain of the bandpass-filter stage.

Integrated-circuit U2 is a National LM565 phase-locked loop that demodulates the 67-kHz frequency-modulated (FM) signal from U1. The LM565 PLL consists of a voltage-controlled oscillator (VCO) set to 67 kHz, and a comparator that compares the incoming frequency-modulated 67-kHz signal at pin 2 with the VCO signal fed into pin 5.

The output of the comparator represents the phase difference between the incoming signal and the VCO signal, and is therefore the audio modulated by the subcarrier. Treble de-emphasis of 150 µs is provided by a .033-µF capacitor (at pin 7).

The free-running VCO frequency is determined by the .001-µF capacitor at pin 9, and the resistance between the positive rail and pin 8 (100 ohms in series with R19). Variable-resistor R19 adjusts the oscillator frequency (also known as the "center frequency") so that the incoming signal is within the lock range of the PLL.

To minimize noise in the demodulated output, it is important to reduce the lock range of the PLL to a minimum. That is achieved by shorting pins 6 and 7 together. To a lesser extent, the lock range—and therefore the noise output—becomes smaller for lower input

PARTS LIST FOR THE SCA ADAPTER

SEMICONDUCTORS

U1, U3, U4—TL071 FET op-amp, integrated circuit
U2—LM565 phase-locked loop, integrated circuit
U5—7812 3-terminal 12-volt regulator, integrated circuit

CAPACITORS

C1—4.7-µF, 16-WVDC, electrolytic
C2—2.2-µF, 16-WVDC, electrolytic
C3—1-µF, 16-WVDC, electrolytic
C4—1-µF, 35WVDC, electrolytic
C5, C6—0.22-µF, metallized polyester
C7—.033-µF, metallized polyester
C8—.022-µF, metallized polyester
C9—.0068-µF, metallized polyester
C10—.0056-µF, metallized polyester
C11–C14—.0022-µF, metallized polyester
C15–C17—.001-µF, metallized polyester
C18—560-pF polystyrene
C19—220-pF ceramic

RESISTORS

(All resistors are ¼-watt, 5% precision units unless otherwise noted.)
R1—20,000-ohm, 2% precision
R2—18,000-ohm
R3–R8—10,000-ohm
R9, R10—1800-ohm
R11–R14—1100-ohm, 2% precision
R15—1000-ohm
R16, R17—560-ohm
R18—10,000-ohm, miniature vertical trimmer potentiometer
R19—5,000-ohm, miniature vertical trimmer potentiometer

ADDITIONAL PARTS AND MATERIALS

Printed-circuit board, hookup wire, audio leads, solder, etc.

signals, so we keep the input signal as low as possible without affecting the PLL's operation.

Following U2 is the 18-dB/octave filter containing U3, which has a gain of one for the desired signal frequencies. The filter is followed by the final stage, U4, which has a gain of 10.

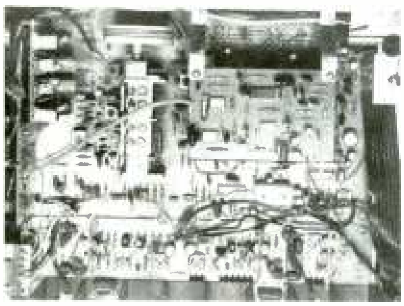
The adapter is ideally powered from the tuner or receiver it is built into, so we had to make its input-voltage requirements non-critical. The solution is to use a 12-volt, 3-terminal regulator that enables the circuit to be powered from any +15- to +30-volt supply.

The three op-amp IC's and the PLL are all biased to half the supply voltage by a voltage divider consisting of two 10,000-ohm resistors, which is decoupled by a 4.7-µF capacitor. The center of the voltage divider is connected to pin 3 of each op-amp and the PLL.

PCB Assembly. The printed-circuit board for the project (see Fig. 3) measures just 3-5/8 × 2-1/4-inch and will help ease assembly if made. Point-to-point assembly can be used but will be a bit difficult to perform accurately.

No special points need to be watched when installing the parts on the board except that component polarities must be correct (see Fig. 4). Note also that U1 has a different orientation to U2, U3, and U4.

When assembly and soldering are finished, check your work carefully and then connect a DC supply of between 15 and 30 volts. Now check the voltage at the output of the 3-terminal regulator, at pin 7 of the TL071 op-amps, and at pin 10 of the PLL. In each case, the reading should be close to 12-volts. The voltage at pins 3 and 6 of each op-amp, and pin 3 of the PLL, should be close to 6-volts DC.



The photo shows the SCA Adapter installed in an older AM/FM stereo receiver, the Harman Kardon HK5701. Two brackets were used to suspend the Adapter above the tuner board.

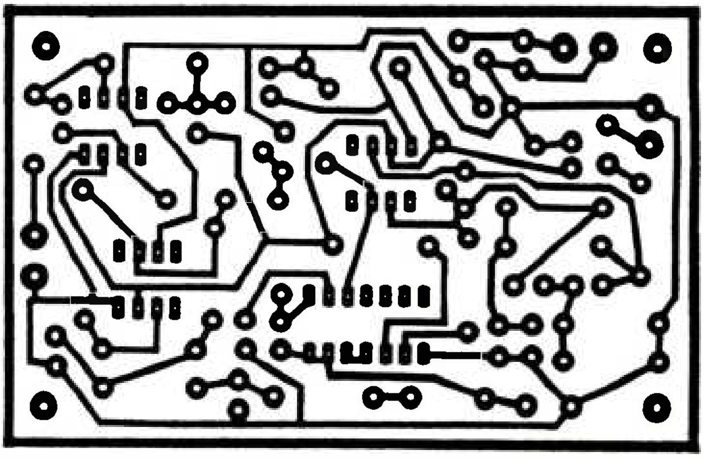


Fig. 3. Full-size PC artwork for the SCA Adapter. Its use is recommended.

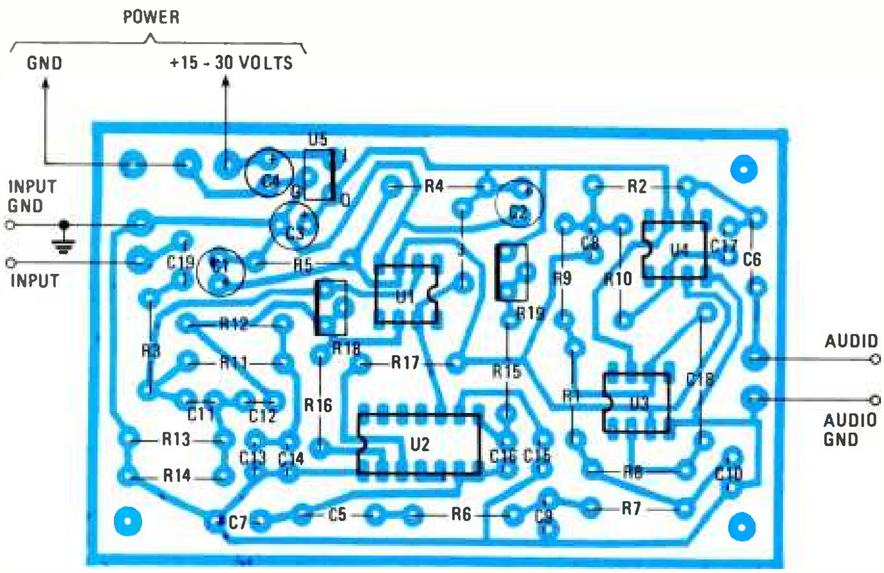


Fig. 4. Take care when assembling the board; U1 is oriented differently from U3 and U4.

If everything is okay, you are ready to install the Adapter in your FM tuner or stereo receiver.

Finding the Signal. Here comes the tricky part. Ideally, you need access to the circuit diagram of your tuner or receiver. Next, you need to identify a positive DC-supply rail of between +15 and +30 volts. Then, you need to find the output of the FM demodulator of your receiver or tuner.

In a stereo tuner, that comes before the multiplex decoder and treble de-emphasis networks. In a mono tuner, you must identify the demodulator output before de-emphasis. After de-emphasis, the 67-kHz signal will be non-existent.

Most medium-priced tuners use two IC's to do most FM-signal processing. They are the IF amp and detector IC, followed by a multiplex (MPX) decoder IC. The most convenient point to pick off the 67-kHz signal is at the input to the MPX decoder.

Setting Up. Having found the signal and made the necessary connections from the Adapter to your tuner, the set-up procedure is relatively simple. First, make sure that R18 is set so that its wiper is turned toward the LM565. That will provide maximum signal. Now adjust R19 so that there is an audio signal. Find the extreme settings of R19 where the audio signal drops out, then set R19 between the two extremes.

Resistor R18 is used to minimize noise from the audio signal when the FM-signal level is poor. Adjust the trimmer until the sound becomes distorted and then back off the adjustment until the distortion is no longer audible. If you have a strong FM signal, adjustment of R18 will have no effect on the noise level, and so it should be left at its maximum-resistance setting. ■

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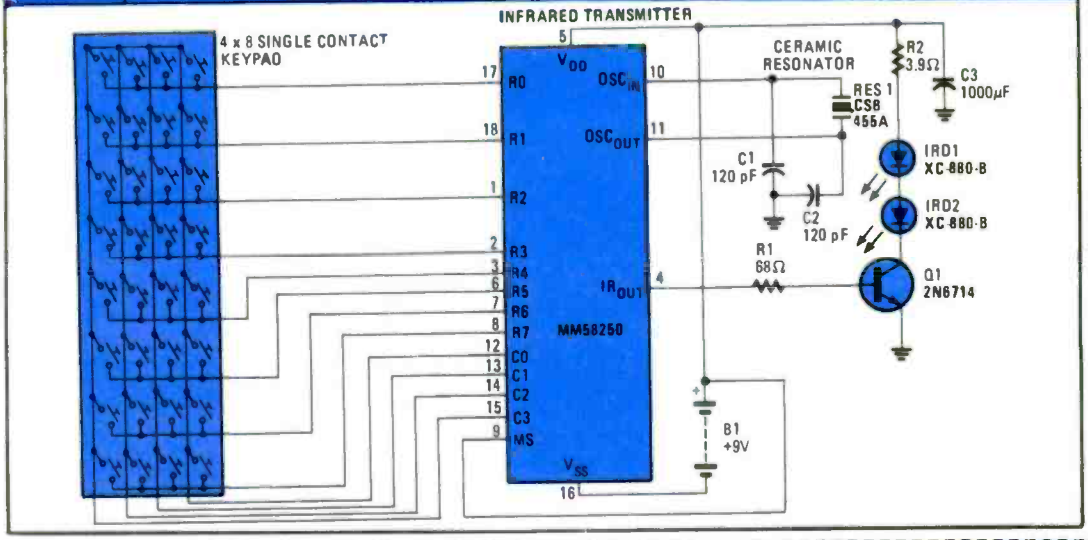

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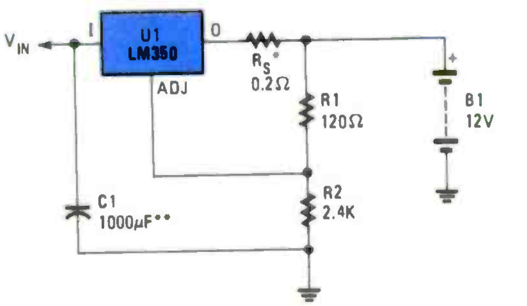
95 Popular Electronics FactCard — Regulator Applications

SIMPLE 12V BATTERY CHARGER

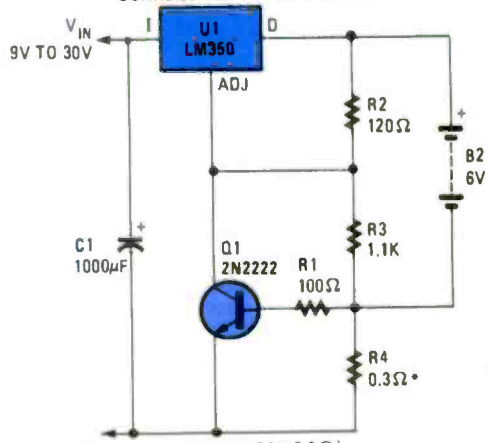


*R_S—SETS OUTPUT IMPEDANCE OF CHARGER $Z_{OUT} = R_S\,(1 + \frac{R2}{R1})$

USE OF R_S ALLOWS LOW CHARGING RATES WITH FULLY CHARGED BATTERY.

**THE 1000µF IS RECOMMENDED TO FILTER OUT INPUT TRANSIENTS.

CURRENT LIMITED 6V CHARGER



* SETS PEAK CURRENT (2A FOR 0.3Ω)

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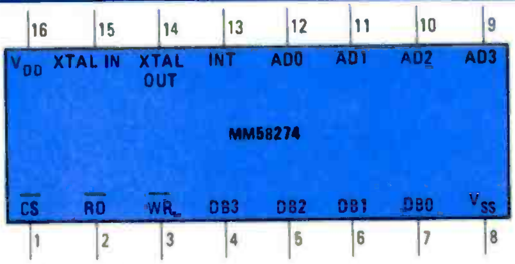
96 Popular Electronics FactCard — MM58274: Microprocessor Compatible Real Time Clock



FEATURES

- Same pin-out as MM58174A
- Timekeeping from tenths of seconds to tens of years in independently accessible registers
- Leap year register
- Hours counter programmable for 12 or 24-hour operation
- Buffered crystal frequency output in test mode for easy oscillator setting
- Data-changed flag allows simple testing for the time rollover
- Independent interrupting timer with open drain output
- Fully TTL compatible

GENERAL DESCRIPTION

The MM58274 is fabricated using low threshold metal gate CMOS technology and is designed to operate in bus oriented microprocessor systems where a real time clock and calendar function are required. The on-chip 32.768 kHz crystal controlled oscillator will maintain timekeeping down to 2.2V to allow low power standby battery operation.

ABSOLUTE MAXIMUM RATINGS

DC Input or Output Voltage	−0.3V to V_{DD} + 0.3V
DC Input or Output Diode Current	± 5.0mA
Storage Temperature, T_{STG}	−65°C to +150°C
Supply Voltage, V_{DD}	6.5V
Power Dissipation, P_D	500 mW
Lead Temperature (Soldering, 10 seconds)	260°C

OPERATING CONDITIONS

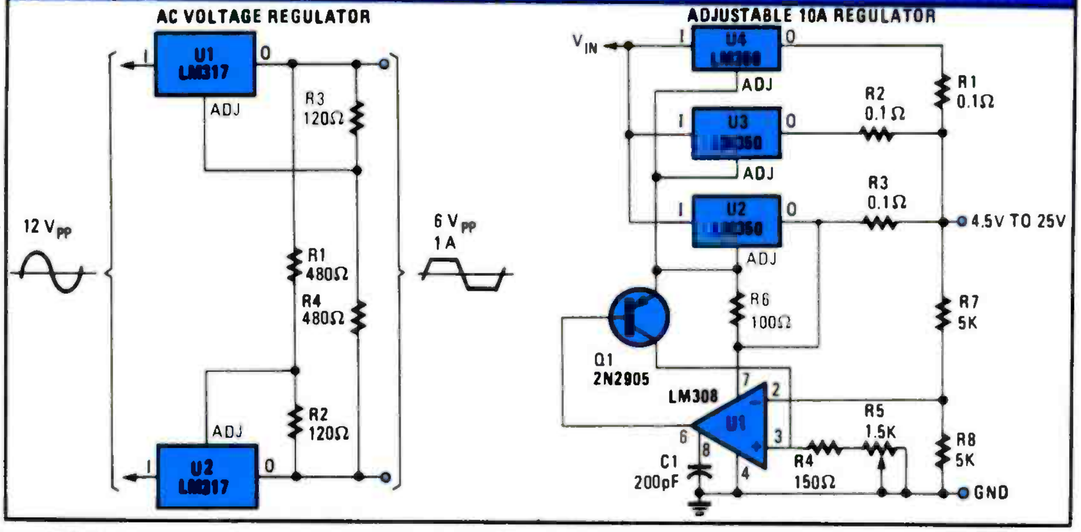
	Min	Max	Units
Operating Supply Voltage	4.5	5.5	V
Standby Mode Supply Voltage	2.2	5.5	V
DC Input or Output Voltage	0	V_{DD}	V
Operating Temperature Range	−40	85	°C

94 Popular Electronics FactCard — MM58250: Infrared Transmitter

ELECTRICAL CHARACTERISTICS

PARAMETER	CONDITIONS	TYP	MAX	UNITS
Supply Voltage Supply Current (Active) Oscillator Frequency*		455	10 5	V mA kHz
Output Voltage Logic "0" Logic "1"	150 μA Sink 10mA Source		0.6	V V
Output Current	$V_{DD}-1.4V$		−20	mA
Input Levels Logic "0" Logic "1"	MS = 0, $4.5 \leq V_{DD} \leq 5.5$ Direct Mode		0.5	V V
Input Current R_0-R_6, MS R_7	MS = 0, $4.5V \leq V_{DD} \leq 5.5V$ $0V \leq V_{IN} \leq V_{DD}$ $V_{IN} = 0.4V$		1.0 0.6	μA mA
Input Current R_0-R_7 MS	MS = 1, $3.0V \leq V_{DD} \leq 10V$ $V_{IN} = 0.4V$ $0V \leq V_{IN} \leq V_{DD}$		1.6 1	mA μA
Output Current Logic "1" Source "1" Source Logic "0" Sink "0" Sink	MS = 1 $V_{DD} = 3V$, $V_{OUT} = V_{DD}-1V$ $V_{DD} = 10V$, $V_{OUT} = V_{DD}-1V$ $V_{DD} = 3V$, $V_{OUT} = 0.4V$			μA μA μA μA
Output Current Logic "1" Logic "0"	MS = 0, $4.5V \leq V_{DD} \leq 5.5V$ $V_{OUT} = 0.4V$		1	μA

95 Popular Electronics FactCard — Regulator Applications



96 Popular Electronics FactCard — MM58274: Microprocessor Compatible Real Time Clock

ELECTRICAL CHARACTERISTICS

Parameter	Conditions	Typ	Units
High Level Input Voltage (except XTAL IN)			V
Low Level Input Voltage (except XTAL IN)			V
High Level Output Voltage (DB0-DB3)	$I_{OH} = -20$ μA $I_{OH} = -1.6$ mA		V V
High Level Output Voltage (INT)	$I_{OH} = -20$ μA (In Test Mode)		V
Low Level Output Voltage (DB0-DB3, INT)	$I_{OL} = 20$ μA $I_{OL} = 1.6$ mA		V V
Low Level Input Current (AD0-AD3, DB0-DB3)	$V_{IN} = V_{SS}$		μA

Parameter	Conditions	Typ	Units
Low Level Input Current ($\overline{WR}$, $\overline{RD}$)	$V_{IN} = V_{SS}$		μA
Low Level Input Current ($\overline{CS}$)	$V_{IN} = V_{SS}$		μA
Output High Level Leakage Current (INT)	$V_{OUT} = V_{DD}$		μA
Average Supply Current	$V_{DD} = 2.2V$ (Standby Mode) $V_{DD} = 5.0V$ (Active Mode)	4	μA mA
Input Capacitance		5	pF
Output Capacitance	(Outputs Disabled)	10	pF

PERSONAL POCKET PAGER

This local-area paging system can help keep you in touch with family, friends, and co-workers.

By Dan Becker

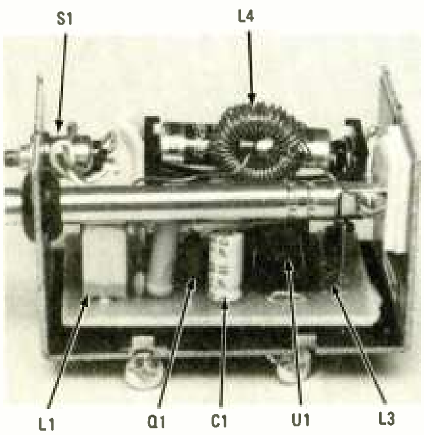
While working outdoors or in your garage, often it would be helpful for those indoors to have a convenient way to alert you if you are needed. Or perhaps your children are playing outdoors and you would like an easy way to call them in. This article describes a wireless transmitter/receiver combination—called the *Personal Pocket Pager*—that allows you to page (beep) someone from a distance of up to about 100 feet.

When activated, the transmitter sends out an amplitude modulated (AM) 49.890-MHz RF carrier. The receiver detects, amplifies, and decodes the RF signal, which, in turn, activates a piezo beeper (buzzer). The receiver is small enough to carry in a pocket or sit on your workbench. The transmitter is also small and fits easily into a pocket for quick access.

The Transmitter. Figure 1 shows a schematic diagram of the transmitter circuit. A 7555 CMOS oscillator/timer, U1, generates a 490-Hz squarewave. Resistors R1–R3, and capacitor C3 determine the squarewave's frequency. Capacitor C2 and L3 prevent RF currents from reaching the trigger input, pin 2 of U1; at the same time, 490-Hz signals pass unattenuated. The 490-Hz output of U1 at pin 3 is used to drive a crystal-oscillator circuit built around Q1, which generates the 49.890-MHz RF-carrier signal.

Capacitor C5 bypasses RF current to ground, placing transistor Q1 in a common-base configuration. Resistors R4–R6 set Q1's quiescent DC emitter current to about 7 milliamperes (mA). Inductor L1 is used to tune capacitors C6, C7, and Q1's collector-base capacitance to a resonant frequency of 49.890 MHz. RF transformer T1 matches the low impedance of the whip antenna to the 780-ohm load resistance required by the oscillator. The antenna-loading coil, L2, tunes out the capacitive reactance exhibited by the electrically short whip antenna changing the antenna into a resistive load. Capacitors C1, C4, and C8 filter the V+ (power supply) bus.

With switch S1 closed, the squarewave signal from U1 periodically grounds the pin 3 end of resistor R6. With R6 grounded, Q1 is supplied a DC current that, in turn, allows Q1 to generate an RF carrier. In that way, U1 switches Q1 on and off at a frequency of 490 Hz to generate an amplitude-modulated RF envelope.



Shown here is the Pocket Pager's completely assembled transmitter, which should give you some idea of its actual size. Because of tight spacing, the resistors have been vertically mounted.

The RF Receiver. Figure 2 shows the schematic diagram of the RF receiver. Transistor Q1 and its components comprise a super-regenerative receiver. Resistors R1–R4 bias Q1 for a quiescent-emitter current of about 1 mA.

The primary and secondary currents of T1 are 180-degrees out of phase, providing positive feedback. Capacitor C6 tunes T1 to resonance at 49.890 MHz. Capacitor C6 and transformer T1 make the circuit into a Hartley RF oscillator. Capacitor C4 is non-critical, but it does improve performance by providing an RF current path around transistor Q1 for the discharge from the T1/C6 tank circuit.

Capacitor C1 couples the antenna to the primary of T1. From there, the received signals are used to drive the base of Q1 through T1's secondary and capacitor C2 (which affects Q1's DC bias rate). Because of that, the circuit oscillates at two frequencies simultaneously: 49.890 MHz, and 450 kHz. During each 49.890-MHz cycle, before RF oscillation begins, Q1 acts like a high gain RF amplifier, greatly magnifying the antenna's signal.

Once amplified, the signal causes an increase in the average DC emitter current of Q1; and that, in turn, increases the voltage drop across resistor R4. So, amplitude variations in the

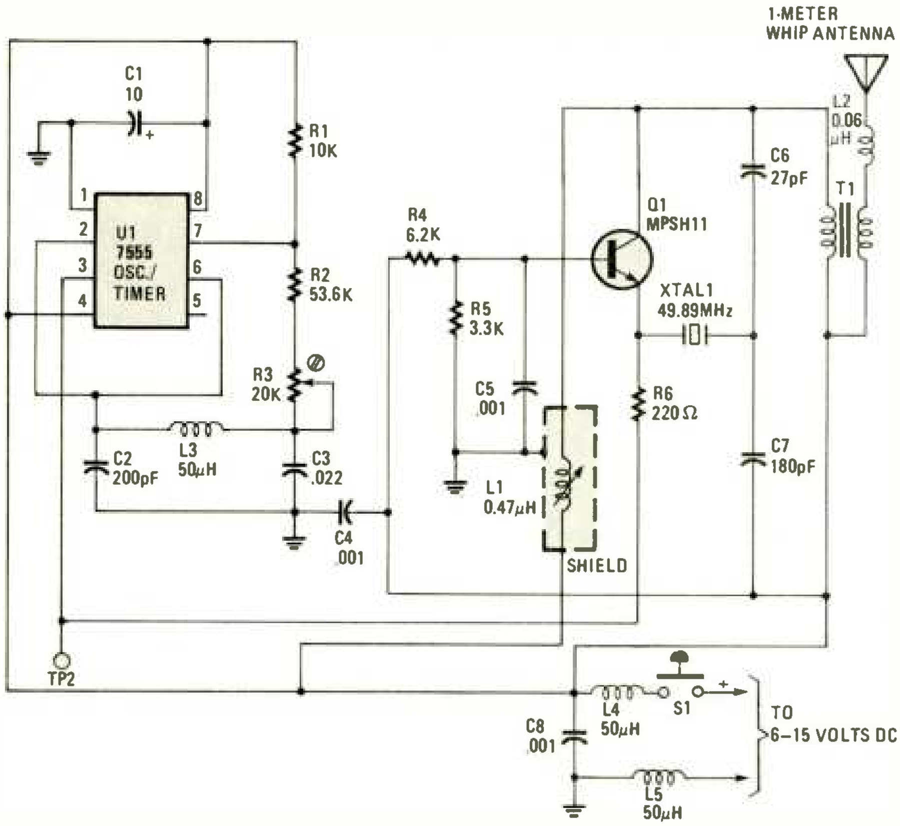


Fig. 1. The transmitter is built around a 7555 CMOS oscillator/timer, U1—whose frequency is dependent upon the values of resistors R1–R3 and capacitor C3—and is designed to generate a 490-Hz squarewave output.

antenna's signal result in voltage variations across R4. Capacitor C7 couples the demodulated RF signal that appears at R4 to op-amp U1.

Op-amp U1-a provides 10 dB of gain to the 490-Hz signal from R4. Op-amp U1-b further amplifies and shapes the 490-Hz signal into squarewave pulses. To do that, resistors R5 and R6 set the voltage gain of U1-a to 40 dB (100 times). Resistors R7–R9, R12, and R13 fix the quiescent DC-output voltage at pins 1 and 7 to 2.5-volts. Resistor R10 allows a test probe to sample the 490-Hz tone at pin 1. A ferrite bead (connected in series with R10 and located at TP1) and C9 block any RF current that may be present. Another ferrite bead (connected across the opposite end of C9) keeps RF current from reaching any test probes connected to circuit ground. Capacitor C10 couples the 490-Hz signal, from pin 7 of U1-b, to pin 3 of U2 (an LM567 PLL tone decoder). Resistor R16 divides pin 7's output voltage, decreasing the transmitter's range, but increasing the receiver's immunity to interference from other transmitters using the 49-MHz band.

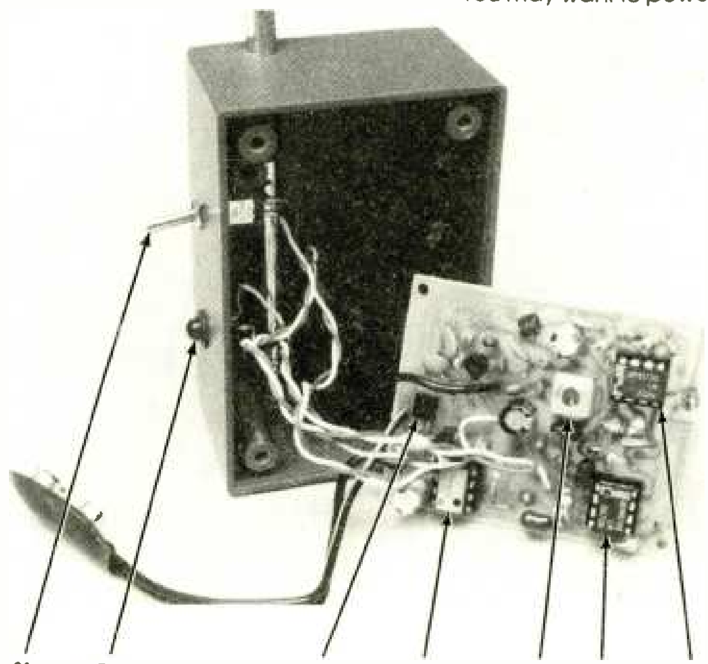
Integrated-circuit U2 contains circuits that can be set to detect a specific signal frequency when applied to its input at pin 3. Resistors R17 and R18, and capacitor C14 set the detection frequency to 490 Hz. Capacitors C11 and C12 fix the circuits bandwidth to less than 100 Hz. Pull-up resistor R19 keeps output pin 8 high until a signal is decoded, at which time pin 8 goes low. Upon going low, pin 8 grounds the cathode of LED1 through current-limiting resistor R20, causing it to light.

Capacitor C15 couples a high-to-low trigger pulse from U2 to U3 (a 7555 oscillator timer). After triggering, pin 3 of U3 goes high, turning transistor Q2 on. When Q2 conducts, the negative lead of the piezo buzzer (BZ1) is grounded, causing BZ1 to sound. Resistor R22 and capacitor C16 fix the time interval during which BZ1 sounds to about one second.

Pushbutton S1 allows you to transmit a signal by connecting power to the circuit. A low power voltage regulator, U4, provides a constant 5-volts source, which is used to operate the circuit. Capacitors C3, C8, C13, C17, and C18, and RF choke L3 bypass RF and the 490-Hz signals to ground, filtering the V+ bus.

Construction. Because both units include RF circuitry, printed-circuit boards are recommended. Full-sized templates of the printed-circuit boards for Personal Pocket Pager's transmitter and receiver (respectively) are shown in Figs. 3 and 4. You can etch your own, or you can purchase etched and drilled boards from the source given in the Parts List.

You may want to power the receiver



Here is what the receiver's printed-circuit board looks like with all the components installed. The receiver is somewhat larger than it's counterpart, the transmitter. If used as a stationary unit, it can be powered from a wall-mounted power supply, or a home-brew power supply circuit.

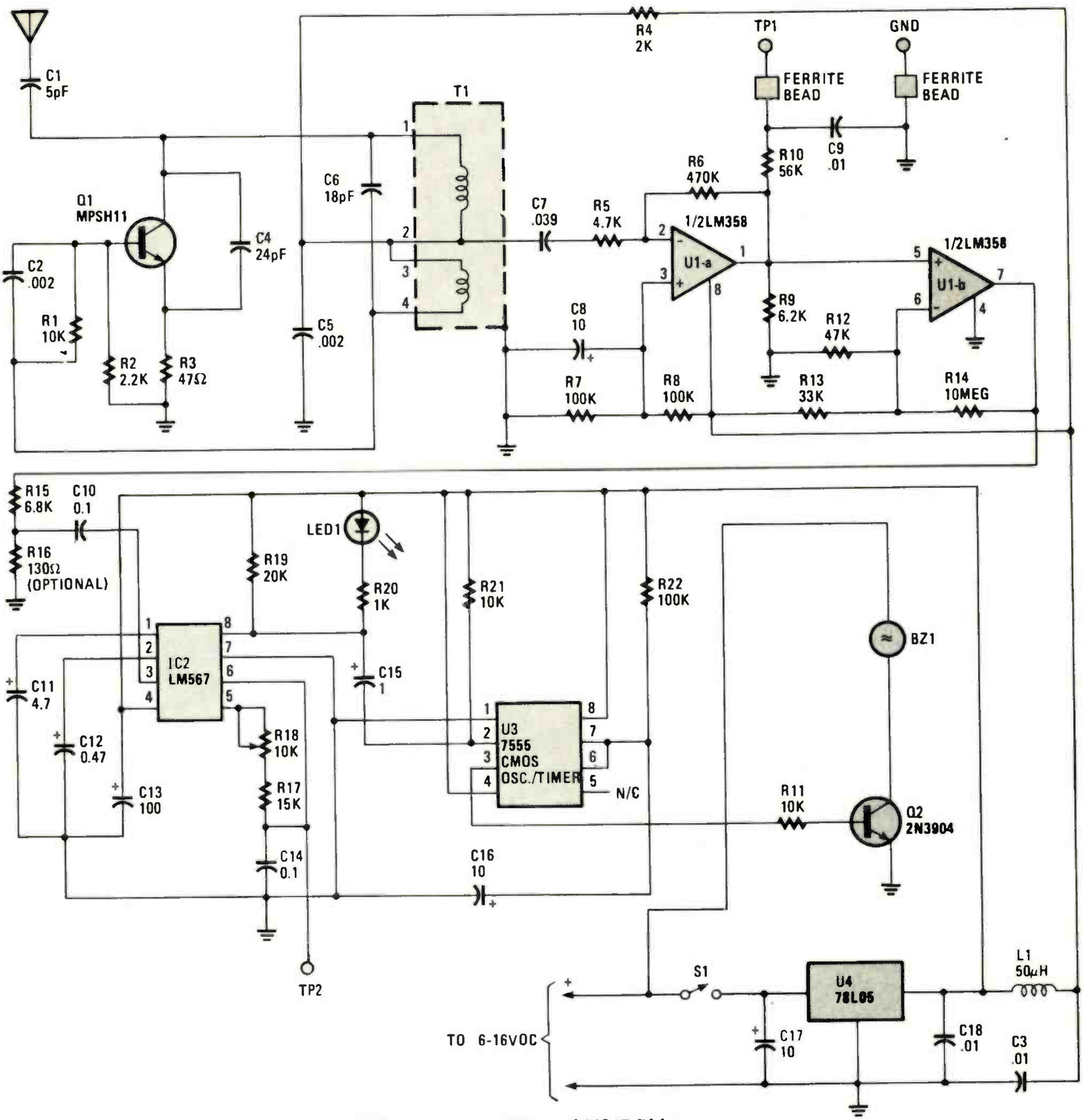


Fig. 2. The RF receiver is built around an LM358 dual op-amp (U1), an LM567 PLL tone decoder (U2), and a 555 oscillator (U3).

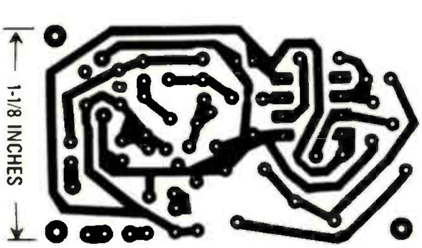


Fig. 3. Shown here is a full-sized template of the transmitter's printed-circuit board.

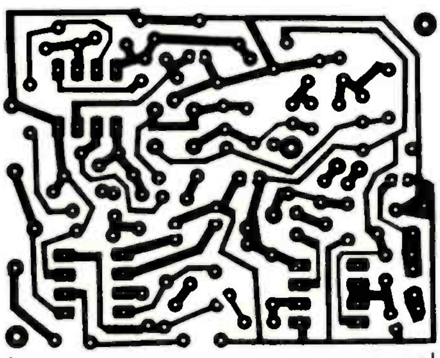


Fig. 4. Here is a full-sized template of the receiver's printed-circuit board.

from an AC-to-DC wall transformer. If so, the receiver will fit into an enclosure about 2½ by 3 inches. Alternatively, make the receiver portable by selecting an enclosure that is large enough to hold a battery—almost any rechargeable battery, in the 6- to 12-volt range, works fine. Before assembling, use the receiver's printed-circuit board as a template to mark mounting holes in the enclosure. Drill the holes, using a 3/32-inch bit, for the mounting hardware. In addition, drill a hole for the antenna, a 1/8-inch hole for the wire from the wall transformer (if applicable), and mounting holes for the piezo buzzer, on-off switch S1, and LED1.

For the transmitter, select an enclosure with enough room for the printed-circuit board, a whip antenna, and a 9-volt battery. Before assembling the circuit board, use it as a template to mark the enclosure for mounting holes. Drill the mounting holes with a 3/32-inch bit. Finally, drill appropriately sized mounting holes for pushbutton-switch S1, and a hole for the whip antenna.

Following Figs. 5 and 6, assemble the transmitter and the receiver (respectively) printed-circuit boards. Observe the proper polarity of the electrolytic capacitors, the IC's, and the diodes.

Mount the capacitors and resistors. The capacitors are mount flush against the board to minimize lead lengths; that's especially important in the RF and tone decoder circuits. Note that all resistors vertically mounted.

Don't forget the test points. Figure 7 shows the construction of the test point terminals. Test point TP1 on the transmitter board (see Fig. 5 for its location,

PARTS LIST FOR THE RF TRANSMITTER

SEMICONDUCTORS

U1—7555, CMOS oscillator/timer integrated circuit
Q1—MPSH11, ECG229, TCG229, or SK3246/229, NPN RF transistor

RESISTORS

(All resistors are ¼-watt, 5%, unless otherwise noted.)
R1—10,000-ohm
R2—53,600-ohm, 1%
R3—20,000-ohm, trimmer potentiometer
R4—6200-ohm
R5—3300-ohm
R6—220-ohm

CAPACITORS

(All capacitors must be rated at for least 16 WVDC.)
C1—10-µF, electrolytic
C2—200-pF, ceramic disc
C3—0.022-µF, metalized film
C4, C5, C8—0.001-µF, ceramic disc
C6—27-pF, ceramic disc
C7—180-pF, ceramic disc

INDUCTORS

L1—0.47-µH, RF inductor, TOKO 7KSM series
L2—0.6-µH, antenna loading coil
L3-L5—50-µH, miniature RF choke
T1—RF transformer (see below)

ADDITIONAL PARTS AND COMPONENTS

S1—Single-pole single-throw, momentary contact pushbutton switch
XTAL1—49.890-MHz series resonant crystal
Printed-circuit board, antenna (one-meter whip or, a one-meter length of #22 hookup wire), enclosure, 8-pin DIP socket, wire, solder, etc.

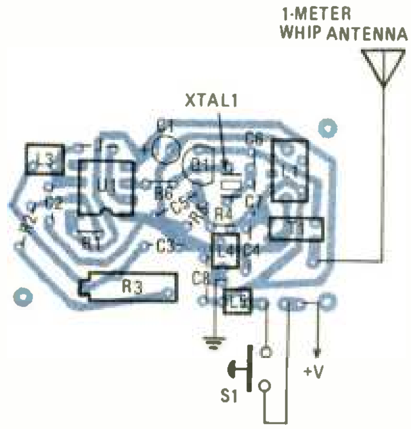


Fig. 5. Following this layout diagram, assemble the transmitter, being mindful that the resistors are vertically mounted on the board due to tight spacing.

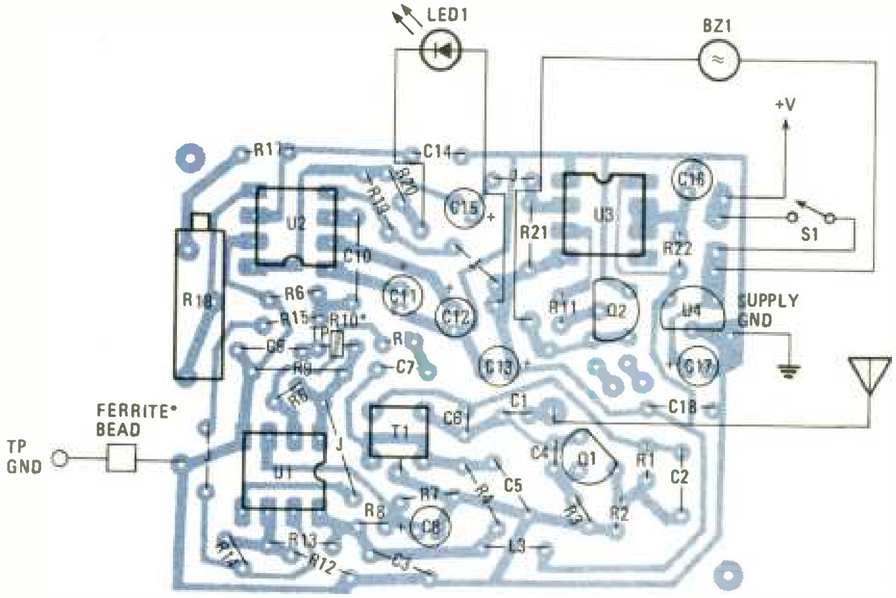
and Fig. 7A for construction details) is made by bending a ¼ inch, 180-degree loop in one lead of resistor R6. Install and solder the resistor onto the printed-circuit board so that the loop is accessible with a test probe.

Similarly make two test points on receiver's printed-circuit board (see Fig. 6 for their locations). Test point TP1 (see Fig. 7B) is made by inserting a ferrite bead over one lead of resistor R10. Make a ring in the lead so that the bead stays in place, and then solder the lead to the board. Install a second ferrite bead over a ½-inch length of hookup wire to form TP2. Bend the end of the lead into a ring to secure the ferrite bead in place, and connected the other end (with the ferrite bead installed) on the printed-circuit board.

On the transmitter circuit, solder one lead of the antenna loading coil, L2, to the printed-circuit board, and attach the other lead to the base of the whip antenna.

Tuning. The following alignment procedure uses a frequency counter and an amplifier/speaker with an auxiliary- or microphone-input jack. All test points are referenced to the circuit-board ground.

Temporarily, remove U2 (receiver) from its socket. Apply power to the transmitter and receiver circuits. Adjust trimmer potentiometer R18 for 490 Hz while measuring the frequency at TP2 (receiver). Similarly, adjust R3 for 490 Hz while measuring the frequency at TP1



*SEE TEXT

Fig. 6. Assemble the receiver printed-circuit board, using this layout diagram as a guide. Note the locations of the two ferrite beads, and be sure not to leave them out.

(transmitter). Remove the frequency counter and attach an audio amplifier/speaker to TP1 (receiver).

Using a small screwdriver, adjust the core of T1 (receiver), and the core of L1 (transmitter) until the top of each core is even with the top of its housing. A rushing noise, and possibly the 490-Hz tone, should be heard. Alternately, adjust L1 and T1 for the strongest reception of the 490-Hz tone. Next, place the transmitter at the fringe of its range and tune T1 (receiver) for the best reception. Disconnect all test equipment and power, and reinsert U2.

A second harmonic of the transmitter's signal may be detected on an FM receiver tuned to about 100 MHz. If so, minimize that signal by carefully adjusting L1.

PARTS LIST FOR THE RF RECEIVER/ALERT BEEPER

SEMICONDUCTORS

U1—LM358 dual op-amp integrated circuit
U2—LM567 tone decoder, integrated circuit
U3—7555 CMOS oscillator/timer integrated circuit
U4—78L05 low power +5-volt regulator, integrated circuit
Q1—MPSH11, ECG229, TCG229, or SK3246/229, NPN RF silicon transistor
Q2—2N3904 general-purpose NPN silicon transistor
LED1—Light-emitting diode (any color)

RESISTORS

(All resistors are ¼-watt, 5%, units unless otherwise noted.)
R1, R11, R21—10,000-ohm
R2—2200-ohm
R3—47-ohm
R4—2000-ohm
R5—4700-ohm
R6—470,000-ohm
R7, R8, R22—100,000-ohm
R9—6200-ohm
R10—56,000-ohm
R12—47,000-ohm
R13—33,000-ohm
R14—20 megohms
R15—6800-ohm
R16—1300-ohm
R17—15,000-ohm
R18—10,000 ohm, 20-turn, trimmer potentiometer
R19—20,000-ohm
R20—1000-ohm

CAPACITORS

C1—5-pF, ceramic disc
C2, C5—0.002-µF, ceramic disc
C4—24-pF, ceramic disc
C6—18-pF, ceramic disc
C7—0.039-µF, metallized film
C8, C16, C17—10-µF, electrolytic
C3, C9, C18—0.01-µF, ceramic disc
C10, C14—0.1-µF, metallized film
C11—4.7-µF, electrolytic
C12—0.47-µF, electrolytic
C13—100-µF, electrolytic
C15—1.0-µF, electrolytic

ADDITIONAL PARTS AND COMPONENTS

L1—50-µH, RF choke
T1—RF transformer
S1—Single-pole, single-throw toggle switch
Printed-circuit board (see below) or perfboard, VHF ferrite beads, antenna (two feet of #22 hookup wire), 8-pin DIP sockets, plastic enclosure, piezo buzzer, hookup wire, solder; hardware, etc.

ORDERING INFORMATION

Note: The following components for the project are available from Time Space Scientific, 101 Highland Dr., Chapel Hill, NC 27514:

TRANSMITTER

TS3 printed-circuit board, $9.95; TR6-1 inductor kit includes T1 and L1–L5 only, $10.95; complete transmitter kit TR6-2 (including all semiconductors, resistors, capacitors, one DIP socket, $26.95. Antenna, switch, and enclosure not included.

RECIEVER COMPONENTS

TS3310, transformer T1, $7.95; TS2 printed-circuit board, $8.95; complete receiver kit RC2-1 (including all semiconductors, resistors, capacitors, ferrite beads, L1, T1, antenna wire, and DIP sockets) is available for $27.95. Enclosure and battery not included.

Add $4.50 for shipping and handling (a one time charge covering all items ordered). NC residents must add sales tax. For technical information write to Time Space Scientific at the above address, and include a self addressed stamped envelope.

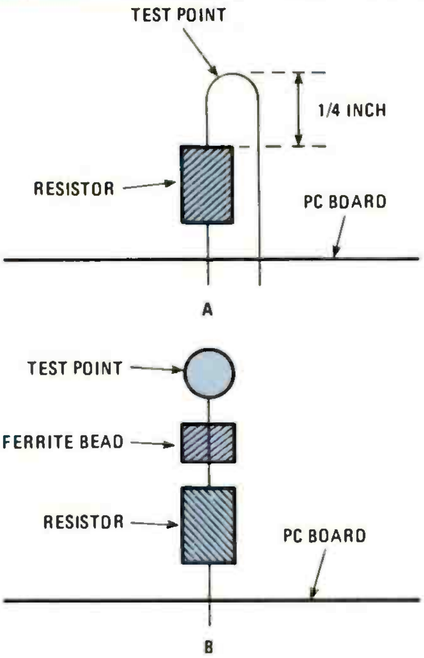


Fig. 7. Shown here are construction details of the test point terminals.

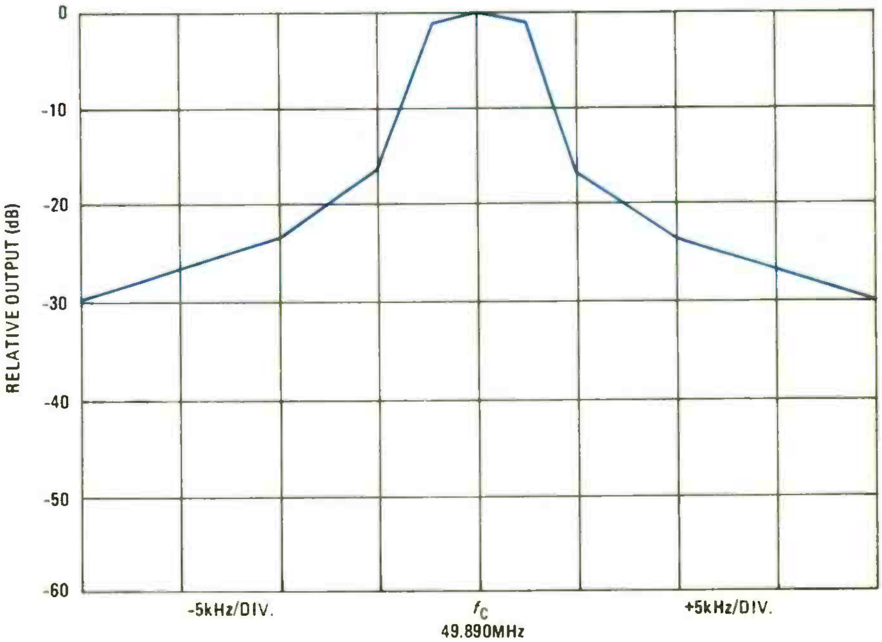


Fig. 8. This diagram illustrates the RF of the transmitter, as seen on a spectrum analyzer. As Required by FCC regulations, Part 15, the bandwidth is less than +/–10 kHz.

FCC Rules. The Personal Pocket Pager is designed to comply with part 15 of the FCC rules and regulations. It can be built without having to obtain special permission from the Federal Communications Commission. However, it is recommended that you read part 15, sections 15.133, 15.118 and 15.119 of the Federal rules and regulations which are available at most libraries.

Figure 8 shows the signal of the RF transmitter, as seen on a spectrum analyzer. As required by FCC regulations, Part 15, the bandwidth is less than ±10 kHz. ■

BUILD THE SPEEDI-WATT

Here's an easy-to-build circuit that can be used as an electronic speed control for electric drills or fans, as a power controller for electric blankets or soldering irons, or as a lamp dimmer, and for much, much more.

Look around your home and you will probably find a number of AC-powered appliances that could provide improved service to you and your family with the use a speed or power controller. We've put an electronic controller together that we call Speedi-Watt* that is ideal for that purpose. Speedi-Watt is cheap to build, compact in size, and, best of all, it is very easy to put together. As a bonus, Speedi-Watt incorporates electromagnetic-interference (EMI) suppression circuitry. That means that you will not be plagued by those herringbone TV patterns that more electrically-noisy units produce.

The Speedi-Watt is an easy-to-make circuit module to which you will need to add a knob, a three-wire power cord, a three-terminal AC plug and matching AC socket, and a suitable plastic case. The whole project should go together in about one evening.

The resulting dimmer and speed control is suitable for lamps, fans, or universal motor loads up to 500 watts (or approximately 4 amperes at 117-volts AC). By universal motors, we mean AC motors with brushes such as those used in electric drills, food mixers, and sewing machines.

Circuit Details. Speedi-Watt's schematic diagram is essentially a typical dimmer circuit that uses a phase-controlled Triac (TR1) as the power-control element. A Triac is a high-power switching device developed by General Electric about 25 years ago. It is similar in function to a silicon controlled rectifier (SCR) or thyristor.

*This story first appeared in Silicon Chip, Australia (December, 1987); reprinted here with permission.

In effect, an SCR is a bipolar switch that can operate at AC frequencies up to 400 Hz. Like a silicon controlled rectifier, it is non-conducting until it receives a trigger voltage between its gate and the anode electrode (MT1). When that happens it switches into conduction and remains that way until the voltage reverses in polarity or the current dies away to zero.

The difference between a Triac and an SCR is that while an SCR will only work with one voltage polarity, the Triac will work with both. It can conduct on both half-cycles of an AC waveform. It can be made to control the AC power fed to a load merely by being made to conduct early or late in each successive AC half-cycle.

Such a method of power control is referred to as *phase control*, because the timing of the gate trigger pulses is varied with respect to the phase of the AC waveform.

The device used to generate the trigger pulses is the Diac (D1), also developed by General Electric at the same time as the Triac. A Diac is referred to as a breakdown diode because it is non-conducting at all voltages up to its breakover point. When the breakover point is reached, it "breaks down" to the conducting state. It remains in that state until the voltage reverses in polarity or the current dies away to zero.

The Diac is used in conjunction with a capacitor to deliver a pulse of current to the gate of a Triac.

Now look at the complete circuit of Fig. 1. Note that the Speedi-Watt circuit works at 117-volt AC power-line potential. In other words, the whole thing is inherently lethal if you touch any part of the circuit while it is connected to the AC power line. Don't worry, though—when it is correctly assembled it is completely safe.

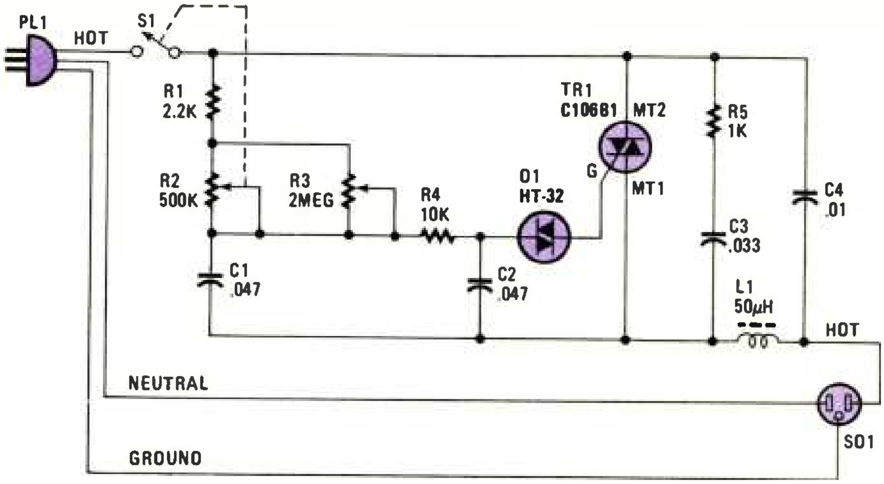
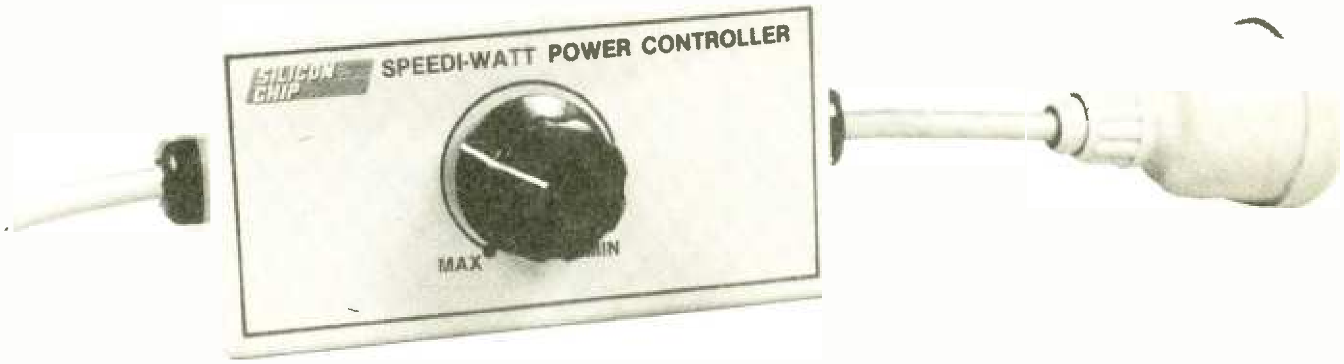


Fig. 1. The circuit for Speedi-Watt is a standard light dimmer with components for RFI suppression and a snubber network. The latter consists of resistor R5 and capacitor C3 which reduce the counter-EMF caused by the load at SO1.



BY LEO SIMPSON

The hot lead of the AC line connects to a single-pole switch (S1) and then to resistor R1, which feeds two potentiometers (R2 and R3) which are both wired as variable resistors in parallel. Potentiometer R2 is Speedi-Watt's control element; it feeds current to capacitor C1 and to a second changing network consisting of resistor R4 and capacitor C2.

When the voltage across C2 rises above about 30 volts (either polarity), the Diac (D1) breaks over and delivers a trigger pulse to the gate of the Triac (TR1). That causes the Triac to turn on and apply the full power-line voltage to the external load connected to SO1.

Varying the setting of potentiometer R2 alters the phase (timing) of the trigger pulses fed to the Triac and so alters the average power level fed to the load.

Resistor R5 and capacitor C3 form a *snubber* network across the Triac to protect it from back-EMF voltages generated by inductive loads each time the Triac turns off.

Inductor L1, a 50-µH choke, and capacitor C4 form an interference-suppression filter. Some of those essential components are often not incorporated in usual domestic light-dimmer circuits.

PARTS LIST FOR SPEEDI-WATT

RESISTORS

R1—2200-ohm, ¼-watt, fixed resistor
R2—500,000-ohm potentiometer, PC-mount optional (includes switch S1)
R3—2-megohm, trimmer potentiometer, PC mount
R4—10,000-ohm, ¼-watt, fixed resistor
R5—1000-ohm, 1/4-watt, fixed resistor

CAPACITATORS

C1—.047-µF, 400-WVDC Mylar or ceramic capacitor
C2—.047-µF, 100- to 400-WVDC Mylar or ceramic capacitor
C3—.033-µF, 200-WVDC Mylar or ceramic capacitor
C4—.01-µF, 200-WVDC Mylar or ceramic capacitor

ADDITIONAL PARTS AND MATERIALS

D1—Diac, 27-37-volt (30-volt nominal), 50-mA (Teccor HT-32 or equivalent)
L1—50-µH choke, 4 amps (see text)
PL1—Plug, 3-terminal, AC-power type
Q1—Triac, 200-volts AC, 4 amps (GE type C106B1 or better)
S1—SPST switch (part of potentiometer R2)
SO1—Jack, 3-terminal, AC-power type
Plastic utility box, with plastic lid, (5¼ × 2⅝ × 1¾ in.), plastic knob, 3–6 feet of 3-wire, rubber-covered AC power cord, 2 power-cord grip grommets, 1 two-way insulated terminal block, solder, wire, hardware, decals, epoxy, etc.

Wiring It Up. You could use a printed-circuit board as the author did, but for you to make just one etched board would be time consuming. All that is needed is a perfboard and point-to-point wiring to interconnect and mount the components.

Should you plan to make several

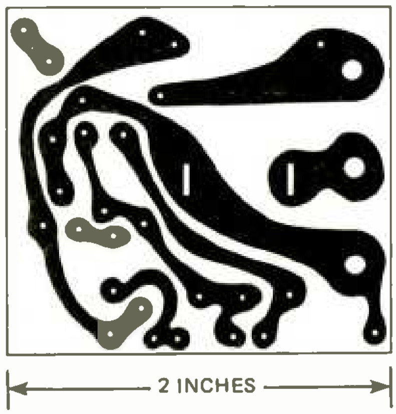
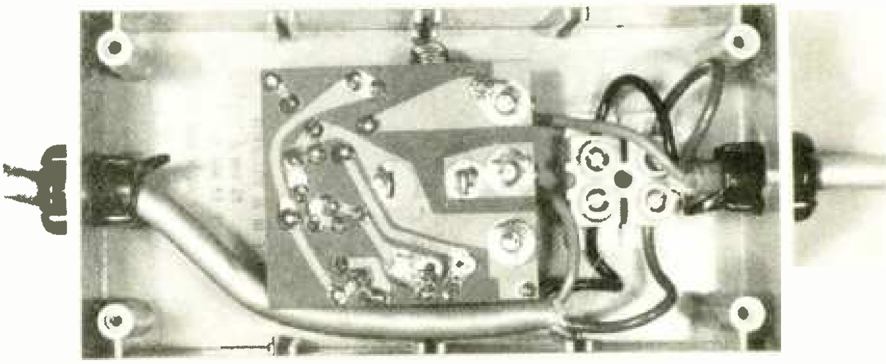


Fig. 2. The same-size foil pattern is shown here for those who wish to use a printed-circuit board. A perfboard circuit would operate just as well.



The circuit board was mounted in a plastic case to make a handy speed control. The power cords are anchored with cord-grip grommets. A larger plastic case is required to mount an AC outlet socket on the case instead of the power cord.

units, printed-circuit board construction is the way to go. The single-sided copper-clad board is small, measuring only 1¾ × 2 inches. You can make several from the standard-size sheets available at most electronics stores. Use the same-size foil pattern shown in Fig. 2 and mount parts on it using Fig. 3 as a guide.

Since the circuit is electrically hot, a plastic-shaft unit is recommended for potentiometer R2 to minimize the possiblility of shock. If you cannot locate a plastic-shaft potentiometer, use epoxy to secure the knob to the potentiometer shaft; do not use the set screw.

Note that the board is designed to accommodate the special potentiometer/switch unit that the author used in the original prototype. That unit may be difficult to find in this country. It is perfectly acceptable to mount any 500K potentiometer/switch combination on the case instead of the board and use leads to connect the parts. Suitable units are available from Mouser Electronics (2401 Highway 287 North, Mansfield, TX 76063), and many other distributors.

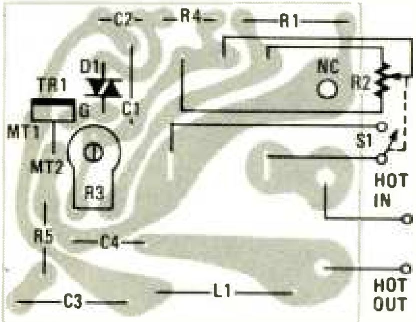


Fig. 3. The completed printed-circuit board with all the parts in place is shown here. You may have trouble finding the brass screw terminals, so solder leads directly to the board from the power cords. The bottom terminal was not used.

Choke L1 can be fabricated by winding 35-50 turns of No. 18–20 enameled wire on a 1-inch O.D. (outside diameter) toroidal core. If you wish, you can also use a J. W. Miller M5248 heavy-duty hash choke (available from Mouser and others); that is a 68-μH, 5-amp unit, but will work fine for this application.

Use a plastic case and use a knob that completely covers the shaft and mounting hardware. A good size plastic case for Speedi-Watt should measure about 5¼ × 2⅝ × 1¾ inches. The author fitted a 3-terminal AC line socket to a short length of three-wire power

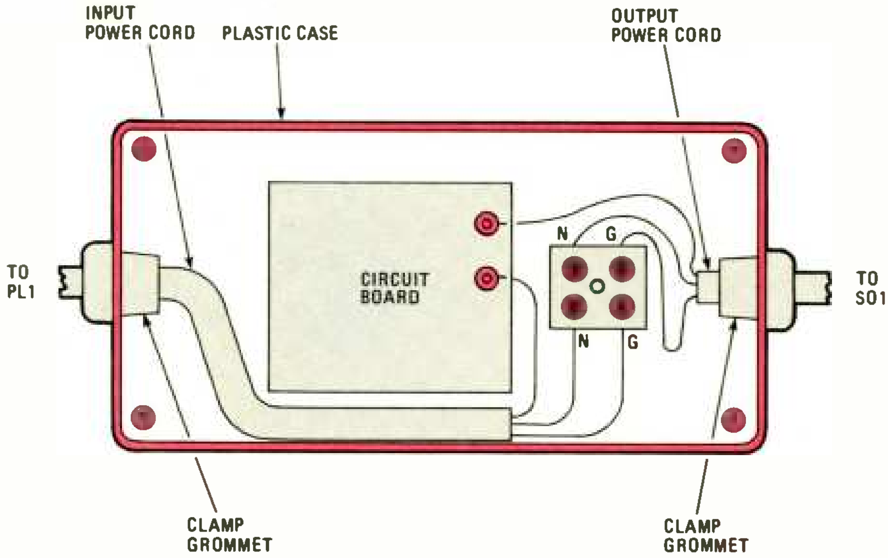
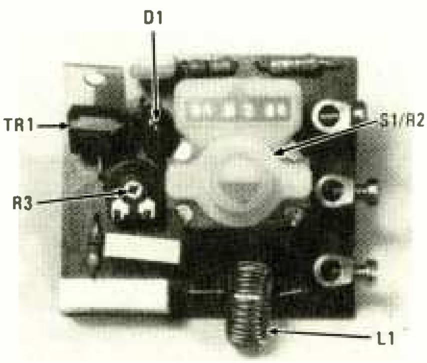


Fig. 4. Wiring the Speedi-Watt is no problem at all once the printed-circuit board is completed. Connect the AC power cords to the plug and socket.

This is what Speedi-Watt looks like when it's finished. The neat all-plastic construction ensures against possible shock hazard.



The circuit board looks like this when the potentiometer and the brass terminals are fitted. The original design allowed for connecting the wire from the middle to the bottom terminal when an external power switch is used to control the circuit.

cord and a three-pin AC plug to another length of three-wire power cord. Both of those power cords had the insulation stripped back at one end and then they were fed into opposite ends of the case and anchored with cord-grip grommets.

Speedi-Watt is connected as shown in Figs. 1 and 4. Note the optional two-way insulation terminal block used to terminate the ground and the neutral wires from the two power cords. The terminal block should not be anchored to the case with metallic hardware, but secured with a dab of epoxy or some super glue. The idea is to avoid having any exposed metal work on the surface of the plastic case.

When you have completed the wiring, switch your multimeter to the low-ohms range and check the continuity of the ground and neutral wires from the AC plug to the AC socket. Check also that there is no resistance between hot, neutral, and ground for both the AC-line socket and plug. If all is ok, your Speedi-Watt dimmer is ready for set up and use.

Test and Adjustment. Now connect a table lamp and plug the dimmer into a wall AC outlet. You should be able to smoothly control the lamp brightness over the potentiometer's whole range.

With that accomplished, you can, if you wish, set the minimum brightness of the lamp by adjusting trim potentiometer R3. That is a trial-and-error process though and you should not make any adjustments to the circuit while the AC voltage is applied. ■

GIZMO®

JANUARY 1989 A CHRONICLE OF CONSUMER ELECTRONICS VOLUME 2, NUMBER 1

CIRCLE 63 ON FREE INFORMATION CARD

Fax to the Max

TOSHIBA FACSIMILE MACHINE (3300). Manufactured by: Toshiba America, Inc., Telecommunication Systems Division, 9740 Irvine Blvd, Irvine, CA 92718. Price: $1,995.95.

In the world of consumer electronics, the 1980's might carry the designation "decade of the facsimile machine." Since 1981 the use of facsimile transmission devices has increased dramatically. By some estimates, there are about two-and-a-half million of those devices currently in use around the globe. In the U.S. alone, an estimated one-and-a-half million machines will be in use by 1990.

A decades-old technology, facsimile transmission took off as a result of a couple of factors. In the early part of this decade, digital microprocessors replaced mechanical parts in the machines, increasing their reliability and bringing down their cost. Then, in 1981, the International Telegraph and Telephone Consultative Committee adopted a set of standards that made it possible for most units, regardless of manufacturer or country of origin, to communicate with each other. Suddenly, the fax machine was the hot new business and communications tool. Today there are about 30 manufacturers of the units and some 100 models on the market.

The *Toshiba Facsimile Machine (3300)* is a representative example of the units that are gaining favor with all kinds of businesses, institutions and professionals. **GIZMO's** encounter with the 3300 makes clear the reasons for the explosive growth in fax use. Once the simple protocol of usage is understood, that machine is extraordinarily easy to operate. If a person can use a telephone and a copying machine, he or she can use a fax.

Outfitted with a telephone handset that

includes a keypad, the 3300 also incorporates a second phone keypad and can memorize 30 fax numbers (dedicated facsimile-transmission phone lines) and another 30 non-fax numbers. Other telephone features include last-number redial, speed-dialing from memory, handset volume control, on-hook dialing, tone-/pulse-dialing selection, adjustable ringer, and even a "digitized music-on-hold selection." A back-up battery system protects the memory function against power failures.

At the front of the 3300, a roll of thermal paper is inserted into a covered compartment. Received transmissions are printed on that paper; when the unit is used as a low-volume copying machine, the thermal paper is also used for reproductions. To use as a copier, the original document is inserted into a slot in the rear top of the unit and the start button is engaged, just as if the document was to be transmitted. However, when the 3300 is not communicating with another fax, the unit copies the inserted document onto the thermal paper. It can even make enlargements. The 3300 wasn't the most efficient or fastest copier we'd ever used—but sitting right there on the desk, it was extremely handy.

A "manual/automatic" control allows that fax machine to be used both as a combination telephone/fax-transmission unit or for unattended receiving of documents. Set to manual, telephone calls can be received in the usual way. If the high-pitched tone that signals facsimile transmission is heard when the receiver is picked up, a press of the start button will put the 3300 into the fax mode (during which no conversations can be carried out via the handset). When sending, the start button activates the fax-signal tone.

Even in the auto-receive mode, a "voice monitor" function allows the sender to talk to the 3300 user before sending the facsimile message. In that mode, the sender's voice is heard over the unit's monitor speaker.

Setup requires connection to the phone line (with a modular jack) and connection to either a three-prong electrical outlet or to a standard outlet with an adapter. The machine is readied for use with a function keypad located under the 3300's LCD display. (The LCD display, by the way, can be set to show information in either English or French using the function keypad.) A reset button and a paper-jam bar complete the unit's top-mounted controls. At the back of the machine, a volume dial adjusts the loudness of the monitor speaker.

Gizmo is published by Gernsback Publications, Inc., 500-B Bi-County Blvd., Farmingdale, NY 11735. Senior Writer: George Arthur.

The LCD display guides the user through each setup step: Selecting dialing mode; time and date setting (each document sent carries this information as well as the name of the sending party, business or company); facsimile resolution and contrast; LCD contrast; ring delay; auto-receive mode; elapsed-time alarm (a signal goes off every three minutes to help keep track of time, especially for long-distance transmissions or calls); and a function called "auto journal." That last feature enables the 3300 to print out a record of the last 20 facsimile transmissions.

During fax transmission, the LCD continues to offer step-by-step guidance. When a number is dialed, the display shows it. Once fax-to-fax connection is established, the LCD shows "on-line," and indicates what class of facsimile machine is on the other end (G-3 or G-2; the 3300 is compatible with both). Finally, during transmission the display will indicate success—"pg. 1 okay" or a similar message—or point out problems—"paper jam" or "send again" (indicating fouled-up transmission).

A second source of information is the recording paper itself. As the manual explains, "trouble codes are printed on the recording paper when operational problems have prevented normal communications." If the display shows "NG" (for "no good") a two-digit number will appear on the paper, signaling such maladies as a paper jam or overheating.

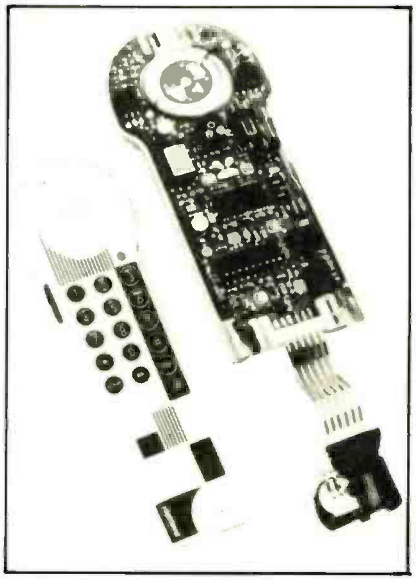
Being new to the wonderful world of fax, it took us a few false starts to get the hang of it, but soon we were sending documents across town and across the country. One problem we had was that the more slowly the transmitted document went through the fax, the larger its transmitted version was. That was caused by having the paper-jam bar in the wrong position. The Toshiba instruction manual isn't altogether clear about the positioning of the bar; it took a call to the company's toll-free service number to discover what we were doing wrong.

According to Toshiba, facsimile transmission via telephone lines works like this: The originating fax scans the document and converts the information into a data stream representing the black-and-white elements of the original. That is sent via the phone line to a receiver in the receiving facsimile unit that records the image line-by-line, creating an exact duplicate, or "picture," of the transmitted document.

However it works, fax is faster and often cheaper than other hard-copy communications methods. For an obvious example, it's a good deal cheaper to make a four minute long-distance call to fax some documents than to send the same information via an overnight express service. The 3300's delay-send function even allows the user to set the machine to take advantage of lower telephone rates that are in effect during certain hours of the night.

Fax owners are also finding out that, just as with standard mail and telephones, there's a certain tendency toward frivolous or unwanted fax use. In some parts of the country, unsolicited sales-promotion literature is transmitted to unsuspecting facsimile owners whose fax numbers have turned up on lists circulating among sales personnel in the area.

But the fax revolution is undoubtedly here to stay. When (and if) prices ever come way down, the era of electronic mail on a massive scale will finally arrive. (We wonder will happen to the Post Office in that event?) What shape that era might take remains to be seen, but judging from the Toshiba 3300, the technology is already at hand. ■



Swisstel Retell

The following is a response to GIZMO's report on the Swisstel Telephone (October 1988) from Peter Buckles, president of Swisstel, Inc. (300-1 (c), Route 17, Lodi, NJ 07644).

The test report on the *Swisstel Telephone* which appeared in **GIZMO** bears only a passing resemblance to the actual Swisstel telephone, which since its market introduction in May, 1987 has been well received by many satisfied consumers.

Instead of enumerating the often erroneous statements in the article, we want to outline the overall technological qualities of the instrument. Though it is a corded telephone, it has virtually no interior wires; instead, it has "Surface Mounted Design" (SMD) circuitry, produced by state-of-the-art robotic production technology. While countless telephones contain a jungle of interior wires, Swisstel's interior is as clean, sleek, and well designed as the telephone itself. Indeed, its SMD circuitry permits Swisstel to market a telephone that is a mere half-inch thick and weighs only 3.5 ounces.

Though we are proud of Swisstel's singular design features, we are even prouder of its quality—a direct result of its robotic production technology. That technology has eliminated all potential problems caused by human error during the instruments' manufacture. (Such problems plague other telephone manufacturers, who rely on individual workers to solder wires into place correctly time after tedious time. With one mistake an entire unit can malfunction.) Thanks to Swisstel technology and design, we offer consumers a five-year warranty, one of the longest in the telecommunications industry.

We have tested thousands of individual Swisstel instruments and each one offers superb audio quality. Swisstel uses the finest audio components available. It has received glowing reviews from Associated Press, United Press International, *Business Week*, the New York *Daily News*, and *Newsweek*, among others.

Swisstel is one of the most successful new phones introduced in the United States in the past quarter century. It is selling briskly in department stores and specialty shops, where many of our purchasers are women, ages 18 through 46.

Available in ten attractive colors and with 5 colorful accessories, Swisstel Telephones are technologically advanced designer telephones of the very highest quality. To prove our point, we invite anyone to visit our facility in New Jersey and test as many Swisstels as they would like. We are convinced that once you test a Swisstel (fairly and accurately), you will love the phone.—*Peter Buckles* ■

VIDEO CUT UPDATE

Our October report on the *Video Cut 10* neglected to mention that the Dot Line Corp. (11916 Valerio St., N. Hollywood CA 91605), as well as Photo Systems, Inc., distributes the product in the United States. The *Video Cut 20*, a companion product to the Video Cut 10, has a suggested retail price of $2,349.50, not $2,200 as **GIZMO** reported.

Tower of Power

PARSEC INDOOR FM ANTENNA (LS-4). Manufactured by: Parsec of Delaware, Ltd., 400 W. 9th St., Wilmington, DE 19801. Price: $59.95.

New York, where **GIZMO** does its testing, can be an FM listener's nightmare. There are few problems associated with receiving the big, powerful signals at the center of the dial. But the various non-profit, educational, ethnic, and low-power stations—mostly at the lower end of the dial—are like ghost radio stations. They exist, they offer unique programming, but often they're more heard about than heard. At certain locations and times of the day the stations may come in clearly, but it seldom lasts. Most often they disappear in a burst of static, to be replaced by some higher powered neighboring signal.

Or at least that's been our experience (and not just in New York), when depending on the standard wall-mounted simple dipole antenna for FM reception.

Parsec of Delaware, Ltd., a company that specializes in FM antennas, manufactures three different units that promise to deliver superior performance: The Beam Booster, an FM Dish, and the *LS-4 Indoor FM Antenna*, which **GIZMO** tested. Both the dish and the LS-4 use what's described as a "Gallium Arsenide Field Effect Transistor" for "higher gain and lower noise levels to FM signals than traditional metallic silicon transistors."

The LS-4 is 17¼-inch tall obelisk (think of the Washington Monument) with a small green power-indicator light and a gain-adjustment knob mounted on one side. The unit, which plugs into a wall outlet with an AC adapter, is supplied with three types of receiver connectors—F-plug, screw, and "pushbutton" style. Setup takes just a little more time than tuning in a hard-to-receive FM station.

CIRCLE 67 ON FREE INFORMATION CARD

We used the LS-4 with both a six-year-old stereo receiver and a brand-new Onkyo quartz synthesized tuner amplifier (*TX-850*). While results were short of miraculous, the improvement in reception was noticeable in both units. Across the spectrum, reception was crisper and better modulated; that was particularly evident with the older receiver. The antenna's gain control was a useful secondary adjustment that seldom failed to tighten and brighten a station's sound.

The LS-4 didn't seem particularly effective at drawing in hard-to-receive FM signals. Lower-powered stations continued to elude tuning, their reception apparently depending more on atmospheric conditions than on anything within the listener's power to improve.

Set on its base, the LS-4 is an omnidirectional antenna. Parsec also advises that the higher the location of the antenna, the better the results. In a horizontal position, however, it becomes "highly directional," useful in receiving weak signals in some cases—namely, those in which the signal location of the desired station is known or (more limiting still) when the weaker signal isn't broadcast from a tower or structure shared with more powerful stations.

Horizontal use didn't have much effect when the LS-4 was used with our older receiver. But connected to the Onkyo TX-850, the same positioning did bring in stations otherwise unavailable. Assisted by the amp's computer-controlled "automatic precision reception system," weak signals were at least clean and unwavering, if slightly less robust than easily received stations. It was useful to reposition the horizontal LS-4 occasionally while listening; although, in at least one case, the station eventually disappeared under the assault of a bigger adjacent noise.

That was our experience. What Parsec says makes it all possible is a "noise figure less than 1.5 dB," adjacent-band rejection of "better than 26 dB," intermodulation of "less than 0.08 percent at 100 mV," and an amplification gain of "32 dB, minimum." Our ears tell us that the Parsec LS-4 is no panacea when it comes to unsatisfactory FM reception, but that it does work better (and looks a lot more attractive) than a dipole antenna fastened to the wall. Looking and generally sounding better add up to two reasons why that indoor FM antenna is worth an examination.

Parsec's FM Dish, introduced to the market last August, uses a "three-step am-

(Continued on page 6)

CIRCLE 64 ON FREE INFORMATION CARD

Letter Quality

SMITH CORONA ELECTRONIC TYPEWRITER (XL 2500). Manufactured by: Smith Corona Corp., 65 Locust Ave., New Canaan, CT 06840. Price: $229.

Word processing, laser printing, letter-quality computer printers...what many of us learned in high-school typing courses often seems as outmoded today as some skill learned in the past century. But, to borrow Mark Twain's well-known quote, reports of the death of the typewriter are greatly exaggerated.

In fact, contemporary electronic typewriters have borrowed a great deal from both word processors and computers. And as any but the most dedicated computerist will admit, there are times when sitting down to a typewriter keyboard makes a lot more sense than firing up the PC-printer combo.

If the typewriter is on its last legs, nobody's told *Smith Corona*, which introduced a new "executive line" of five typewriters in three different categories earlier this year. The *XL 2500* is the top of the Smith Corona line of electronic typewriters and a fairly convincing argument for the continuing utility of that century-old communications tool.

The XL 2500 offers a number of automatic correction features. Perhaps the most impressive is Smith Corona's trademarked "Spell-Right" electronic dictionary. That built-in lexicon offers 50,000 words and, on those new models, will catch word redundancies and beginning-of-sentence capitalization mistakes. When an incorrectly spelled word is typed, an audio signal is heard.

Perhaps unfortunately for users who aren't good spellers, the Spell-Right feature doesn't supply the correct spelling. Instead, once the typist has erased the misspelled word and typed in a correction, the function checks the new letter combination. Presumably, with really difficult-to-spell words and in the absence of a conventional dictionary, this signal-erase-new-spelling sequence could continue for quite some time. Errors the electronic dictionary can identify include misspellings, transposition of letters, repeating the same letters, unintended space between letters, and character omissions.

In using the XL 2500 we found it slightly disconcerting that proper names, in particular, would set off the misspelling signal. Smith-Corona apparently anticipated that reaction; the Spell-Right function can be disengaged by pressing the code key and the "D" key, marked with a book symbol designating the electronic dictionary feature.

The XL 2500's redundancy check can help eliminate a typing mistake especially common in transcription and retyping from manuscript—the typing of the same word twice in a row. The beep sounds when the same word is repeated. Finally, "Wordfind" will reposition the typewriter's print wheel under the incorrect word if the user has keyed in letters faster than the XL 2500 can print them. Although we're not particularly fast typists, we regularly outran the machine's printing speed when the automatic return was engaged. There's a limitation to that too, however. As the owner's manual explains, "changing pitch in the middle of a line or using the half space feature deletes correction memory."

Standard-typewriter features have been streamlined and expanded with the XL 2500. Spacing between lines (the user can select single, double, or one-and-a-half spacing); pitch selection (ten-characters-per-inch Pica or twelve-characters-per-inch Elite); and automatic centering and return are all set or engaged by pressing the code key located on the bottom of the keyboard and one of the top row of keys, each clearly designated by a guide printed just above the keyboard. Enhanced features that are engaged in the same manner are page-end signal (another beep) and subscript and superscript (clearly a feature borrowed from word-processing programs). One drawback is that spacing must be reset each time the typewriter is turned on—an easy-enough adjustment, but one that the novice XL 2500 user is likely to forget, at least at first.

One design aspect that we didn't like was the placement of the code and margin-set keys to the left of the space bar. The left margin is selected by moving the print element to the desired margin location and pressing the margin-set key. The right margin is set in the same manner, except that it's necessary to depress the code key. When first using the XL 2500, occasionally a finger would slip as it stretched to engage the code key or hit the space bar—and we found ourselves with a new left margin when the print element moved to the next line.

We also had some minor problems with the tab set. Although a beep is supposed to confirm each setting, our test model had a balky key which didn't always register the desired tabulation setting. Pressing hard or repeatedly brought a confusing two beeps and only occasionally set the tab.

The lift-off correction system, however, worked smoothly and cleanly. The "correct" key, to the right of the space bar, lifts off a single character. The "WordEraser" key lifts off an entire word with a single keystroke. Continuous pressure on the correct key will erase up to an entire line. Even when erasing bold-face words (which the XL 2500 creates by repeating and blackening the letters typed after the bold-face function is engaged), the removal was clean and complete.

Another new feature of this machine is Smith Corona's "Right Ribbon System." If the "wrong combination of ribbon and correction cassette is inserted," a flashing green light (mounted in the shift-lock key) indicates "mismatched ribbons and cassettes." The company says that the correction cassette for the XL 2500 and companion models is "the first drop-in correction cassette for a portable electronic typewriter."

The shift-lock light, in addition to indicating that upper-case letters are engaged, "flashes when the typewriter cover is not closed properly or the typewriter has received an incorrect command." That feature's powers of interpretation, however, are fairly limited. Perhaps it was merely our brief experience with the typewriter, but the light seemed to flash at least once every time we used the machine for reasons we that couldn't discern. The manual merely says that the cover should be properly closed or the space bar touched to "stop flashing light."

Once we knew our way around it, the keyboard was comfortable to use and had a fairly firm touch. And the finished product, the typed page, could stand comparison with pages issuing from typewriters costing hundreds of dollars more. Whether this lightweight machine, which makes extensive use of plastic parts, would give the years of use expected from more expensive typewriters is an open question. Even today, plastic has its durability limitations.

Equipped with a snap-in-place cover and a bottom-mounted carrying handle, the XL 2500's cord wraps neatly around a built-in rack at the back of the machine. Plastic construction shows its positive aspect in that this really is a portable machine, as much so as a briefcase or book bag. An exceptionally good machine for student use, or for the use of someone who types regularly if not all the time, the XL 2500 is easy to get used to and loaded with features that reveal their utility with use. It's a well-thought-out hybrid of word-processing functions and traditional typewriter features. ■

Radio Lilliputian

ACTION AM/FM HEADSET RADIO (7-1990). Manufactured by: General Electric Co., Audio Communications Products, I-455, P.O. Box 1976. Indianapolis, IN 46026. Price: $26.95.

The continuing miniaturization of consumer-electronic products has its marketing roots in the introduction three decades ago of the transistor radio. Hailed at the time for both its portability and its small size, the battery-powered, cigar-box-sized radios were a first step on the road that has led to complete music systems small enough to slip into a coat pocket.

While our attention these days is focused on other, more glamorous, products the garden-variety portable radio is still shrinking. The recently introduced *Action AM/FM Headset Radio (7-1990)* from *General Electric* is a bright blue-and-yellow palm-size package. But within its ½-inch thick, 3¼- by 1¾-inch case is an AM/FM radio worthy of the name. Clear reception produces impressive listening on a headset that delivers more than merely adequate sound.

According to GE, this is an "action" radio—weather-resistant and sturdy enough to withstand "the active lifestyles of music listeners of the 1990's" (making it a product only slightly ahead of its time). The diminutive receiver is sturdily designed, with headphone jack and battery compartment (for the 7-1990's single "AAA-cell" power source) protected by flexible vinyl covers. Its trio of controls, in yellow, lies flat against the case.

Anyone who has struggled with mini-radio tuning will appreciate one refinement in this unit. The AM/FM dial is among the most easily read we've seen on a midget radio. The two broadcast bands are clearly separated horizontally and a vertical thin red line makes the visual aspect of tuning in a station precise and easy for anyone with normal vision. The notched, nickel-sized, station-selection thumb wheel is easily manipulated. If our experience is any guide, users of the Action radio won't have to worry much about the slightly smaller volume wheel.

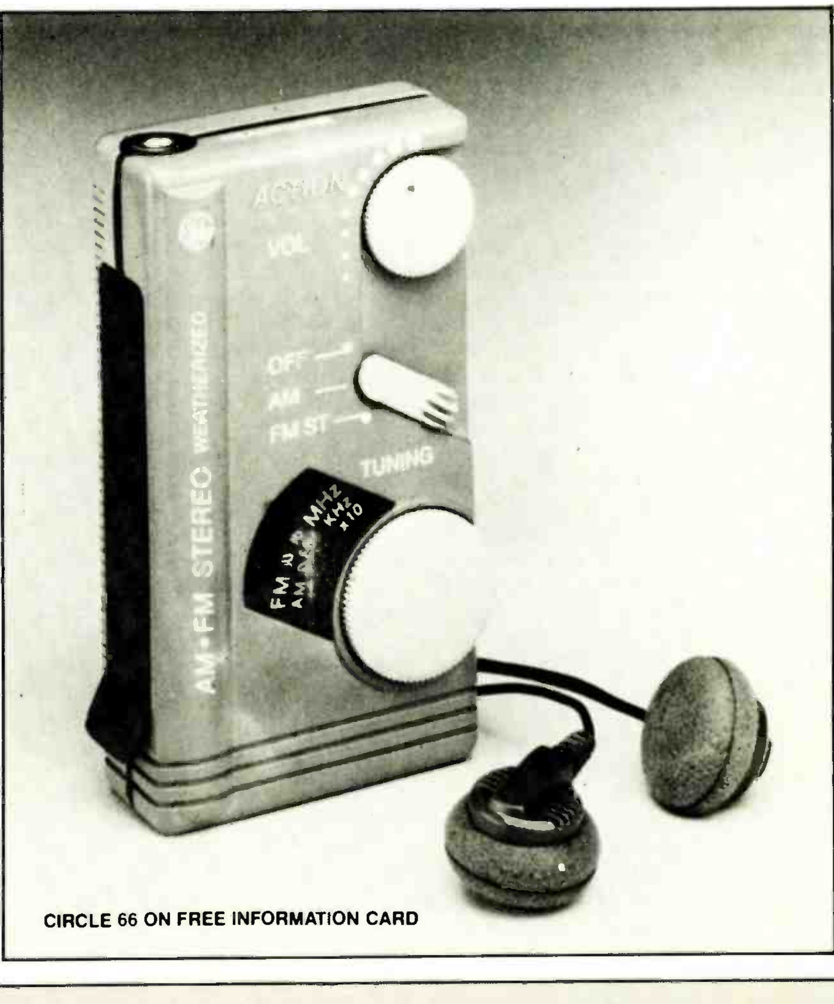
With a new battery, even at the lowest audio setting, the 7-1990 delivered plenty of decibels. Besides the simple directions, the radio's package includes a booklet warning against listening through the headset at excessive volume and including guidelines for "traffic safety." That advice is summed up with the slogan, "use your head when you use your headset."

In a variety of situations, the Action radio's reception, both AM and FM, was impressively clear and unwavering. Listening in the office (thanks to its headset) the small radio's sound was as well-modulated and clear as the same FM station heard through **GIZMO's** rather ancient office stereo receiver. Besides a built-in automatic frequency-control system, "to reduce station drift," the 7-1990 uses an AM antenna built into the radio and an FM antenna that is combined with the headset cord.

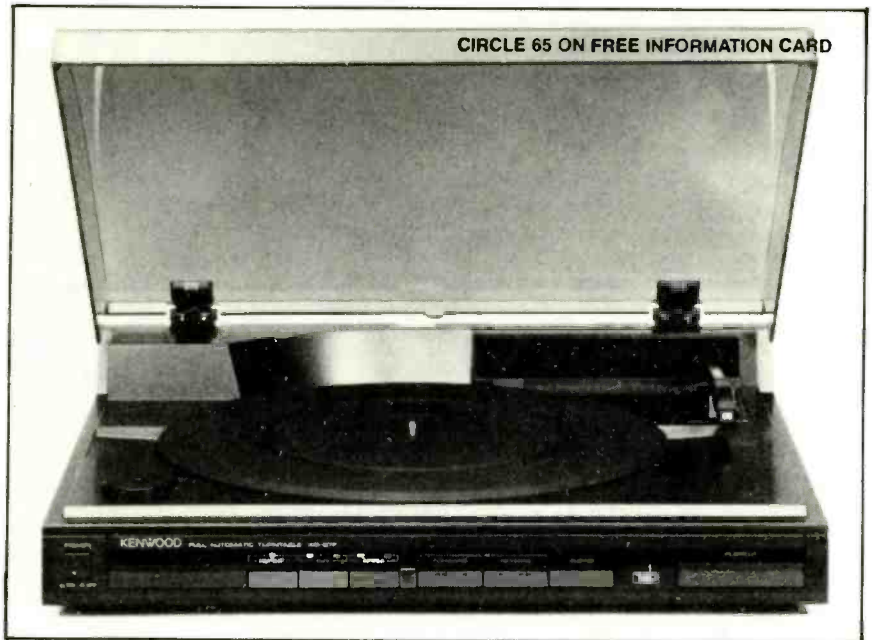
This being the real world, reception isn't, of course, perfect. Walking down an urban street, with signals bouncing off buildings and each other, stations would cut in and out and static could build to unbearable levels. But blaming the 7-1990 for that is akin to blaming the messenger for bad news. Within the given limitations, the radio is a satisfactory personal-size receiver.

In one respect, this mighty mite for the '90s represents little advance over its portable-radio ancestors. Portability is dependent upon a vinyl-like fabric case, through which a strap passes, allowing the radio to be worn on arm, waist, or even as a headband. The carrying-case openings for the

(Continued on page 7)



CIRCLE 66 ON FREE INFORMATION CARD



Linear Thinking

KENWOOD FULL AUTOMATIC TURNTABLE (KD-67F). Manufactured by: Kenwood U.S.A Corp., 2201 E. Dominguez, Long Beach, CA 90810. Price: $209.

OK, everyone's agreed—the age of vinyl is drawing to a close and the anointed successor, the compact disc (aided and abetted by audio tape), is turning the LP record out to audio-reproduction pasture. But there still remain many millions of vinyl records (with new ones pressed every day) that still have a few more millions of miles to go around the turntable spindle before being trashed.

With the music industry whole-heartedly supporting the CD revolution, consumers owe companies like *Kenwood U.S.A. Corp.* a vote of thanks for actually marketing new turntables. (Don't they know the vinyl record is doomed?) Last year, Kenwood introduced two linear-tracking units, the deluxe *KD-77FC* and the turntable **GIZMO** had an opportunity to use, the *KD-67F*. Minus the KD-77FC's seven-program random-access-memory function, the KD-67F seems a good example of what a basic turntable is like in this electronic age of feature-laden components.

Not that this slick unit is just any platter-and-tone-arm generic turntable. Like its higher-priced sibling, the 67F mimics the music-selection methods associated with both tape and CD players. But (undoubtedly to some consumers' relief) it does so in a simpler manner. The table's smoked-finish clear cover is designed to stay closed at just about all times except when the record is being flipped or replaced.

Nine controls and two indicator lights are grouped across the front panel of the unit. The streamlined but standard turntable adjustments are power, a repeat function, and selection between long-play and single (30- and 17-inch) records. The size selection in turn cues a speed selection (unless the user independently selects rpm). A manual-search function, two controls that move the tone arm forward and back, and a two-way cuing control add some "full automatic" flexibility to the LP-listening experience.

Underneath the hinged cover, a lightweight linear-tracking tone arm, made of plastic, moves with a minimum of friction and contact across the record. Powered by Kenwood's advanced motor, the 67F's quiet operation is immediately apparent to ears accustomed to the rumble and surface noise that standard turntables often seem to pick up.

After a few weeks of using the 67F we wouldn't go as far as the Kenwood product news release, which describes the KD-67F as eliminating "all tracking errors." That leaves the record's condition out of the listening equation and, unfortunately, the turntable doesn't treat banged up or often-played LPs with any more tenderness than the standard traveling tone arm. Some of our more beloved albums revealed skips previously undiscovered and unheard. When the "tracking error" belongs to the record, no amount of precision engineering will help.

Although we're sometimes inclined to wonder if automatic operation is all that labor-saving, the KD-67F's simple-to-use primary controls won us over. After a while, the prospect of lifting a tone arm off its stand and putting it on the edge of a record seemed like time-consuming drudgery. The music-search system also turned out to be something more than window dressing. But we wish that the department that designed the turntable's cover had gotten together with the designers of the manual-search system. The semi-translucent cover makes it impossible to visually cue up a cut. While we experimented with shining a flashlight beam onto the LP, we finally deferred to reality and opened the cover when we wanted to skip a selection. At least the search operation can be operated with one hand.

Selecting record size each time the power goes on seemed less than handy. We also mourn the passing of manual "pitch control." Some of our favorite tunes sound better speeded up just a tad. This turntable lacks that option.

But one indisputable advantage emerged after our use of the unit. Records picked up significantly less dust and visible residue than on our usual turntable. Like tens of thousands of other audio slobs who listen to music in less than climate-controlled conditions, we've gotten used to picking little mats of fuzzy lint off the stylus before and after each record. With this Kenwood linear drive turntable, that became a hygienic ritual of the past.

"Win a few, lose a few" would seem to be the lesson of **GIZMO's** tests. While we could have done without the turntable's sensitivity in picking up skips on some older records, we were delighted by the end of discernible surface noise and the disappearance of stylus lint. Music search worked well, but linear tracking doesn't accommodate the flexibility embodied in manual pitch adjustment.

Maybe the best guide to making a decision about linear tracking is the condition of the potential buyer's record collection. Is the consumer considering jettisoning the entire vinyl library for new copies? At that point (to our way of thinking) the switch to CD would be on the agenda. If compact-disc proponents are right, consumers won't be faced with those kinds of quandaries for very much longer. Until then, the KD-67F clearly rates as an option worth having. ■

PARSEC ANTENNA

(Continued from page 3)

plification process" according to the company. Besides the Gallum Arsenide Field Effect Transistor, the unit features electronic tuning and a circular element that can be aimed to "focus clearly on one FM signal, thereby increasing signal strength another 3 dB anu eliminating multipath distortion." It's a serious FM antenna offered at the equally serious suggested retail price of $219.95. For consumers this side of fanatical regarding FM reception, the LS-4 may be just the ticket. ■

Budget Time

NDQ SPORTS TIME ALARM CHRONOGRAPH (SMWS8). Distributed by: NDQ Marketing, Subsidiary of Hattori-Seiko, 989 Sixth Ave., 7th Fl., New York, NY 10018. Price: $9.95.

It was the news release that attracted our attention to the *NDQ Sports Time Alarm Chronograph*. "NDQ Marketing Introduces Diver's Watch With Alarm & Chronograph," it was headed. It went on to describe the *SMWS8* as "a rugged diver's watch...ideal for scuba diving, snorkeling...".

Having a passing acquaintance with some of the truly extraordinary aquatic timepieces available, we thought a diver's watch at less than $20 was a major marketing achievement. But somewhere between the publicity and the product, the SMWS8 "diver's watch" became "water resistant to 150 feet."

All things considered, however, the NDQ Sports Alarm Chronograph is something of a marketing marvel, although of the sort consumers have become jaded about. Like the last century's "dollar watches," the contemporary micro-chip watch has put accurate time-keeping within reach of millions at a very affordable price. The "laser quartz" SMWS8 may not be a "rugged diver's watch," but holding it under a running faucet or keeping it in a container of water overnight didn't seem to affect its functioning during the week or so that we used it.

CIRCLE 39 ON FREE INFORMATION CARD

What almost capsized our test of the SMWS8, however, came at the start. Over the years we've formulated the informal rule of thumb: The more simple the micro-chip watch, the more complicated it is to set. This timepiece is not an exception to the rule.

We're not really sure what the problem was (although the directions printed on the watch packaging may be at the root), but the first SMWS8 we tried to set refused to follow the sequence outlined. A trio of case-mounted buttons control all of the watch's functions. Because of the need for a reasonably waterproof casing, the buttons are a trifle difficult to manipulate. The rigid plastic casing appears to be a single piece that includes the wrist strap, into which the timepiece is placed and sealed beneath the plastic "crystal." We finally used the eraser end of a pencil and pushed hard. Otherwise, the casing successfully resisted finger pressure.

The directions are straightforward and step-by-step; unfortunately the SMWS8 acted as if it hadn't read the instructions. When we pressed button "C" to set the time (or, in the nomenclature of the directions, to "enter the desired mode") and then pressed "B," the seconds did not begin flashing. Instead, the watch appeared to go into the stopwatch function—not our "desired mode." At that point, we felt completely lost. Directions for these watches always assume the user will go through the outlined sequence with complete success. There never seems to be any guidance on how to abort a maneuver and return to the starting point with a clean slate.

The watch finally was set by an associate who seems to have a knack for such tasks—a terribly imprecise and non-technological factor to depend upon. When we asked him what he'd done, he wasn't able to say.

Patience would seem to be the key. The second SMWS8 *NDQ Marketing* sent to us followed the sequence outlined on the package's instructions to the letter. Instead of the half hour of ineffectual poking and pressing we'd gone through with the first watch, the second was set and keeping time, and showing correct date and day, within 10 minutes of breaking it out of the package. However, as we discovered inadvertently later that same day, we'd managed to unknowingly set the timepiece's alarm function.

Perhaps the least likable aspect of this budget-priced watch was its so-called "one year warranty." A close reading of the tiny type outlining the offer revealed that it would cost $3.95—to offset "the cost of handling"—to send it to the "NDQ Service Center."

In any event, repairs wouldn't be on the agenda. Instead, a replacement watch, not necessarily the same model but "of equal value and similar appearance," will be sent to the warranty holder. A $4 charge to replace a $9.95 watch would seem to be poor marketing arithmetic.

But a warranty and repairs aren't really the point with today's extraordinarily low-priced electronic timepieces. Those are really disposable watches—timepieces the consumer can wear without worry and discard with impunity. Time may be money, but keeping track of it has seldom been so cheap, especially not at 150 feet under water. ■

GE RADIO

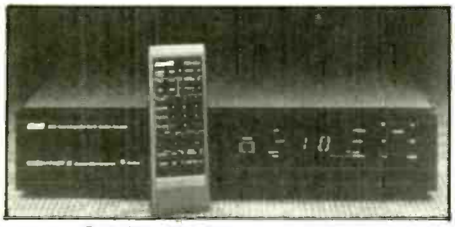
(Continued from page 5)

radio's tuning knob, volume control, and FM/AM and power switches partially obscures each. The highly readable dial was no longer visible, and sliding the radio into the case inevitably meant that volume, station, or band selection had to be readjusted.

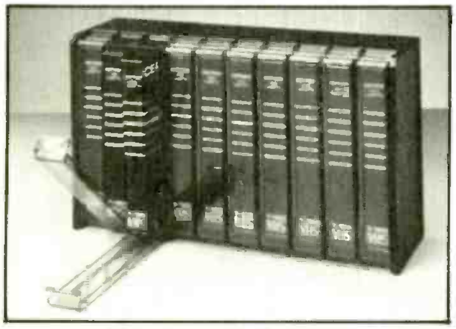
Despite its generally sturdy design, the Action AM/FM radio is by no means rugged. It may be "weather resistant," but the directions note that the headphones aren't, and that the radio itself is vulnerable to "salt water or salt spray."

But in our exposure to the 7-1990, its price-performance ratio seemed a positive one. If we found ourselves in need of a radio, say on a trip or during a general power outage, this GE model would fill the bill nicely. A small marvel of technology of the kind we've come to take for granted, this receiver is a worthy successor to the tiny portables of decades past. ■

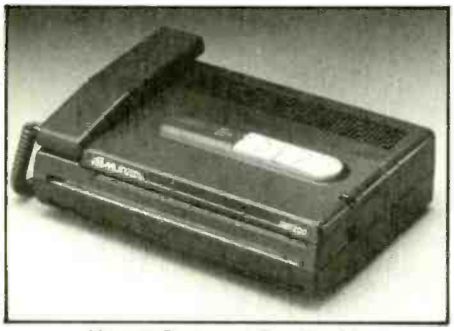
Gizmo/Bytes



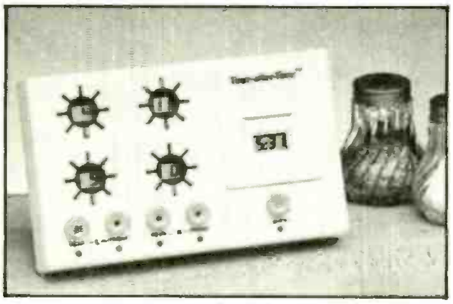
Satellite-TV Receiver Decoder



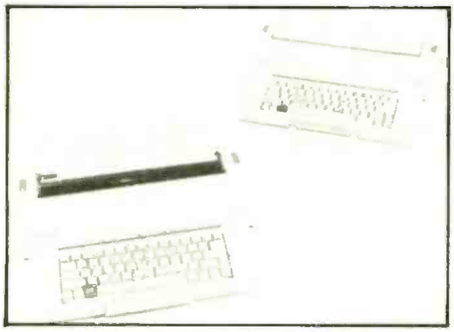
Videocassette Organizer



Murata Personal Fax Machine



Electronic Cooking Timer



Olympia Electronic Typewriter

Satellite-TV Receiver Decoder

If you're considering getting into satellite-TV reception but aren't interested in investing in a deluxe system initially, you aren't alone, according to *R.L. Drake Co.* (P.O. Box 112, Miamisburg, OH 45342). In response to consumer demand that company has introduced a new *Integrated Receiver Decoder (ESR1024)*, an "entry-level satellite TV receiver." In addition to a VideoCipher II decoder, the system includes "priority view," a capability allowing the owner to pre-program up to 30 channels, and a lock-out feature to restrict access to selected signals. An infrared remote control offers simplified programming and the IRD allows reception of digital stereo from subscription channels. The ESR1024 decoder is designed to make later upgrading or expansion of the system possible. Price (approximately): $900.

CIRCLE 57 ON FREE INFORMATION CARD

Video Library File

In the videocassette-storage field, the search for a "better mousetrap" continues. Among the newest entries is a ten-cassette capacity *Video Library Case/Organizer*, available in both VHS and Beta sizes. From *Certron Corp.* (1651 S. State College Blvd., Anaheim, CA 92806), the unit stores cassettes in individual plastic compartments for "extra protection from image-degrading dust and dirt." Each compartment has a separate cover that when opened, "provides a lever-action response...for easy, fingertip access" to each cassette. Price: $19.99.

CIRCLE 48 ON FREE INFORMATION CARD

Personal Facsimile

The manufacturer is calling it "the industry's lowest-priced, fully featured personal facsimile." The *Personal Facsimile (M1200)* from *Murata Business Systems* (4801 Spring Valley Rd., Dallas, TX 75244) incorporates the functions of a telephone, facsimile machine, and a copier into a unit weighing less than ten pounds. Its telephone features a keypad offering all standard phone features and the M1200's automatic/manual receive lets the fax operate either manually or automatically, eliminating the need for a dedicated phone line. In transmission, the machine offers normal- and fine- print resolutions and is compatible with both group 3 and group 2 fax machines. Murata calls the M1200 an affordable alternative to comparable equipment "for first-time and low-volume users." Price: $899.95.

CIRCLE 46 ON FREE INFORMATION CARD

Electronic Cooking Timer

Experienced cooks know that a big part of meal preparation is timing—specifically, getting everything onto the table at the proper time. *Hammacher Schlemmer* (147 E. 57th St., New York, NY 10022) distributes the *Time-after-Time Electronic Cooking Timer* that the firm calls, "the only five-course" culinary timer on the market. The device uses five individual timers to synchronize the preparation of up to five different parts of a meal. After entering the cooking time of each food, the unit's electronic processor calculates a schedule; an alarm and LED signal alert the cook to begin cooking each of the items. After all foods have been cooked, an alarm sounds and the meal is ready to be served. The Time-after-Time operates on two AA-size batteries (included) and can be mounted on stove or refrigerator with a built-in magnet. As with all the products it distributes, Hammacher Schlemmer offers an "unconditional guarantee." Price: $37.50.

CIRCLE 51 ON FREE INFORMATION CARD

Electronic Typewriter

A long-established manufacturer in the contemporary typewriter industry, Olympia, has a new moniker and a new line of "personal" typewriters. Now called *AEG Olympia, Inc.* (3140 Rt. 22, Box 22, Somerville, NJ 08876), the company has rolled out the "500 series," including the *XL 505 Electronic Typewriter*. The 505 offers a 5,000-character editing memory, a 50,000-word spell-check feature, automatic lift-off correction memory, and automatic word delete, plus automatic centering, carriage return, underlining, paragraph indent, and decimal tabulation. The typewriter can use a variety of Olympia printwheels. Price: $289.

CIRCLE 47 ON FREE INFORMATION CARD

Gizmo/Bytes

Integrated, Single-Step 35mm Camera

At its market introduction in September, the new Mirai *Integrated, Single-Step 35mm Camera* was dubbed "the world's most advanced camera" incorporating "the broadest range of photographic capabilities currently available in any single camera." Although technology moves fast nowadays, the Mirai from *Ricoh Consumer Products Group* (155 Passaic Ave., Fairfield, NJ 07009) is still on the cutting edge of photographic development. The camera, which even looks different from conventional 35mm units, includes a computer-controlled autofocus lens, built-in motor drive and flash units, automatic-exposure capabilities, motorized manual and macro focusing, and a super high speed shutter. The flash system alerts the user to underexposure before the picture is taken. The Mirai lens is a variable-focus type, rather than a conventional zoom lens. Among its advantages, when combined with the camera's constant automatic refocusing capabilities, is an unusually long focal range (rated by Ricoh at 4:1). An exclusive programmed "automatic backlight control" metering system allows the camera to automatically increase or decrease the exposure in variable amounts to handle extreme contrast. Another special feature of the Mirai is a "special sensor film transport system" using a double infrared system to "read" the film's perforations, with a choice between continuous advance at two frames-per-second or single-shot advance. The entire unit weights 33 ounces. Price: $795.

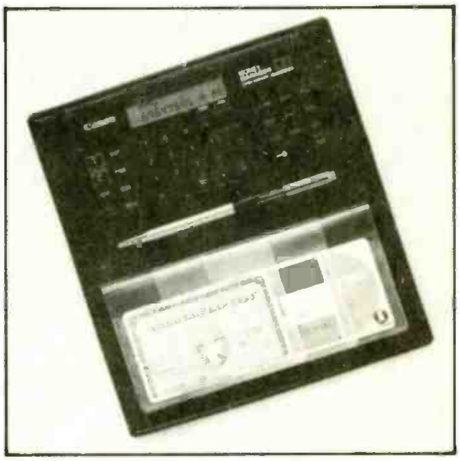
CIRCLE 43 ON FREE INFORMATION CARD

Integrated 35mm Camera

Checkbook Recorder

A big trend in consumer electronics is "getting personal" with the customers. A recent example is the "Personal Money Manger" *Checkbook Recorder* from *Canon U.S.A., Inc.* (One Canon Plaza, Lake Success, NY 11042). The calculator provides balancing calculations with transaction-history storage function for checking accounts and charge accounts. The Checkbook Recorder can keep track of every transaction with its description items, dates, and amounts once the user enters the data. A trio of search functions provide easy verification of transactions and a security function provides financial confidentiality. The unit features a two-line, twelve-digit display, including AM/PM designations, and month and day display. Up to 90 separate transactions can be stored in its three memory banks and up to a dozen description items (like house rent, car loan, utilities, telephone, food, etc.) can be stored. Power comes from a single lithium battery and the recorder comes equipped with a case and pen. Price: $32.95.

CIRCLE 53 ON FREE INFORMATION CARD

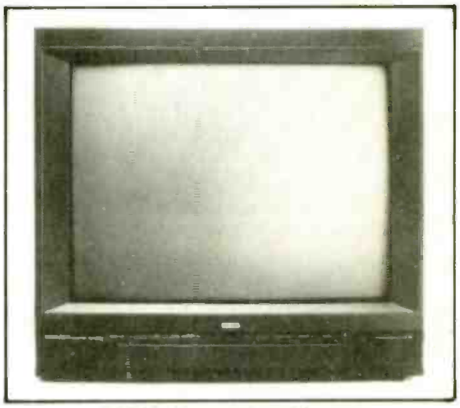


Canon Checkbook Recorder

S-VHS Compatible TV Monitor/Receiver

Super-VHS users are in luck. *Yamaha Electronics Corp., U.S.A.* (6660 Orangethorpe Ave., Buena Park, CA 90620) has introduced a 27-inch *S-VHS Compatible Television Monitor/Receiver (YM-270S)*, in addition to the two S-VHS monitor/receivers already offered by the company. The new YM-270S features a flat, square, picture tube; automatic color correction; 142-channel PLL-synthesized tuning; MTS; on-screen channel display; a stereo amplifier; two video inputs; and monitor and TV outputs. Other features include a clock, last channel memory, seven-day memory retention, black-level retention, and peak-white suppressor, and "stereo-wide" circuitry that is said to "expand the stereo image beyond the screen and cabinet when the YM-270S's own speakers are used." Price: $899.

CIRCLE 45 ON FREE INFORMATION CARD

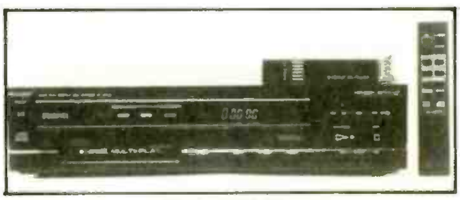


S-VHS-Compatible Monitor

Compact Disc Player

In its announcement of new CD players, *Sharp Electronics Corp.* (Sharp Plaza, Mahwah, NJ 07430) asserts that the new models are for "digital purists." But for many consumers, the most interesting feature of the new *DX-C5000 Compact Disc Player* will probably be its six-disc changer. The player can store up to 32 songs in memory, controlled via the front panel or by wireless remote. A digital display indicates the disc, track, and program number being played. The DX-C5000 also offers continuous and repeat play, and a memory back-up that stores an entire CD magazine's memory programs even while changing functions. The purists, we imagine, will be interested in the system's "double over-sampling digital filters." Price: $399.95.

CIRCLE 56 ON FREE INFORMATION CARD

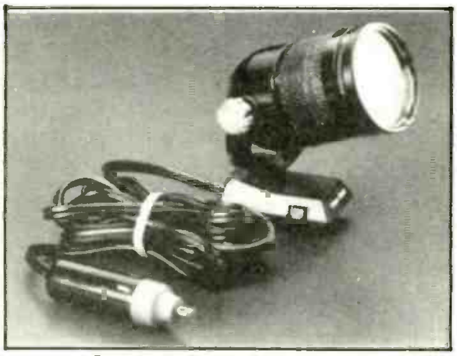


Sharp CD Player

Gizmo/Bytes

Wireless Headphones

Integrated Answering System



Quartz Halogen Video Light

Portable Computer

Wireless Headphones

Wireless listening is a technology that remains controversial: some consumers like existing wireless systems while others wouldn't touch them with a ten-foot speaker-connection cord. *Datawave, Inc.* (19611 Ventura Blvd. 2nd A., Tarzana, CA 91356) is hoping its new *Private Waves Wireless Headphones (WH-100)* can please both groups. The company says that the Private Waves system relies on radio frequency transmission rather than infrared technology. In contrast to "other so-called wireless headphones," Private Waves offers "range and sound quality" both "more sophisticated and flexible," to a distance of 75 feet. A compact transmitter is connected to the audio-out or headphone jack of a TV, VCR, stereo, or CD player. The lightweight receiver (three-and-a-half ounces) clips to the listener's belt, shirt pocket, or "other item of clothing." Miniature headphones plug into the mini-receiver, and are powered by two AAA-size alkaline batteries (good for about 50 hours). Price: $99.95.

CIRCLE 58 ON FREE INFORMATION CARD

Videocassette Labeling System

Drowning in a sea of uncertainly identified video tapes? To transform your cassette collection into a file instead of a pile, *Discwasher, Inc.* (4310 Transworld Rd., Schiller Park, IL 60176) has introduced its *Professional Video Cassette Labeling System*. Labels are inserted into see-through plastic label sleeves that adhere to the spine of the cassette. Discwasher thinks the system will put an end to the video heartbreak of "label build-up," which the company calls "a sticky problem." The basic Video Cassette Labeling System includes 15 double-sided paper labels and five label sleeves for both VHS and Beta tape cases. Price: $3.99.

CIRCLE 41 ON FREE INFORMATION CARD

Integrated Answering System

Yet another product deemed "ideal for the first-time buyer"—this one offered by *Northwestern Bell Phones* (9394 W. Dodge Rd., Suite 100, Omaha NE 68114)—is the "Favorite Messenger" *Integrated Answering System*, with voice-activated recording, beeperless-remote operation, ten-number memory, last-number redial, automatic toll saver, and lighted keypad. Desk- or wall-mountable, the Favorite Messenger is sold with a one-year warranty and is hearing-aid compatible. Price: $149.99.

CIRCLE 55 ON FREE INFORMATION CARD

Quartz Halogen Video Light

"Let there be light" remains a useful adage, even in the world of low-light camcorders. *Arkon* (11627 Clark St., Suite 101, Arcadia, CA 91006) is marketing a compact, lightweight *Cam-Cool Quartz Halogen Video Light (CL-500)* that makes it possible for camcorders to "produce professional-looking results under low lighting conditions." Fabricated of aircraft alloy aluminum and weighing five ounces, the Cam-Cool will run continuously for 45 minutes with power from a standard 6.5-amp/hour, 12-volt battery. There's also an eight-foot power cord equipped with a car-lighter (DC) adapter. The Cam-Cool also features a 180-degree self-locking bracket for what Arkon calls "precise 'bounce' lighting." Price: $69.95.

CIRCLE 54 ON FREE INFORMATION CARD

Portable Computer

If you've been looking for a personal computer that takes "advantage of the best desktop and portable computers have to offer," a new model from *Scantech Computer Systems, Inc.* (12981 Ramona Blvd., Unit I&H, Irwindale, CA 91706-3797) merits some attention. The *LCD-286 Portable Computer* weighs just 22 pounds, but includes an Intel 80286 microprocessor; 20-megabyte hard-disk drive; 5¼-inch floppy-disk drive (1.2-megabyte capacity); an adjustable and tiltable 80-column by 25-row, 9-inch LCD screen; and one megabyte of "fast zero wait-state RAM." All that and "100 percent IBM PC/AT compatibility," too. By not "relying on specially-manufactured accessories," Scantech says, "the LCD-286 will never become obsolete." Price: $3,495.

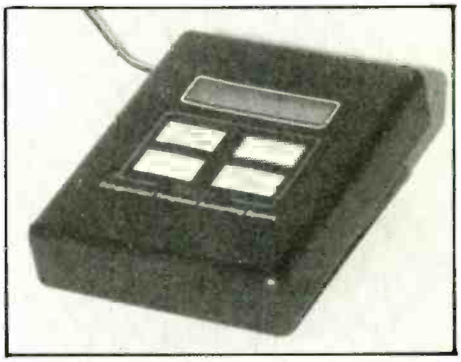
CIRCLE 44 ON FREE INFORMATION CARD

Gizmo/Bytes

Computerized Telephone Accounting System

Businesses often fret about use and abuse of their telephones by employees. A "unique, self contained" *Computerized Telephone Accounting System (TA-100B)* aims to do something about reducing that worry. From *Camcorp* (61 N. Plains Industrial Rd., Wallingford, CN 06492), the product "doesn't require the aid of a computer or PBX system." When the unit is connected to a telephone or fax machine, it records every call made by phone number, date, time of call, and minutes per call. The system can log up to 1,600 calls and furnish a summary of calls by phone or account number or give an itemized accounting of all calls. The unit measures approximately 5- × 6- × 3-inches. Power is supplied via an AC adapter. In addition, Camcorp offers a one-year parts and labor warranty as well as a free update of the " 'call cost chip' in the event that phone rates change." The company says the TA-100B was designed specifically for small businesses and self-employed individuals, but we know some parents of teenagers who might be more than a little interested in the device. Price: $449.

CIRCLE 52 ON FREE INFORMATION CARD

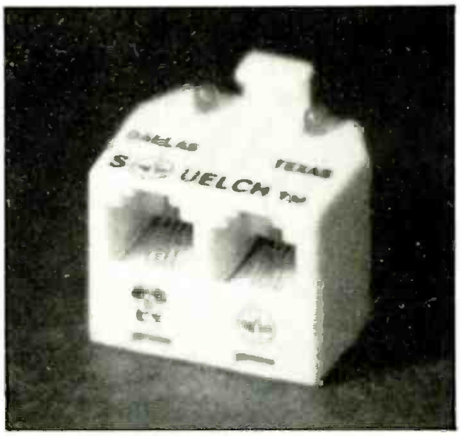


Phone Call Accounting System

Squelch Telephone Accessory

A news release from *Effective Solutions* (14902 Preston Rd., Suite 212-310, Dallas, TX 75240) announces that the firm's *Squelch Telephone Accessory* was granted a U.S. patent last year and that they "are the only company manufacturing this product under the patent." The product in question is described as "an easy-to-use accessory which provides automatic control of extension telephones." By plugging in an extension phone via the accessory, the user is assured that the second instrument will not interfere with calls on a directly connected phone. If you use a modem or facsimile, Effective Solutions says, "the Squelch allows the extension to be used when the fax or modem is off, but automatically protects a transmission in progress." Connecting an answering machine via the device assures that the phone's answerer "automatically takes priority over the machine when a directly connected phone is picked up." A pair of LEDs provide verification of correct installation. Price: $9.95–$15.

CIRCLE 42 ON FREE INFORMATION CARD

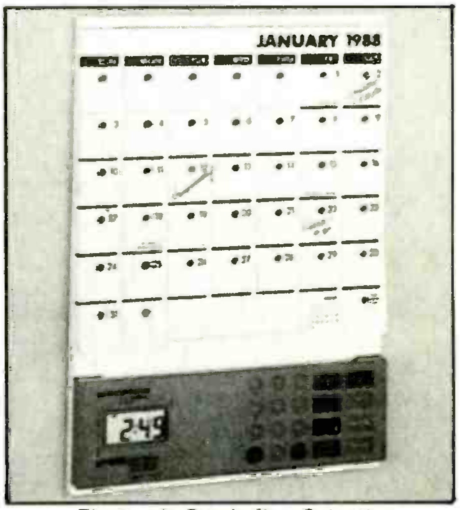


Squelch Telephone Accessory

Electronic Reminding Calendar

Not necessarily a new product, but one that's proved its staying power, the *Electronic Reminding Calendar* from *Hammacher Schlemmer* (147 E. 57th St., New York, NY 10022) can be programmed to signal special dates, annual events, or important deadlines. The reminder is delivered with flashing LED lights which can be set for up to three days before the important date. What the catalog calls "its patented 60-year memory" can store as many as 2000 different dates. The calender also shows time and date and allows the review of all events entered into memory. Two AA-size batteries provide memory backup; the calendar itself plugs into a standard wall outlet. Price: $79.95.

CIRCLE 40 ON FREE INFORMATION CARD

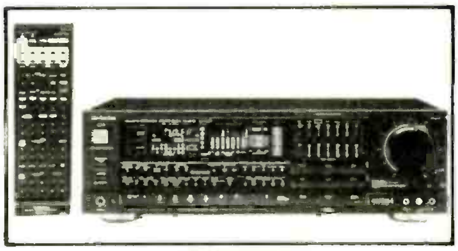


Electronic Reminding Calendar

A/V Receiver

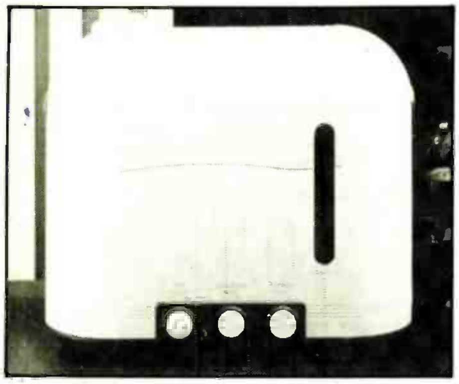
Does anyone own just a TV, stereo, and VCR anymore? Our impression is that American consumers have moved on to the more elaborate home audio/video entertainment center. A new, top-of-the-line *A/V Receiver (SA-R530)* from *Technics* (One Panasonic Way, Secaucus, NJ 07094) is geared to that development, with features designed to further integrate home electronic entertainment. The unit includes a remote control with learning capability that can serve as a "central command unit over other infrared remote-control video equipment." The 103-function remote can learn the major commands of most VCRs, TVs, and wireless infrared cable-control boxes. A major audio feature is a built-in digital Dolby surround system through which "the audio signal is converted to a digital signal and processed for sound effects." Then the system converts the signal back to clean, clear analog. That feature creates "theater-like sound" (with the addition of a rear speaker system) and the user can select any of six surround modes: Theater, hall, club, concert hall, studio, or stereoplex. The SA-R530 features separate rear-speaker amplification, a power rating of 100-watts-per-channel, and a seven-band electronic graphic equalizer that "stores ten EQ curves in memory for instant, push-button recall." Price: $850.

CIRCLE 50 ON FREE INFORMATION CARD



A/V Receiver

Gizmo/Bytes



Decorator Ultrasonic Humidifier

Decorator Ultrasonic Humidifier

It's about time some manufacturer offered a "decorator" line of home humidifiers, which is why the new *Ultrasonic Humidifier (1844)* from *Soundesign Corp.* (Harborside Financial Center, 400 Plaza Two, Jersey City, NJ 07311) didn't surprise us. According to the product release, the 1844 is aimed at "consumers who want the benefits of an ultrasonic humidifier without sacrificing on style." Soundesign gave it a "white, European-styled exterior," and says that as a result it's "attractive enough to be used anywhere in the home." The unit can vaporize the contents of its two-gallon tank in as little as twenty hours and broadcasts cool water-vapor mist via a 360-degree rotation nozzle. Both mist intensity and the humidity level can be adjusted. Once the desired humidity level is reached, the 1844 shuts off automatically. The unit also turns off if it tips over or whenever the water level is low. An LED indicator tells the user when a tank refill is needed; there's also an audible signal that can be used when desired. Price: $89.95.

CIRCLE 59 ON FREE INFORMATION CARD

Prenatal Soundshare System

Prenatal Soundshare System

This may be the product that makes born electronic consumers out of the next generation of babies. From *Infant Technology, Inc.* (P.O. Box U, Stanford, CA 94309), the *Listen Baby Prenatal Soundshare System* is described in a company brochure as consisting of a stereo speaker pack, hand-held microphone, and "heart-shaped dual listening adapter." The theory seems to be that mom, dad, and siblings can not only listen in on, but also bill and coo to, the unborn child. Infant Technology supplies what it dubs "Infant Age Music," but points out that expectant parents can "make their own tapes"—at least suggesting that the child will recognize mom's voice. The booklet's two-page list of "additional reading and clinical references," bolsters the case for Listen Baby. In our limited experience, the kid will be hearing and (making) lots of noise later on—without tapping into his or her nine months of guaranteed peace and quiet. Price: $60.

CIRCLE 61 ON FREE INFORMATION CARD

AM/FM Stereo Receiver

AM/FM Stereo Receiver

Moderation is usually considered a virtue, but in stereo-component design that value seems to have fallen by the wayside. *Yamaha Electronics Corp., USA* (6660 Orangethorpe Ave., Buena Park, CA 90620), however, is offering a new AM/FM stereo receiver described as "delivering moderate power with high dynamic power/low impedance drive capability." The *RX-500U Stereo Receiver* with remote control is rated at 50-watts-RMS-per-channel and features circuitry designed to assure that the unit "will reproduce digital sources with full fidelity and [that it] can be used with multiple speaker systems." The RX-500U features direct PLL IF-count digital-synthesis tuning with sixteen-station random-access presets, auto seek, and manual up/down tuning. The receiver's infrared remote permits input-source and station selection, and volume control. Dual tape-monitor inputs and an independent "record out" selector are also features of the new model. Price: $379.

CIRCLE 62 ON FREE INFORMATION CARD

Dynamic Stereophone

Moving Coil Dynamic Stereophone

Stereo headsets are fairly mundane products, but a new model introduced by *Signet* (4701 Hudson Dr., Stow, OH 44224), as described in a new product release, sounds downright exotic. The *Moving Coil Dynamic Stereophone (EP400)* is said to use "a high-flux Samarium Cobalt magnet and oxygen-free silver/copper wire for the voice coil winding." The same oxygen-free copper is used in the ten-foot audio cord for "maximum conductivity and minimal signal loss," yielding "extended dynamics and distortion-free sound." Audio engineering aside, the EP400's adjustable double-headband system combines strength and rigidity even as it evenly distributes the weight of the unit. Mesh-covered foam earpads are mounted with a dual-swivel system so that they can be adjusted to individual head shapes while providing the best possible performance and the greatest degree of comfort. Price: $100.

CIRCLE 60 ON FREE INFORMATION CARD

Build a 10-MHz Frequency Counter

Need a frequency counter that won't cost a mint? This hobbyist-grade instrument is just the ticket for budding techs on a tight budget!

PAUL AMAN

Anyone interested in electronics sooner or later (usually sooner) needs some sort of test equipment. Almost every electronics hobbyist has a digital or analog multimeter, but there are times when simple voltage, current, and resistance measurements just won't do. Sometimes, such as when working with digital circuits, a frequency measurement is needed. That's the time when you need an oscilloscope or frequency counter.

Unfortunately, a low-end oscilloscope or a frequency counter will cost $200 to $300, or more; that's more than many beginning hobbyists want to spend. Unless, of course, it is a **Popular Electronics** *10-MHz Frequency Counter*! Built around three integrated circuits, that useful instrument can be put together for about $40 by anyone who is reasonably adept at soldering.

Circuit Operation. Figure 1 shows the schematic diagram of the 10-MHz Frequency Counter. The circuit consists of an ICM7208 seven-decade counter (U1), an ICM7207A oscillator controller (U2), and a CA3130 biFET op-amp (U3). Integrated circuit U1 counts input signals, decodes them to 7-segment format, and outputs signals that are used to drive a 7-digit display.

Integrated circuit U2 provides the timing for U1, while U3 conditions the input signal to provide a suitable waveform for input to U1. The 5.24288-MHz crystal frequency is divided by U2 to produce a 1280-MHz multiplexing signal at pin 12 of U2. That signal is input to U1 at pin 16 and is used to scan the display digits in sequence.

The cathodes of each digit are taken to ground several times each second, activating any segments of the digits whose anodes are high as the result of decoding by U1. The crystal frequency is further divided to produce a short "store" pulse at pin 2 of U2, followed (after about 0.4 milliseconds) by a short "reset" pulse at pin 14 of U2. The frequency of the pulses is determined by the state of U2 pin 11.

When pin 11 of U2 is taken to ground through S1, the pulses occur every 2 seconds and cause U2 pin 13 to go high for one second, which prevents additional input signals from entering U1. That causes the count latched in U1's internal counters to be transferred to the display.

Integrated circuit U2 pin 13 then goes low for one second, allowing a new count to be entered into the seven decade counters of U1. That cycle is repeated, continuously updating the display every two seconds.

When U2 pin 11 is taken to the positive supply rail (+5V), the "store" and "reset" pulses occur at 0.2-second intervals, resulting in a 0.1-second count period. Ten input pulses must be counted in order for a "1" to appear on the first digit, D1, so the frequency being measured is obviously ten times larger than the frequency that is shown on the display.

In that mode, the decimal points are driven by R1 and visually indicate that the 0.1-second count period is being used.

Display. The display must have at least seven 7-segment common-cathode multiplexed LED digits. Any common-cathode seven-segment display may be used, so no particular display is specified. If the display chosen has more than seven digits, the extras are not used. For example, the display used in the author's prototype, which was salvaged from an old calulator, has nine digits, only seven of which are used in this project.

Don't be put off by the term "multiplexed." Multiplexed simply means that all like segments of all digits are connected by a single conductor, and that the cathodes of all segments of any one digit are connected to a common terminal. That's accomplished by a printed circuit within the display and limits the number of wires or traces needed to operate the dis-

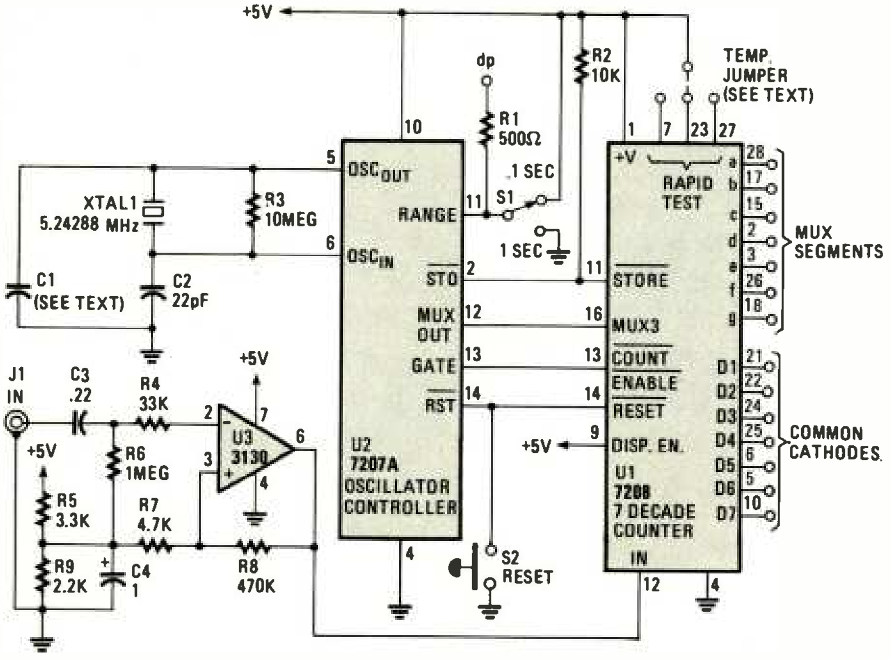


Fig. 1. The 10-MHz Frequency Counter consists of U1, an ICM7208 seven-decade counter; U2, an ICM7207 oscillator controller; and U3, a CA3130 biFET op-amp. The display for the circuit can be any seven-digit, seven-segment common-cathode multiplexed unit.

play. Such units may be salvaged from an appropriate old calculator or purchased from electronic surplus stores.

A multiplexed display can also be fabricated from discrete seven-segment display modules as shown in Fig. 2. More display modules can be added as needed. Duplicating the display shown in Fig. 2 is easy; simply connect all like pins in parallel as shown. For example, pin 1 of the first seven-segment unit—which, for this particular display, is segment "a"—is connected to pin 1 of all the other modules. Pin 3 is the common-cathode connection—it is not connected to the other pin 3 terminals in the set—which is used as the digit-driver (D1–D7) input.

Note that for the display modules used to illustrate the multiplexing concept, there are two common-cathode terminals, pins 3 and 14; since the two pins are internally connected, only one of those terminals need be connected to the circuit in order for the display to function properly, although connecting both would not cause any problems. While the pinouts may vary from one display type to another, the concept remains the same.

If you opt to go with a salvaged display unit, it will be necessary to determine the pinout and configuration; common cathode or common anode. To test a salvaged display when the pinout is not known, temporarily connect a 1000-ohm resistor from a 5- to 9-volt source to pin 1, then touch the source ground to each of the other pins in sequence. If any segment lights, the pin at the resistor is the anode for all like segments in all digits and the pin at ground is the common cathode for the digit with the lighted segment.

Repeat that procedure to identify all segments and cathodes by moving the resistor to the other pins. Make a record similar to that shown in Fig. 1-b for use as a reference during circuit assembly. If no segments light, but do light when the source leads are reversed, the unit is a common-anode type and is not suitable for use in the counter. Do not discard the display; make a record and save the display for some other project.

Power Supply. When all digits are lit, the circuit draws about 160 milliamps. A 5-volt bench supply that is rated at more than 1 ampere may be used, however, a heavy-duty 6-volt battery with a 1-ampere diode connected in series with one of the leads will work, and makes the unit portable.

Space is available on the circuit board (at the top) to mount a 5-volt regulator and capacitors, if desired. If a regulator is used, a 6- to 9-volt AC adaptor may be used to supply the basic DC voltage. To preclude damaging the integrated circuits, U1 and U2 must be powered up before or simultaneously with the application of input signals to U3. The entire circuit is designed to be powered by one common supply.

Assembly. See Fig. 3. The author's prototype of the 10-MHz Frequency Counter was built on a universal printed-circuit board (Radio Shack catalog number 276-170). Note that the horizontal holes in Fig 3 are la-

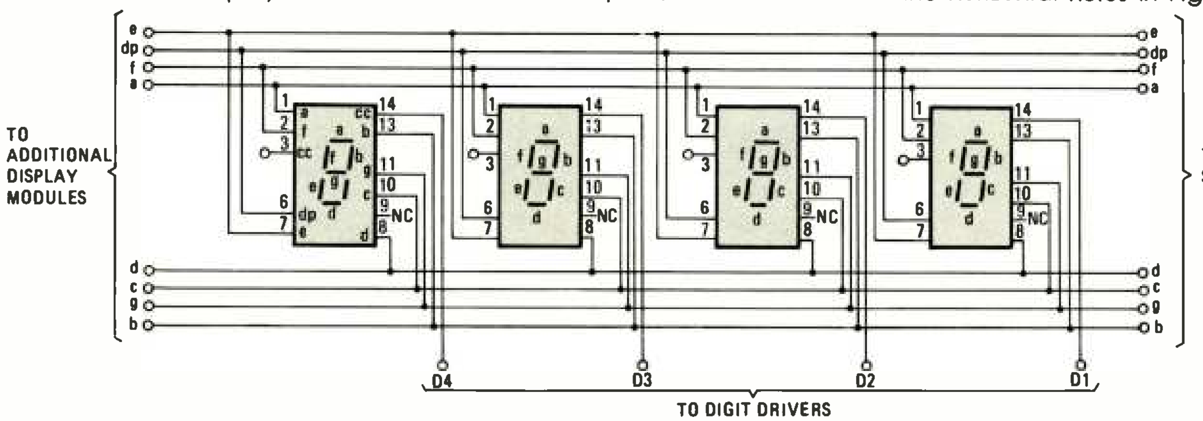


Fig. 2. A multiplexed display can be fabricated from discrete seven-segment display modules by connecting all like pins in parallel. For example, pin 1 of the first seven-segment unit connects to pin 1 of all the other modules.

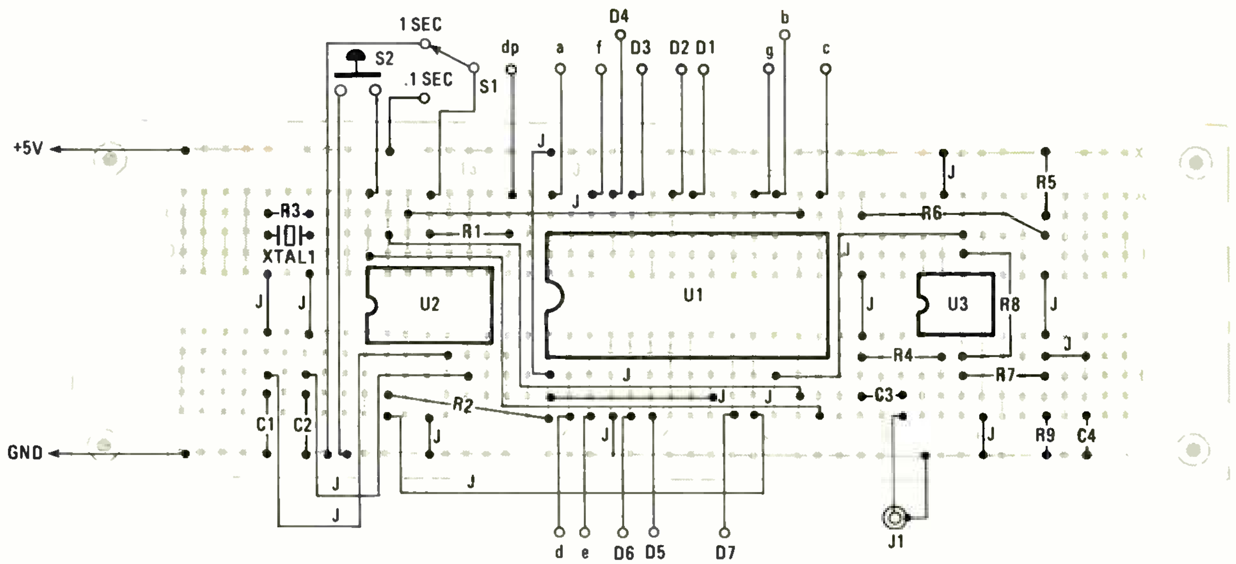


Fig. 3. Here is the parts-placement diagram for the author's prototype of the 10-MHz Frequency Counter. It was assembled on a universal printed-circuit board. Note that the display is not shown in the layout. However, by following the connection scheme outlined in Fig. 2, almost any common-cathode display can be used with the circuit.

beled A through J and that the vertical holes are number 1 through 47. Columns of holes designated X and Y are the +5V and ground buses, respectively.

Carefully locate the positions of the IC's and mark the pin 1 holes with a felt-tipped pen. For example, pins 1 of U1, U2, and U3 are located in holes 19G, 10F, and 37F, respectively. It's a good idea to use sockets (as the author did) for the IC's; aside from making IC replacement easier, doing so also prevents possible damage to those parts during soldering.

After the sockets have been mounted in the proper locations, install the jumper connections (designated J) guided by Fig. 3. The horizontal jumpers may be bare wire, all others should be insulated to prevent shorts. Next begin installing the support components, starting with the resistors, then the capacitors, and finally the crystal (XTAL1).

Solder extra-long color-coded wires to the board for the off-board components. Then, as the positions of the off-board components are established with respect to the case, cut the wires to the proper length and solder them to the components. If you suspect that the wires will interfere with IC installation, insert the IC's before soldering the wires to the off-board components.

Enclosure. Any suitable case may be drafted to house the finished circuit. Mount the power-supply terminals or jack, the input jack, the switches (S1 and S2), and the display on the front panel of the case. The circuit board may be trimmed to about 5-inches long to keep case size at a minimum.

Use a nibbling tool to cut an opening for the display, but do not secure the display to the case until wires from the board have been connected. If a trimmer capacitor is used for C1, as will be discussed later, drill a hole at the proper location to allow for any adjustments without removing the front panel of the enclosure.

PARTS LIST FOR THE 10-MHZ FREQUENCY COUNTER

SEMICONDUCTORS

U1—ICM7208 seven-decade counter, integrated circuit
U2—ICM7207A oscillator controller, integrated circuit
U3—CA3130 biFET op-amp, integrated circuit

RESISTORS

(All resistors are ¼ watts, 5% units, unless otherwise noted.)
R1—500-ohm
R2—10,000-ohm
R3—10-megohm
R4—33,000-ohm
R5—3300-ohm
R6—1-megohm
R7—4700-ohm
R8—470,000-ohm
R9—2200-ohm

CAPACITORS

C1—See text
C2—22-pF, ceramic disc
C3—0.22-µF, ceramic disc
C4—1-µF, 50-WVDC, subminiature electrolytic

ADDITIONAL PARTS AND MATERIALS

J1—Miniature closed-circuit phono jack
S1—Single-pole, double-throw toggle switch
S2—Single-pole, single-throw momentary-contact pushbutton switch
XTAL1—5.24288-MHz crystal
Universal printed-circuit board; seven-digit, seven-segment, common-cathode, multiplexed, LED display (see text); enclosure; IC sockets; power source (see text); wire; solder; hardware; etc.

Testing. To rapid-test the circuit with a frequency that is less than 100 Hz, use a temporary jumper to take U1 pin 7, 23, or 27 to +5V as indicated by the dashed line shown in Fig. 1. Integrated circuit U1 then applies the count to all digits higher than D2.

Data for U2 indicates that C1 may be a trimmer, however, a 22-pF fixed-disc capacitor is satisfactory for most applications, and provides accuracy to .005%. If a closer tolerance is required, use a 6–50-pF trimmer capacitor (such as a Radio Shack 272-1340). Set the range switch to 1 second, apply the multiplexing frequency from U2 pin 12 to the input of U3, and adjust the trimmer for a readout of 1280 Hz.

Frequency Counting. When S1 is in the 1-second position, the count range is 1 Hz to 1 MHz and can be read directly from the display. When S1 is in the 0.1-second position, the count range is 10 Hz to 10 MHz. The number then appearing on the display is ⅒ the frequency being measured. (1 kHz appears as 100).

When a new frequency is being

(Continued on page 103)

THE UNIVERSAL

Use this handy BASIC program to transform abstract equations into tangible graphs!

BY JAMES E. TARCHINSKI

LISTING 1—GRAPHER.BAS

```
1000 'GRAPHER.BAS PROGRAM FOR THE PC
1010 '
1020 CLEAR : SCREEN 0,0,0,0 : COLOR 10,0,0
1030 WIDTH 80 : CLS : KEY OFF
1040 PI = 3.14159265
1050 '
1060 PRINT "****************************************************************************"
1070 PRINT "*                                                                          *"
1080 PRINT "*                              GRAPHER.BAS                                 *"
1090 PRINT "*                                                                          *"
1100 PRINT "*                  (c) 1988 by James E. Tarchinski                         *"
1110 PRINT "*                                                                          *"
1120 PRINT "****************************************************************************"
1130 COLOR 11
1140 PRINT
1150 PRINT "     This program is a plotting utility that allows users to"
1160 PRINT "plot mathematical functions.  If you wish to print out these"
1170 PRINT "graphs, you may do so by using the 'SHIFT-PrtSC' function"
1180 PRINT "of the computer."
1190 PRINT
1200 PRINT "     Before this program is run, however, you must modify the"
1210 PRINT "print values in Lines 7000 - 7160.  You must also define the"
1220 PRINT "two functions that you wish to plot, which may be entered as"
1230 PRINT "subroutines starting at Lines 8000 and 9000."
1240 PRINT "
1250 PRINT "     If you have not yet made these modifications, press the"
1260 PRINT "'E' key to exit the program...."
1270 PRINT "
1280 LOCATE 23,1 : COLOR 7 : PRINT "Press any key ('E' to break)...";
1290 '
1300 IN$=INKEY$:IF IN$<>"" THEN GOTO 1300
1310 IN$=INKEY$:IF IN$= "" THEN GOTO 1310
1320 CLS : IF IN$="E" OR IN$="e" THEN END
1330 '
1340 '
1350 '********** INITIALIZE VARIABLES & SCREEN ************
1360 '
1370 SCREEN 2 : CLS   'enter graphics mode
1380 LINE (76,12)-(76,172)
1390 LINE -(636,172)
1400 '
1410 FOR I=76 TO 636 STEP 56 : LINE (I,170)-(I,174) : NEXT I
1420 FOR I=12 TO 172 STEP 16 : LINE (74,I)-(78,I) : NEXT I
1430 '
1440 GOSUB 7000     'get graph values
1450 '
1460 IF LEN(T1$)>60 THEN T1$=LEFT$(T1$,60)    'limit to 60 characters
1470 IF LEN(T2$)>60 THEN T2$=LEFT$(T2$,60)
1480 IF LEN(X$)>60 THEN X$=LEFT$(X$,60)
1490 C=44-INT(LEN(T1$)/2) : LOCATE 1,C : PRINT T1$;
1500 C=44-INT(LEN(T2$)/2) : LOCATE 2,C : PRINT T2$;
1510 C=44-INT(LEN(X$)/2) : LOCATE 24,C : PRINT X$;
1520 '
1530 L=LEN(Y$) : IF L>18 THEN L=18
1540 FOR I=1 TO L
1550   LOCATE I+2,1 : PRINT MID$(Y$,I,1);   'print y-axis lable
1560 NEXT I
1570 '
1580 DY=(YMAX-YMIN)/10
1590 FOR I=0 TO 10      'lable y-axis loop
1600   J=YMIN+I*DY
1610   LOCATE (22-2*I),2 : PRINT USING "+####.##";J
```

Over the years "A picture is worth a thousand words" has become just another trite cliche. But in the world of electronics, it certainly is the truth.

As an example of how valuable pictures can be in electronics, consider for a moment the schematic diagram. A schematic is nothing more than a pictoral representation of an electronic circuit. Without such diagrams, we would be forced to describe even the simplest of networks by using pages and pages of text: "A ¼-watt, 330-ohm resistor is connected between the output buffer of the 555 timer and the positive 5-volt terminal of the main power supply..."

The Graph. Schematics aren't the only pictures that aid the electronic hobbyist; there are also graphs. Graphs are excellent for conveying the relationship between two or more variables, such as how a voltage changes with respect to time in an AC network. Essentially, graphs transform very abstract mathematical equations into a visual pattern that our minds can easily process and comprehend.

While graphs are generally very easy to interpret and understand, they are not always so easy to create. Starting with a blank sheet of paper, you must first draw the two axis and divide each of them into an appropriate scale. Next you plot anywhere from five to fifty, or more, points, depending on exactly what it is that you are trying to graph. Lastly, you connect the points with a smooth curve and hope that the end result is worth the time it took to draw. Sometimes it's worth the effort and you are pleased with the results. Other times, however, you end up starting the process over and thinking that there has to be a better way. Well, now there is a better way: *Grapher.Bas*!

Grapher is BASIC-language program for PC's that plots one or two mathematical functions on a high resolution screen. There are no scales to calculate, no points to plot by hand, and no curves to draw. All you need to do to get high-quality graphs is to modify several constants in the program, enter the mathematical equations to be plotted, and then run the program—Grapher will do the rest.

Using Grapher. To use Grapher, load BASIC into your computer, enter Listing 1, and immediately save the program to disk to protect yourself in case of a system crash. After loading the program and typing in RUN and RETURN, you should see a page of text appear on the screen. In it are instructions on how to use the program. For testing purposes, disregard the warning about making modifications and press the space bar to continue.

If you have entered the program correctly, you should see the text page replaced with a graph carrying the very technical sounding title: "THIS IS THE FIRST TITLE LINE OF THE GRAPH," followed by another title line. The title lines are a good example of the program's frills. When using the program, you will replace those lines with the title of your particular graph. You

LISTING 1 (continued)

```
1620 NEXT I
1630 '
1640 J$=STR$(XMAX) : LOCATE 23,81-LEN(J$) : PRINT J$;
1650 DX=(XMAX-XMIN)/10
1660 FOR I=0 TO 8 STEP 2          'lable x-axis loop
1670   J=XMIN+I*DX
1680   LOCATE 23,7+I*7 : PRINT USING "+###.#";J
1690 NEXT I
1700 '
1710 '********** MAIN PLOTTING SECTION ********************
1720 '
1730 SX = (XMAX - XMIN) / 560
1740 '
1750 FOR ML=1 TO 2
1760   FOR X = XMIN TO XMAX STEP SX
1770     IF ML=1 THEN GOSUB 8000 ELSE GOSUB 9000
1780     IF Y<YMIN OR Y>YMAX THEN 1820     'out of range, next value
1790     PY = 172 - (Y-YMIN) * 160 / (YMAX - YMIN)
1800     PX =  76 + (X-XMIN) * 560 / (XMAX - XMIN)
1810     IF X=XMIN THEN LINE (PX,PY)-(PX,PY) ELSE LINE -(PX,PY)
1820   NEXT X
1830 NEXT ML
1840 '
1850 IN$=INKEY$:IF IN$<>"" THEN GOTO 1850
1860 IN$=INKEY$:IF IN$= "" THEN GOTO 1860
1870 IF IN$<>"E" AND IN$<>"e" THEN 1850     'push E to exit loop
1880 END
1890 '
1900 '
7000 '========== PLACE CONSTANT VALUES HERE ===============
7010 '
7020 YMIN = -1.5     'minimum y value
7030 YMAX = 1.5      'maximum y value
7040 'place y-axis title below (18 characters, max.)
7050 Y$ = "THIS IS THE Y-AXIS"
7060 '
7070 XMIN = -360     'minimum x value
7080 XMAX = 360      'maximum x value
7090 'place x-axis lable below (60 characters, max.)
7100 X$ = "THIS IS THE GRAPH'S X-AXIS"
7110 '
7120 'place two title lines below (60 characters, max.)
7130 T1$ = "THIS IS THE FIRST TITLE LINE OF THE GRAPH"
7140 T2$ = "(And this is the second title line)"
7150 '
7160 RETURN
7170 '
7180 '
8000 '========== PLACE FUNCTION #1 BELOW =================
8010 '
8020 Y = SIN(X*(PI/180))
8030 '
8040 RETURN
8050 '
8060 '
9000 '========== PLACE FUNCTION #2 BELOW =================
9010 '
9020 Y = 1.2*SIN(X*(PI/180)+30*(PI/180))
9030 '
9040 RETURN
```

will also change other labels shown on the screen. We'll describe how to make those modifications a little later.

A moment or two after the title appears, if you've entered the program correctly, a graph similar to the one shown in Fig. 1 should materialize on your screen. The graph is a plot of two sinewaves having the same frequency, but different magnitudes and phase angles.

When the plotting process is complete, the program begins running a loop that is constantly looking for a press of the E key. Once E has been pressed, the program halts execution and returns you to the BASIC language editor (with the "OK" prompt displayed).

The Program. Having looked at an example of the type of chart Grapher is capable of producing, let's discuss how you can modify the program to graph the functions that you'd like to see displayed.

Let's analyze lines 7000–7140 of the program, looking at the sample graph shown in Fig. 1. Notice first of all that the variables YMIN and YMAX of the program, which are defined by lines 7020 and 7030, are used to specify the minimum and maximum values of the Y variable that will be displayed on the screen. In lines 7070 and 7080, XMIN and XMAX are defined in the same manner for use with the graph's X-axis. Simply modify the values (before you run the program) to accommodate the range of the variable you wish to plot.

Although any values for XMIN and XMAX will generally work, sometimes you may select values of YMIN and YMAX such that the points Grapher needs to plot are outside of the range displayed on the screen. The result of that is that no points will appear on the screen when the program is run. That would be the first place to look for mistakes if your graphs do not appear as you expect them to.

The variable Y$ in line 7050 is assigned a value to be used as the title of the graph's Y-axis, and the variable X$ of line 7100 is used for the title of the X-axis. Similarly, the program has two lines associated with the main title (7130 and 7140), and those lines assign values to variables T1$ and T2$.

To modify the four labels to fit your own graphs, merely change the string values to whatever text you would like to see on the graph. Because the program automatically centers the title and axis labels, there is no need to "pad" the strings with extra spaces. When entering the variables, be careful not to exceed the maximum allowable lengths; the Y-axis label can be up to 18 characters long, while the other three strings can be up to 60 characters in length.

The last thing you must do before Grapher can plot your functions is to type into the program the functions you want to plot. To do that, you need to enter each function as a subroutine, one starting at line 8000 and one at 9000. Your subroutines should always return a value in the variable Y for every value of X that is used by the routine; that is, every value of X that is between XMIN and XMAX.

In Listing 1, Function 1 is a simple sinewave with an amplitude of one and a phase angle of zero. Function 2 is also a sinewave, but with an amplitude of 1.2 and a 30° phase angle. Please keep in mind that BASIC assumes all angles are in radians. Because the variable X is in degrees, the ratio $\pi/180°$ is used to convert degrees into radians.

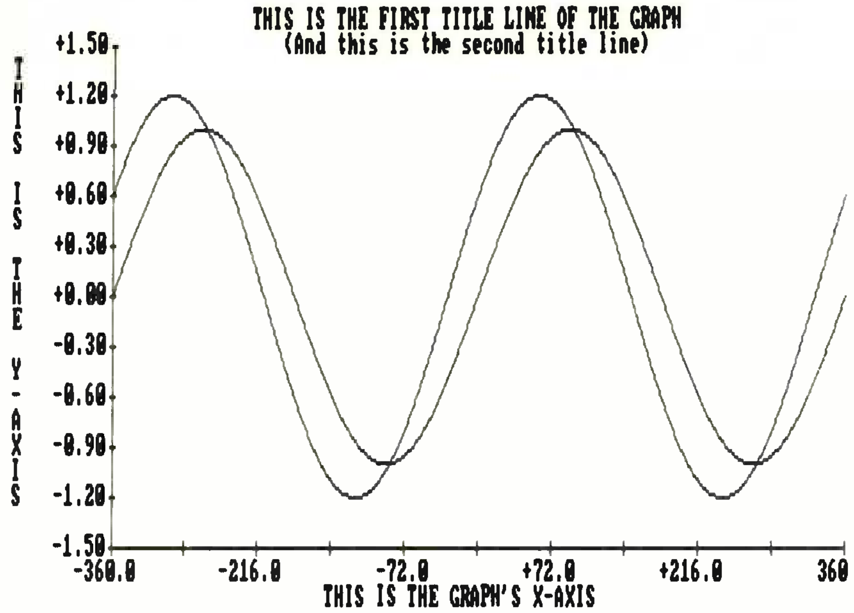


Fig. 1. The two sinewaves shown here are the "default" functions. To display your own functions and label the axis modify grapher as described in the text.

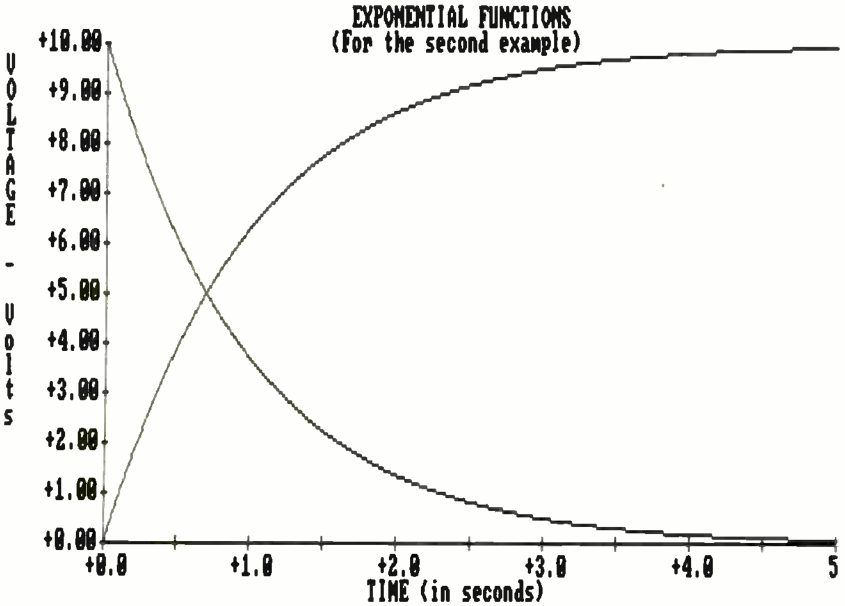


Fig. 2. This is another example of the Grapher program's output. Lines 7000–9040 of Grapher were modified as shown in Listing 2 on page 100 to allow the program to produce the graph shown in this illustration.

As an example of how to modify the program to use other functions, Fig. 2 shows another set of plots generated by Grapher: the rising and falling exponential functions. Listing 2 shows the modifications necessary to to generate that graph.

Keep in mind that the functions described by the subroutines don't have to be just one line long, they just have to return a single value of Y for every value of X in the range from XMIN to XMAX. For example, the subroutine listed below could be used to plot a 2-volt sinewave that has been clipped to +1.75 volts.

```
8020 Y = 2*SIN (X*(PI/80))
8024 IF Y>1.75 THEN Y=1.75
8028 IF Y<-1.75 THEN Y=-1.75
8040 RETURN
```

Another important point to remember is that subroutines must always end with a RETURN statement. Failure to include that statement, depending on where it is supposed to be located, is punishable by a simple error message, the halting of program execution, or the plotting of an incorrect graph.

Program Description. From Listing 1, it can be seen that Grapher is composed of three main sections of code and three "support" areas. The code sections are: 1) program initialization; 2) screen and variable initialization; 3) the main plotting section. The three support areas, which have already been discussed, are: 1) the constant values section; 2) Function 1 definition area; 3) Function 2 definition area.

A general description of each of the six segments of the program follows. For those readers who are more interested in a line-by-line description of how Grapher works, please refer to Table 1, which contains such a description.

Program initialization takes place in lines 1000–1340. This section starts by clearing the program's variables and displaying one screen of instructions. Then, in lines 1280–1320, the user is allowed to gracefully exit the program if they have not modified the print values in lines 7000–7160, or if they have not entered the functions they wish to plot as subroutines starting at lines 8000 and 9000.

In the next section of the program, from line 1350 to line 1700, both the program variables and the screen are initialized. This section takes care of drawing and labeling the graph's axes, displaying the titles of the axes, and displaying the title of the graph as a whole.

The last section of code, the part that handles the actual graphing of the functions, is contained in lines 1710–1900. An outer FOR-NEXT loop, which begins on line 1750, is used to step through each of the two functions in turn. An inner FOR-NEXT loop begins on line 1760 and its purpose is to step through each pixel (or "dot") on the X-axis from the minimum X value (XMIN) to the maximum value (XMAX).

More Words. Grapher's charts do not fill the entire PC screen, but rather use an area that is 160-pixels high by 560-pixels long, for a total of:

160 × 560 = 89,6000 pixels

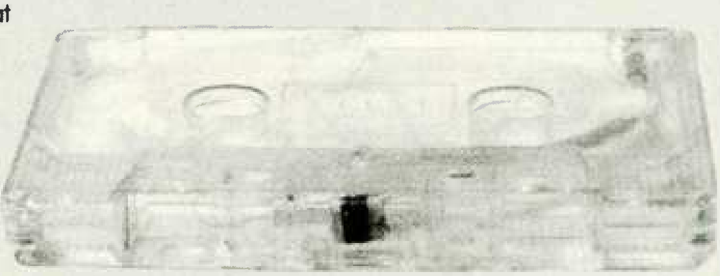
Because the PC uses a method of displaying graphics known as bit-mapping (every pixel is represented by a

(Continued on page 100)

Build The AUDIO COUPLER

Add an audio input to any cassette deck without altering the unit in any way

BY GREGORY R. MCINTIRE



What modern semiconductor technology has done to miniaturize electronic devices in recent years is quite amazing. Take small handheld scanners and ham transceivers for instance. Handheld units will do most everything that the larger table models will do. But, there is one area where they are lacking, at least for some applications.

I recently bought a handheld two-meter ham transceiver, which I decided to use as a mobile rig. It has one drawback though: The audio output and the tiny little speaker work just fine in a relatively quiet environment; but there is nowhere near enough sound coming out of the little rig to overcome vehicle noise and road noise for mobile applications. What could I do?

The first thought to come to mind was to build a small amplifier and speaker unit to be mounted somewhere in my small automobile. Bad idea, the car is too cramped already. Then another thought struck: simply mount some kind of switch and jumpers in the existing radio/tape-player so I could use the audio amplifier and speakers already in the car; that was another bad idea. The car's radio/tape-player is miniaturized, and permanently mounted. Putting a switch and input wiring into the unit would be a big job. Finally I arrived at the perfect solution: Simply input the handheld's audio into the existing tape player at the same place that a cassette tape does—via the tape head!

All that is required, is to place a small coil of wire in an audio cassette-tape body. The small coil must be mounted so that it fits snugly against the tape head in the tape-player. The wires from the ends of the coil are then connected to the audio output of the scanner, handi-talkie, or any other audio device that needs a little more power.

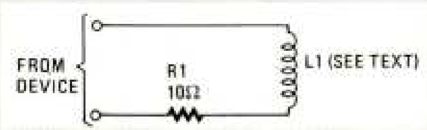
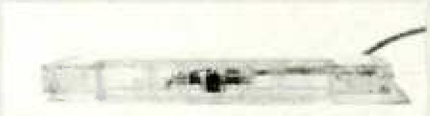


Fig. 1. The terminals to the unit should be connected to the appropriate plug for the device you wish to amplify.



This is the proper position for the coil.

PARTS LIST FOR THE AUDIO COUPLER

L1—200–400-turns of No. 36 or 40 enameled wire
R1—10-ohm, ¼-watt resistor
Cassette-tape housing (see text), fast-drying epoxy cement, shielded audio cable, phone plug (if necessary), etc.

Construction. You'll need to find an old cassette tape held together with small screws. Also the cassette cartridge must have a small flat metal tab with foam or felt on it (normally used to press the tape against the tape head) as opposed to the type that only has a piece of thick foam glued to the cartridge body. Hunt for a bargain since you won't need the tape itself. (I found cassette tapes at three for a dollar at the local discount store.)

To begin, the metal tab will be used to mount the coil. Next, take the cartridge apart and throw out the tape and little rollers, etc. If there is a small flat metal plate behind the metal tab, throw it away too. Next, remove the small metal tab that the foam pad is glued to, and wrap one layer of masking tape, or any thin adhesive-type tape, around the foam or felt pad. The purpose of that is to cover the sharp edges of the attached metal piece. Next, wind between 200 and 400 turns of no. 36 or no. 40 enameled wire around the tab and pad. It takes about about 1-½ feet of wire. That wire is very fine and very easy to break, so be careful. You can salvage some out of an old speaker, earphone, a small toy motor, or even a small audio transformer. It may not be necessary to use wire as small as I used. Larger wire may require more turns though, and there is not a whole lot of room for the coil if it is too large. After the coil is wound, apply a small amount of quick-drying epoxy cement to hold the coil in its place.

Next prepare a length of two-lead wire or shielded cable by connecting a phone plug on one end and tinning the leads on the other. With a small file, saw, or hot knife, cut a small notch in the cassette cartridge in a spot where the wire can enter/exit the cartridge without interference from the tape player. Also, it should be located so that when the tape cartridge is plugged into the tape player, the cable will protrude from the end of the cartridge that is closest to the player opening. Most automobile tape players that I have seen leave one end of the cassette sticking out in the open. If your tape player completely consumes a cassette, you may be able to use a thin flat wire that can be routed so that it exits the tape-player opening without too much stress.

Now drill a small hole in the cassette cartridge right behind the metal tab so that the tiny wires from the coil can pass through it into the body of the cartridge.

Remove the enamel coating at the coil ends by passing them through a

(Continued on page 101)

Sound-Activated KALEIDOSCOPE

Generate eye-catching patterns that change in cadence with an audio signal with this sound-activated kaleidoscope

BY DR. DON H. ANDERSON

Kaleidoscopes have been popular for ages, and over the years, a wide variety of kaleidoscopes have been developed. Most have depended on rotation of either the mirrors, or particles imaged in them, to provide a multiplicity of changing patterns.

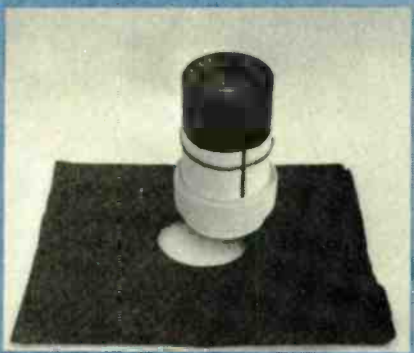
In the 1950's, a kaleidoscope in which the particles were caused to move in cadence with music was shown on television. The *Sound-Activated Kaleidoscope*, described in this article, accomplishes the same thing using readily available materials.

The kaleidoscope can be built to be viewed directly, and sound (be it from radio, tape recorder, or the human voice) can be used to move the particles. It can also be coupled to a musical instrument through a contact microphone.

I've had the greatest success when I coupled the kaleidoscope to an electric organ and projected the image of the moving particles on a screen in front of the organist. The heart of that unit was a small speaker.

Getting Started. For your first experiment, I suggest that you use a 4-inch speaker that has a well suspended cone. The speaker cone is expected to bear the weight of the mirrors and the mount, which may result in severe distortion if the speaker cone is not rugged enough.

The mirrors are, ideally, of front surfaced thin glass or plastic. Front surfaced mirrors are available in a variety of sizes and thicknesses. To help determine mirror size, it is suggest that you build an experimental unit using reflective foil. Many art stores sell reflective foil by the foot. It is easily peeled from its substrate and transferred to a piece of very smooth cardboard or



Shown here is the projection lens mounted in a cardboard tube ready for installation on a cloth-covered cardboard base.

plastic sheeting. The surface that holds the reflective foil should be as free from defects as possible because the film will bring out any the defects in the surface.

Because the unit is to be experimental, its assembly need not be super critical. The mirrors, angled at 60°, are mounted on a thin aluminum plate, which is then mounted on a small paper cylinder. That assembly is then glued to the cone of the speaker.

For particles, crumpled bits of aluminum foil—either plain or colored (like florists use)—works well. Bits of plastic insulation from some brightly colored wire can be used. Another alternative, provided you are located in an area of low humidity, is to use the brightly colored particles (sprinkles) that are used as cake and cookie decorations (high humidity would cause the sprinkles to bond together).

Construction. Begin construction by cutting two pieces of cardboard or plastic to about 2-by-3¼ inches. Be sure they are the same length and width; they'll be used to form the reflecting surfaces in the kaleidoscope. Apply the foil to the cardboard or plastic.

Use thin transparent plastic film to provide the window area. Be sure that the film is stiff enough to hold the mirrors in position after cementing, without buckling. The clear film is the window through which the display will be photographed if you use a video camera. If you make a projection unit, the window will be used to illuminate the particles.

For assembly, a support can be made by gluing two pieces of corrugated cardboard together with the corrugations at right angles. The window material is cut about ⅞-inch wider than the mirror panels, but of equal length.

Refer to Fig. 1. As shown, one of the mirror panels is pinned to establish the spacing of the parts during cementing. Pinning the window material down (as shown in Fig. 2.) allows the two mirror panels to be properly arranged. Two pieces of masking tape placed along the bottom and top edges serve as a temporary support during the cementing process.

Place a small amount of five-minute epoxy cement along the joints. Be careful that the cement does not get on the mirrored surfaces. The first coat must be solid and completely dry before the second coat is applied. Doing

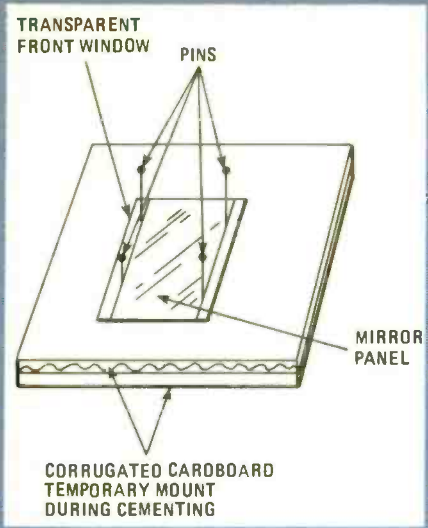


Fig. 1. Pinning one mirror panel to a temporary mount helps to establish the spacing of the parts.

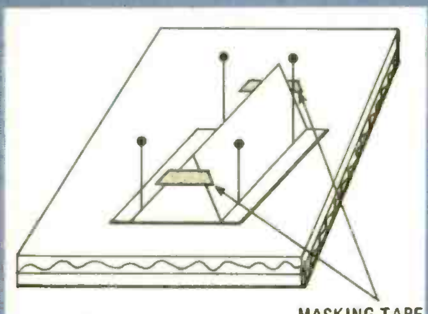


Fig. 2. Two pieces of masking tape placed along the bottom and top edges of the mirror panels serve as a temporary support during the cementing process.

MATERIALS FOR THE SOUND-ACTIVATED KALEIDOSCOPE

Small speaker (size not critical)
Front surfaced mirrors or reflective foil
Plastic sheeting or smooth cardboard (⅛-inch thick)
Clear plastic, rigid (thickness not critical)
White glue
5-minute epoxy cement
Flat black spray paint
Stereo amplifier (optional, see text)
A small slide projector or halogen flashlight
Projector lens or simple lens (4- to 6-inch focal length)
Video camera extension microphone

Note: Front surfaced mirrors are available from Edmund Scientific Company, 101 East Gloucester Pike, Barrington, NJ 08007.

so ensures that the second coat won't run inside the unit. Make sure that the second coat is thick enough to provide good mechanical stability with very rigid joints.

Be particularly careful around the apex of the unit. Any cement that runs inside will forever be a part of image of the kaleidoscope's display.

For the base plate, use aluminum sheeting. You can, if you wish, substitute cardboard if all you are building is an experimental unit. Don't use plastic since it can build up static charges that interfere with the free movement of the particles.

Cut the base plate about ⅞-inch larger than the kaleidoscope and give it a coat of flat black spray paint.

The kaleidoscope is cemented to the painted surface of the plate. The bottom is glued to the paper cylinder. Since white glue and aluminum are not compatible, a self-sticking label was placed on the bottom of the aluminum plate to provide a surface to which the glue would adhere.

Make the cardboard cylinder from card stock: A 5- by 7-inch index card works well. The cylinder is made by gluing 3 or 4 layers together to form a cylinder that's about 2 inches larger than the center of the speaker cone and long enough to extend about ½ inch above the edge of the speaker frame.

While that is drying, mount the kaleidoscope to the top of the base plate. I suggest that you use some cellophane tape for the initial trials. You can cement the assembly in its final position later.

After the paper cylinder is dry, find the balance point of the kaleidoscope by placing it on a finger and moving it around. Glue the paper cylinder at that point. When the joint is thoroughly dry, glue the assembly to the speaker cone. If you ever wish to remove the unit, you'll find that a razor blade or very sharp knife allows you to break

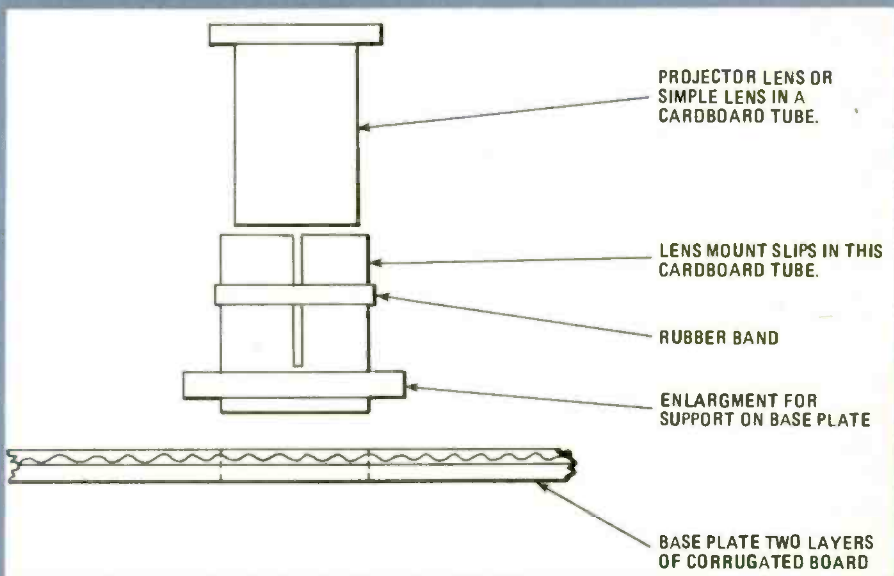


Fig. 3. A lens from a slide projector can be held in place by a cardboard tube wound tightly around the lens. That assembly is placed inside another cardboard tube and held in place by friction, supplied by a rubber band.

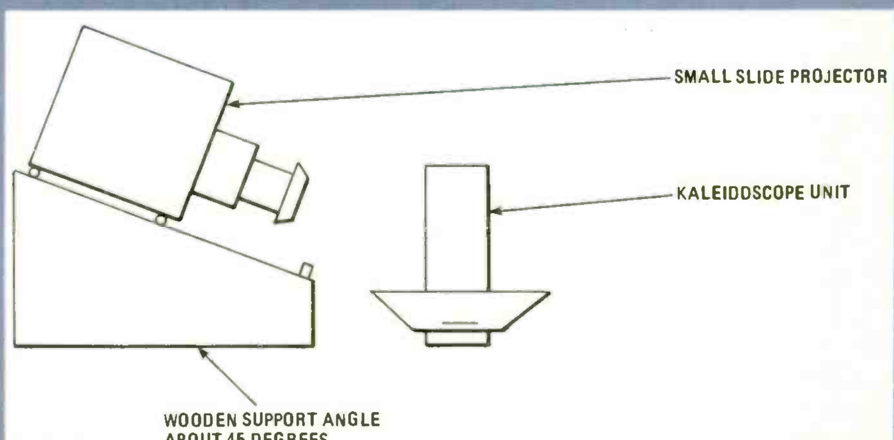


Fig. 4. A slide projector can be mounted on a rack in such a way that the light is emitted at a 45-degree angle into the apex of the kaleidoscope.

the joint between the base plate and the cylinder.

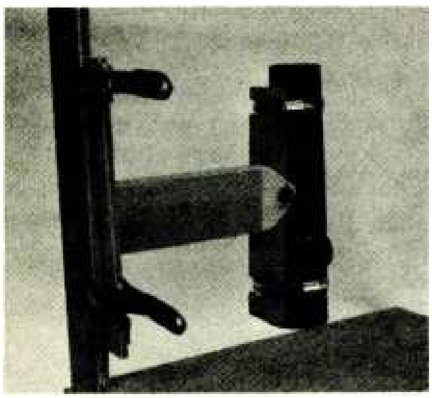
When all joints are set, you can put particles into the kaleidoscope unit and test it with a small radio. You'll find that the load of the kaleidoscope results in some audio distortion. With some speakers, the distortion is so small that it is of no concern.

Optics. The projection lens need not have all the optical quality of a typical slide projector lens. Since the kaleidoscope particles are in motion and at times are flying above the surface, the image is constantly changing in and out of focus. You might try using a simple double convex lens as a start.

Depending on the size of your kaleidoscope, you will need to use a lens with a focal length of 4 to 6 inches. You can try lenses from small hand magnifiers or the so-called close up lenses used with cameras. They usually have the focal length marked on them. A quick way to check your lens is to focus the image of a distant object on a white card. If the distance from the lens to the card is about 4 to 6 inches, it's worth a try.

Some ingenuity may be required to mount the lens. If it is a loose lens, mount it in a cylinder made from several layers of card stock. A ring of cardboard glued on each side of the lens will hold it securely in place. It is suggested that you build a model before building the final carrier. Your final unit can be as professionally finished as your time and talent allow.

If you are using a projection lens from a small slide projector, it can be held in place using the method illustrated in Fig. 3. The cardboard tube is wound tightly around the lens, glued



This simple mount can be used to hold a flashlight at almost any angle for video taping or projecting the images.

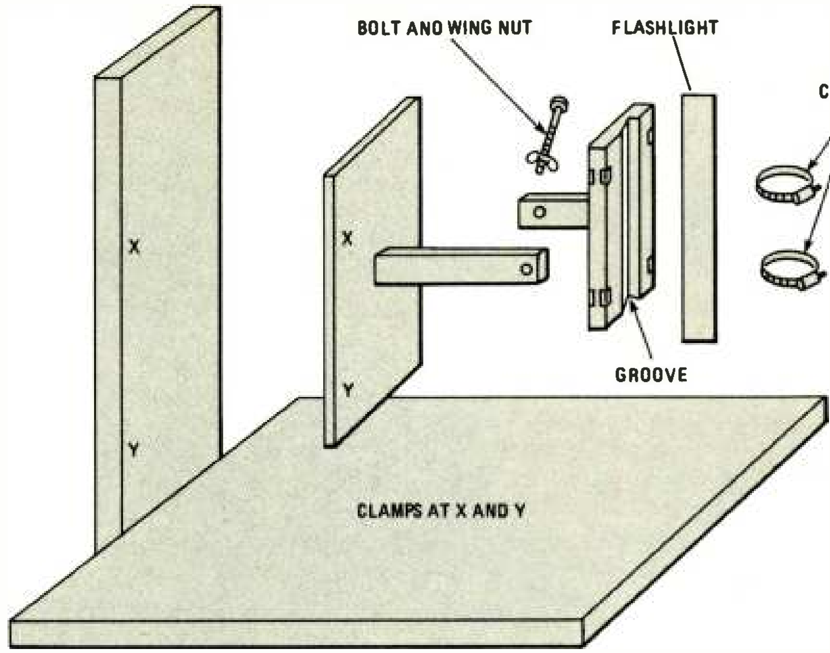


Fig. 5. Shown here are construction details for a typical experimental mount for a flashlight. Such an arrangement allows a flashlight to be used with either a projection unit or a video camera.

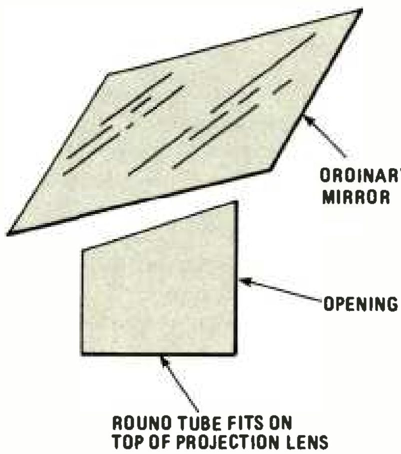


Fig. 6. When projecting the image onto a wall screen, the tube is used to hold a mirror at a 45-degree angle.

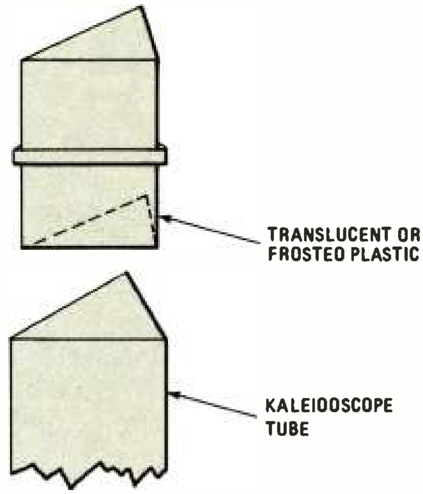


Fig. 7. When video taping, only a relatively small amount of light is required. The light should be diffused. That can be accomplished by placing a piece of frosted plastic between the flashlight and the particles in the tube.

securely in place, a collar mounted to the assembly, and the whole thing glued to a corrugated cardboard panel. When thoroughly dry, one or two slits are cut and a rubber band provides the friction to hold the lens.

Details of the best way to hold the panel above the kaleidoscope are difficult to give. I frequently use corrugated cardboard for the box. Try using a small slide projector as the light source. The slide projector is mounted on a rack, as shown in Fig. 4, so that the light is emitted at a 45 degree angle into the apex of the kaleidoscope.

Trial and error with the lens at several positions and angles may be needed to optimize the conditions. For short projection distances, I have used a flashlight containing a high-intensity halogen bulb with satisfactory results. A typical experimental mount is shown in Fig. 5. That mount or a similar arrangement of your own design allows the flashlight to be used with either the projection unit or for video taping.

If you wish to project the image onto a wall screen (see Fig. 6), the tube is used to hold a simple mirror (taken from an old purse) at a 45 degree angle. When video taping, only a relatively small amount of light is needed. It

(Continued on page 99)

Salvaging An Autotransformer

BY JULIAN SIENKIEWICZ

On the project bench or under your Christmas tree, this troubleshooting device from the vacuum-tube era is just as important today.

An adventure inside a flea market in the next state uncovered an item that will be very useful at home this Christmas. I was on the trail for a few table-top antique radios, *circa* 1940's, when I came upon an old autotransformer—commonly called a *Variac*, which is a trade name. An autotransformer can take line voltage and vary it at its output from zero to 140-volts AC. The unit I found was an import that was sold by Radio Shack in the late 1950's; it had been dropped and slightly damaged. The deep dust and dirt covering parts of it did not bother me—that's the easiest thing to take care of. I bought the gadget for three dollars (the seller drove a hard bargain), and I took my prize home.

The Story Deepens. The following weekend I had a chance to scrutinize the autotransformer. I removed the large control knob from the top, and a few screws, and then gently slid the metal protective shell off. After cleaning the case I found repainting was not necessary.

Inspection revealed that some plastic parts were broken, and some of the Bakelite pieces were still inside the unit. One of the leads to the transformer coil was yanked a bit, and the copper wire that was wound on the toroidal core was stretched. That caused the wiper contact at the top of the unit (where the selected AC voltage is tapped) to ride roughly over the top of the coil. Also the power cord had been cut off near its entry point to the unit.

Everything else looked very good. Even the 5-ampere fuse was in good shape. There appeared to be no short cuts in the manufacturer's construction techniques. The unit was rigidly built with solid Bakelite parts.

I hooked up a power cord and gave the autotransformer the acid test—AC power. Without a load connected, the autotransformer took the voltage without any smoke. In fact, almost no heat was detected; so far, so good. A voltmeter connected to the autotransformer's output jack showed that the output could be varied from 0- to 140.4-volts when the input was rated at 115.1 volts AC (the AC power line was low that day). Next, I added a two-photoflood bank of lights and the autotransformer worked well with a 300-watt load. The variable-voltage tap worked well throughout most of the

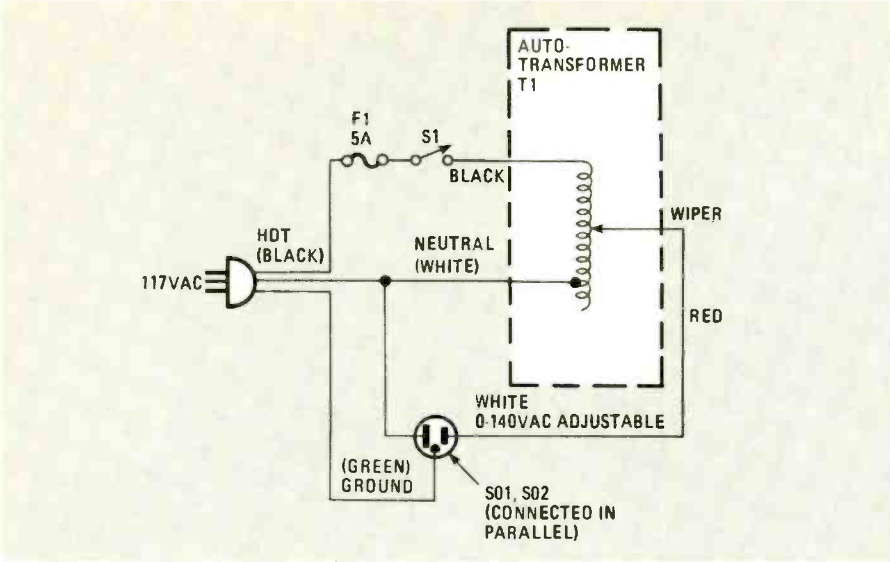


Fig. 1. Here is the wiring diagram for the modified autotransformer. The original fuse holder was reused. The power switch and two-terminal outlet were discarded. Colored insulated wires (black-hot, red-variable AC, and white-neutral) were attached to the short leads on the stripped autotransformer to assist in goof-proofing the final wiring.

range. I was too chicken to take the flood lamps above 130 volts. The results of the tests convinced me that the autotransformer was worth sprucing up and using.

Fixing Up. I began by fixing a *bump* on the tapped coil where the 117-volt AC power line is connected. That was easy to do. Every time I tried to push it down and glue it in place, the turns popped back up again. That technique was not working so I tied a thin leather shoelace to the tap point, and added some weights until the weight was heavy enough to hold the bump down. I applied some epoxy to the sides of the turns so that when the weight was removed, the turns remained in place. Do not ever put glue or cement on the contact surface; the wiper will fail to make electrical contact, and the unit will not work properly. The epoxy set in 24 hours, and the bump was gone.

The next consideration was the broken Bakelite parts. One mounting leg of the autotransformer was gone; broken off and lost forever. However, the rest of the base was good, so I decided that the remaining two legs were sufficient to hold the autotransformer to a breadboard. If necessary, I could have used epoxy to cement the entire base to the board. A plastic tab that was used to secure the cover to the base was floating around inside the case, so I affixed it with some epoxy.

The plastic piece that housed the

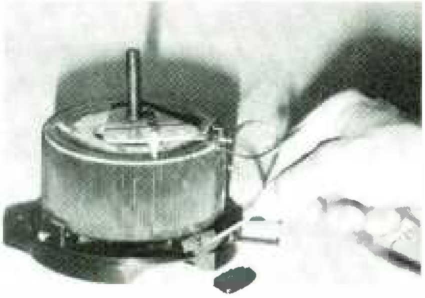
Here's the autotransformer ripe for repair. With a little effort, it turned out to be a worthwhile test-bench tool.

fuse holder and AC outlet, and passed the line cord to the outside, was broken beyond repair. That was not a total loss, because I was not satisfied with the two-terminal AC outlet used in the original unit. I wanted a three-terminal outlet, and a strong contact surface in the outlet to grab the prongs of the AC plug. So I discarded the plastic piece and covered the opening in the cylindrical housing with a piece of sheet metal cut from a 2-pound coffee can. The price of the can was certainly right. The section I had cut from it had almost the same radius as the metal shield, and its indented ribs (common to coffee cans) made it very rigid. I drilled a hole through it and inserted a grommet in it to protect the insulation of the wires to be passed through it. The metal was painted black before installation, and, when finished, the fabricated cover looked as if it was installed by the manufacturer.

The interconnecting leads from the autotransformer were too short to reach an external electrical box, so they were extended using color-coded stranded wire. The splices were soldered and electrically insulated with black plastic tape.

The rest was easy to do. A 6 × 12- × ½-in. hardboard (veneered on both surfaces) was cut and the edges sanded smooth. Any ½- to 1-in. board cut to a convenient size will do. One idea is to purchase a cutting board in a housewares store should you dislike woodworking.

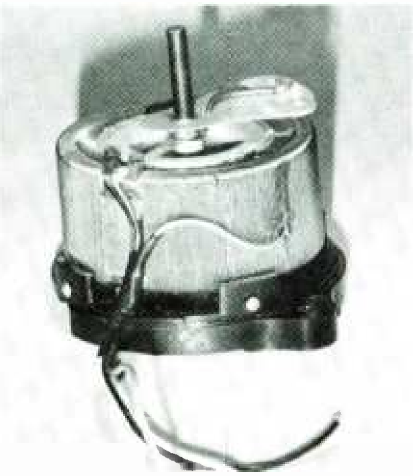
The autotransformer is a one-coil device wound on a cylindrical iron form with the AC line connected across the bottom of the coil and to a tap on a copper turn about 85% of the distance from the first tap. A sliding contact selects one of the coils to pick off an AC voltage. The plastic piece hanging from the leads of the winding was discarded because it was damaged and the single outlet was neither polarized nor of the three-terminal type.



A broken-off part was joined to the base with epoxy. The piece, which was found inside the unit, contains an embedded nut used to secure the unit's shield.

Here's the autotransformer mounted on the board with the electrical box mounted and wired. Note that the fuse holder is easy to reach for fuse replacement.

A piece of a two-pound coffee can was used to close up the hole left in the autotransformer's safety shield. The can had an almost perfect curve and indented ribs for reinforcement. A hole was drilled through it. Once the shield was complete, it was sprayed with a flat black paint. After drying, a grommet was installed.



The leads of the cylindrical winding were too short. Colored leads (a red, a black, and a white) were added to make wiring easy and goof-proof. The splices were soldered, and black plastic tape was used to insulate the splices.

Electrical Work. The autotransformer was secured to the board with wood screws. A 4-in. square electrical box and a face plate for one duplex outlet with toggle switch, was installed on the

I installed a new three-wire power

board about one inch away. Two of the box's circular knockouts were removed and cable clamps were installed. A third knockout was removed and the original fuse holder was installed. The knockout hole was too large for the fuse holder, so an oversized washer was placed on each side of the hole and the fuse holder was installed through them. Should you wish to do that, do not over-tighten the nut because the plastic fuse holder breaks easily. If you can't find washers of the right size, cut out two squares of aluminum and drill a hole in the center of each. One of them should be sized to fit neatly on the inside and one on the outside of the electrical box.

cord and clamped it to the electrical box. The wires from the autotransformer were passed into the box to begin the wiring of the box. In Fig. 1, as in all electrical circuits, the white wires are ground and connect to the silvered screw terminals on the AC outlet. The black wire (it's electrically hot) from the autotransformer goes to the fuse. The red wire from the wiper terminal is also hot and connects to the brass-screw terminal on the outlet.

The Juice is On. I powered up the autotransformer assembly after the fuse was installed. The original unit called for a 5-ampere fuse, so I used a fuse rated at 5 amperes, however, a fuse that has a lower current rating can be used. A voltage check at the AC outlet indicated an output 0 to 140 volts AC as the control knob was moved through its range.

More than just a Christmas-tree bulb saver, the autotransformer is used here to uncover a failing part in an old relic—a Hallicrafters SX-38B shortwave receiver.

The first task I designated to the autotransformer was to discover a fault in an antique tube-design *Hallicrafters SX-38-B* shortwave receiver. The receiver operation was intermittent, but the trouble never lasted long enough to locate the fault. Voltage was applied and I cranked the autotransformer up to 127-volts AC, when the fault occurred and held. The problem was then traced to a defective wax-paper capacitor.

A used autotransformer may be hard to find when you are looking for one. Mouser Electronics sells them in different sizes and configurations. One unit listed in their catalog is a Staco Variable Transformer, catalog No. 563-3PN501 which sells for $125.98; it is comparable to the unit I found.

In a few weeks Christmas will be here and the autotransformer will be put to work on the Christmas tree's lights. Those miniature-bulb sets last much longer when the voltage is down to about 105-volts. ■

E-Z MATH

BOOLEAN ALGEBRA and LOGIC CIRCUITS

BY LOUIS E. FRENZEL, JR.

Don't let logic gates bar your ability to experiment with circuits

If you have followed this math series, you know that we've spent a lot of time covering the math related to basic electrical principles and electronic fundamentals. In this month's installment, we'll head out in another direction for a change of pace. We will discuss a type of math used with digital-logic circuits. That math is known as *Boolean algebra.*

What's Boolean for? Boolean algebra is a collection of simple mathematical procedures used to represent and express the logical operations that go on in a digital circuit. Boolean algebra is very similar to standard algebra. The primary difference is that unlike standard algebra, in which variables can be any value, in Boolean algebra only the values 0 and 1 are recognized. Besides that, most of the basic rules of working with algebraic expressions apply.

The big benefit of Boolean algebra is that it provides a way to express digital-logic operations mathematically. Boolean equations can be written to precisely describe how a logic circuit operates, which can help you to design such circuits. Boolean algebra also provides a way to minimize the number of gates needed in a logic circuit to simplify circuit design. That lowers overall cost, and can help reduce power consumption.

Also, the equations can show at a glance what is going on in a logic circuit to aid you in troubleshooting.

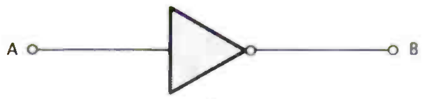
As I've said in previous articles, don't let terms like "Boolean," "equation," "mathematical expression," or "algebra" scare you. Once you learn the jargon and the few simple fundamentals presented here, even complex circuits will be easy for you. So, get ready for a digital-logic refresher, then we will have some fun writing the Boolean equations of a circuit and creating a circuit from the equations.

Review of Digital-Logic Circuits. At one time or another, you probably learned how basic logic circuits work. If not, the following brief summary will bring you up-to-date. The review is also for those of you who need a refresher.

The three basic logic gates are the inverter, AND gate, and OR gate. Two other widely used gates—the NAND and the NOR—are often derived from those basic gate circuits. All of the gate circuits process binary numbers made up of 0's and 1's. Binary 0 and binary 1 are represented by voltage levels. For example, a binary 0 may be indicated with zero volts (ground), while a binary 1 may be indicated by +5 volts.

The Inverter. An inverter is a logic element with a single input and a single output. As its name implies, it inverts an input signal. A binary-0 input produces a 1 output. A 1 input generates a 0 output. The inverter always produces an output that is the complement of the input. Complement here means opposite or reverse. You will also hear the inverter referred to as a NOT gate.

The logic symbol for an inverter is shown in Fig. 1. The triangle represents



A

INPUT	OUTPUT
A	B
0	1
1	0

B

Fig. 1. The simple inverter, A, is shown here with its little four-entry truth table.

a buffer—a circuit that directly passes a binary digit onto the next circuit without changing the value. The circle at the output indicates inversion. So the digit passes through the buffer and is inverted at the gate's output. Note that the input and output are labelled with letters. All logic signals are given a name or designation. Here A is the input and B is the output.

Also shown in Fig. 1 is a table that shows all possible combinations of inputs and outputs. The input, A, can be either a 0 or 1. The table shows the state of the output, B, for each input state. Such a table is called a truth table. Truth tables are used to show what's going on inside a logic circuit.

AND Gate. An AND gate is a logic circuit with two or more inputs and a single output. The output is a binary 1 if all inputs are binary 1. Otherwise, the output is binary 0. The AND gate is often called a coincidence circuit because the output will be binary 1 only when all inputs are simultaneously all binary 1.

The logic symbol for a two-input AND

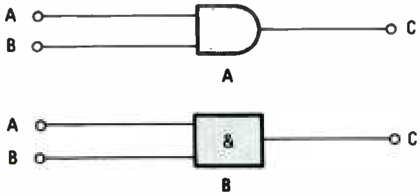
gate is shown in Fig. 2A. The inputs are A and B; the output is C. The shape of the symbol designates its function. An alternate symbol is given in Fig. 2B. The box designates the circuit while the ampersand (&) indicates the gate's function.

The truth table for a two-input AND gate is shown in Fig. 2C. There are always 2^N possible input combinations, where N is the number of inputs. With two inputs, there are:

$$2^2=4$$

different combinations. They are listed in the truth table along with the resulting outputs. Note that the only time the output (C) is 1, is when both inputs are 1.

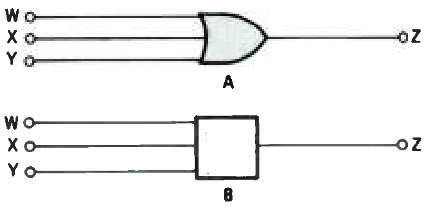
Keep in mind that an AND gate may have more than two inputs. Integrated-circuit AND gates typically have 2, 3, 4, 5, 8, or 13 inputs.



INPUTS		OUTPUT
A	B	C
0	0	0
0	1	0
1	0	0
1	1	1

C

Fig. 2. This two-input AND gate, A, can be drawn as shown in B. The truth table for all its possible states is shown in C.



INPUTS			OUTPUT
W	X	Y	Z
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

C

Fig. 3. For a change, this OR gate, A, is shown with three inputs instead of two. An alternative symbol is shown in B, while the elements truth table is shown in C.

OR Gate. An OR gate is also a logic circuit with two or more inputs and a single output. Its output is a binary 1 if at least one of its inputs is binary 1. Otherwise, the output is binary 0.

The logic symbols and truth table for an OR gate are given in Fig. 3. Note that the "equal to or greater than 1" designation means the OR function. The truth table shows the output Z with the inputs W, X, and Y. With three inputs, there are:

$$2^N=2^3=8$$

possible input combinations. As with AND gates, IC OR gates typically come with 2, 3, 4, 5, 8, or 13 inputs.

A NAND Gate. A NAND gate is the combination of an AND gate and an inverter. It is often referred to as a NOT-AND circuit, and thus its name N-AND. The output is binary 0 only when all inputs are binary 1. For other input conditions, the output is binary 1.

A NAND can be drawn as an AND with an inverter (NOT) circuit, as Fig. 4A shows. However, the special symbol in Fig. 4B is normally used. The circle at the output indicates inversion. An alternate symbol is given in Fig. 4C. Here the triangle or half arrow on the output indicates inversion. The truth table indicates all possible inputs and the corresponding output states. Looking back at the truth table for the AND gate, you can see that a NAND output is its complement. NAND gates with 2, 3, 4, 5, 8, and 13 inputs are available in IC form.

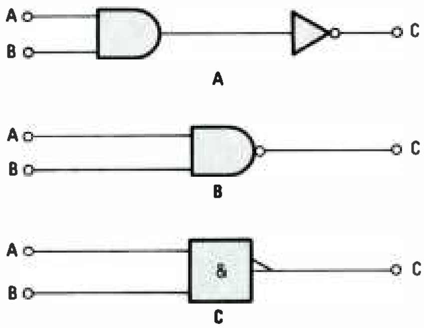
NOR Gate. The NOR gate or NOT-OR circuit is an OR gate followed by an inverter. The output is binary 0 if at least one of the inputs is binary 1. Otherwise, the output is binary 1.

The NOT-OR circuit, shown in Fig. 5A, clearly illustrates the circuit's function, but usually one of the symbols in Fig. 5B or 5C is more often used. The truth table shows the possible input and output states. IC NOR gates are available with 2, 3, 4, 5, 8, and 13 inputs.

Expressing Logic Mathematically. To begin using Boolean algebra, we need to find some way to express the basic logic operations using mathematical expressions. Let's take a look at ways of expressing inversion, AND, OR, NAND, and NOR operations.

As you learn the basic rules, keep in mind that the binary signals to be processed by the logic circuits are known as variables. Variables are signals that can change value. Binary variables can have one of two values; those values are 0 and 1.

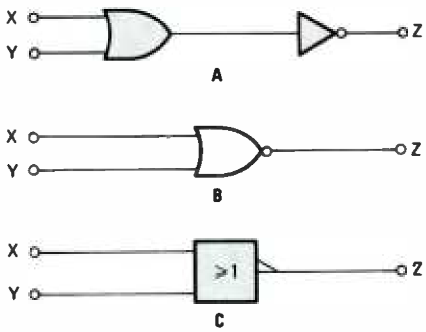
Variables are usually given names to distinguish them from one another. Letters of the alphabet are the most common, although numerous other alpha or alphanumeric names are also used. Usually signals are given some variable name (mnemonic) that is simply a shorthand way of referring to the



INPUTS		OUTPUT
A	B	C
0	0	1
0	1	1
1	0	1
1	1	0

D

Fig. 4. A NAND gate is nothing more than an inverted AND (B). Its output is the compliment of an AND gate's (C).



INPUTS		OUTPUT
X	Y	Z
0	0	1
0	1	0
1	0	0
1	1	0

D

Fig. 5. A NOR gate is nothing more than an inverted OR (B). Its output is the compliment of an OR gate's (C).

signal. An example is a binary signal called "clear," which might be represented by the mnemonic CLR. Many times binary signals are grouped together and related as in a binary number. For example, the bits in an 8-bit word might be given the names A0 through A7. In any case, you will see many different variations.

Inversion. Inversion is expressed mathematically by placing a bar over the variable. In Fig. 6, the input of the inverter is A while the output is B. Note that B is expressed in terms of A. That

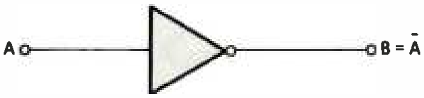


Fig. 6. The complement of a variable can be represented by placing a bar over that variable as shown here.

expression is read B is equal to NOT A. The NOT bar indicates that signal A has been inverted. Remember that A can be either a binary 0 or a binary 1. NOT A, of course, is the opposite, or complement.

Since it is difficult to type a bar over a letter as shown in Fig. 6, other simpler methods have been devised for representing inversion. Sometimes the inverted variable is indicated by an asterisk or a prime (similar to an accent). Using the variables in Fig. 6:

$$B = A^* \text{ or } B = A'$$

AND Function. The logical AND operation is indicated by placing a dot between the two variables to be ANDed. That is illustrated in Fig. 7. The two inputs to the AND gate are A and B

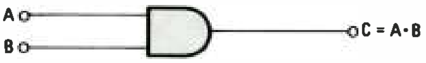


Fig. 7. ANDing of variables is indicated by using a dot between them.

while the output is designated C. Look at this expression for the output:

$$C = AB$$

In regular algebra AB would mean multiply A and B together. That's why the output of an AND gate is often called the product of the inputs. As in regular algebra, it is not necessary to show any symbol between the two variables (although sometimes a dot is used). Instead, they are simply just written adjacent to one another.

Figure 8 shows a four-input AND gate with different input variables. Many times you will see the output expression written with some variables separated by parentheses. Each input term appears within a set of parentheses to keep them visually separated to avoid confusion. But since each expression is written directly adjacent to the next, it

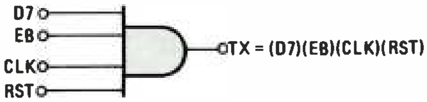


Fig. 8. The variables in Boolean algebra need not be one letter in length, but for clarity, separating them with parentheses becomes necessary.

means that the variables are ANDed together. In Fig. 8, we say that the output product is:

$$TX = (D7)(EB)(CLK)(RST)$$

OR Function. The logical OR is indicated by placing a plus sign between the variables. That is illustrated with the three-input OR gate shown in Fig. 9.

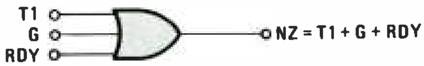


Fig. 9. ORing of variables is indicated with plus signs. Note the three inputs.

Often you will hear the output of an OR gate referred to as the sum of the input variables.

NAND Function. The NAND or NOT-AND function is simply the inverted product of the input variables. An example is shown in Fig. 10. The output expression is written just as it would be for an AND gate, but with a NOT indication given to the entire expression. That can be done by putting a bar over the entire expression as shown in Fig. 10. Alternately, the ANDed input terms can be put into parentheses and an asterisk or

Fig. 10. In a NAND expression, the result of all ANDing is simply inverted.

apostrophe used to indicate the NOT of the function. Note that the B term has a NOT bar over it.

The NOR Function. To produce the NOR function, we simply invert a basic OR output. Figure 11 shows a four-input NOR gate. The output expression is formed by simply writing the input variables separated by plus signs. Then, a bar is placed over the entire expression to invert it. Again note that one term, DZ, is inverted at the input.

Fig. 11. Multiple-input NANDs do not need to have their variables separated by parentheses for clarity.

Now using those basic (Boolean) expressions for each of the logic gates, more complex circuits can be easily represented.

Deriving Boolean Expressions. Knowing the basic rules outlined in the previous section, you can now derive a complete Boolean expression for any larger, more complex logic circuit. The process is simply to work your way through the various logic gates starting with the inputs and building the equation a step at a time. A couple of examples will illustrate the process.

Refer to the circuit in Fig. 12. Note that the input variables are labelled. The output is designated G. Our job is to write the expression for G in terms of the input variables. It's really not as complicated as it sounds.

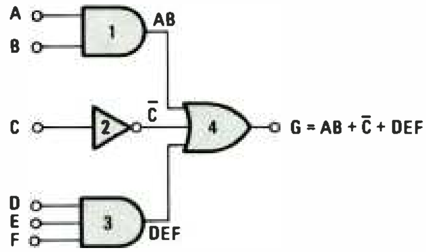


Fig. 12. You end up with a sum of products expression for this circuit after analysis.

To begin, you start with the variables at the inputs to each of the circuits on the left. Write the expression for the output of each circuit. For example, the output of AND-gate 1 is simply AB. The output of the inverter 2 is NOT C. The output of AND-gate 3 is DEF.

The outputs of gates 1 and 3, and inverter 2, form the inputs to OR-gate 4. To complete the expression, simply OR together each of the inputs to gate 4. The output expression G then becomes:

$$AB + \overline{C} + DEF$$

Take a look at the expression we just derived. You often hear an expression like that referred to as a sum of products. In this case, the products are the ANDed variables AB and DEF. The sum, of course, refers to the ORing together of each of the products.

A slightly more complex circuit is shown in Fig. 13. Still the evaluation process is the same. Work your way through the circuit from left to right writing the output expression for each gate. The output of gate 1 is A1(K) as shown. We use parentheses in this case to show the separation between the

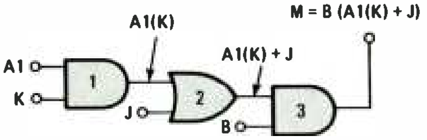


Fig. 13. The output of one gate becomes the input of the next in this circuit.

two variables, yet they are written adjacent to one another to indicate a product or AND function.

Next, the output of gate 1 is ORed with the input of J. The resulting output from gate 2 is:

$$A1(K) + J$$

That becomes one of the inputs to AND-gate 3. That expression is ANDed with input B to produce the final output expression:

$$M = B(A1(K) + J)$$

Again parentheses are used to keep the variables separated and to ensure the correct logical operation is expressed.

Take a look at the example in Fig. 14. Again, the procedure is to develop the output expressions of the input gates,

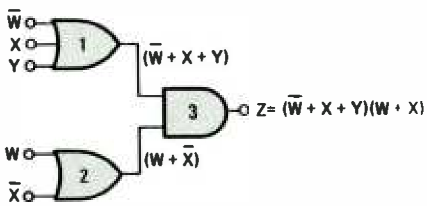


Fig. 14. You end up with a product of sums expression for this circuit after analysis.

then work your way from left to right to create the output. The output from gate 1 is:

$$(\overline{W} + X + Y)$$

The output of gate 2 is:

$$(W + \overline{X})$$

Those two outputs become the inputs to AND-gate 3. We create the final output expression, Z, by simply ANDing together the two expressions. The result is:

$$Z = (\overline{W} + X + Y)(W + \overline{X})$$

You might hear that kind of expression called a product of sums.

Generating a Circuit From Equations. Now let's consider the process of drawing the logic circuit corresponding to a given Boolean expression. Let's start with the simple expression below:

$$W = XY + \overline{Z}$$

The various logic functions implied by the equation are pretty easy to spot. The X and Y are written adjacent to one another indicating that the two signals are ANDed. Simply draw an AND gate with X and Y as the input. The output of that AND gate XY is then going to be ORed with another input called $\overline{Z}$. The plus sign tells us we need an OR gate to do that. If only the variable Z is available, an inverter is needed to produce $\overline{Z}$. The resulting circuit is shown in Fig. 15.

A slightly more complex example is given below:

$$X = (A + B + \overline{C})(\overline{D} + E)(F)$$

The parentheses tell you that you have three different groups of variables ANDed together to form the output, X. The variables in the groups are ORed

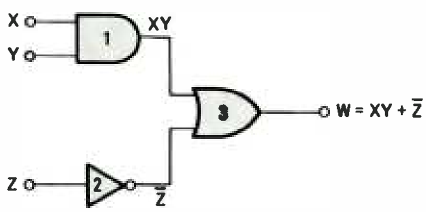


Fig. 15. By drawing the logic symbols that correspond to the Boolean expressions you'll arrive at the correct circuit.

together. You can start by creating the circuits for each group of variables. The plus signs inside the parentheses indicate an OR gate should be drawn. To start you can draw an OR gate with inputs A, B, and $\overline{C}$. Another expression is derived by ORing the input variables $\overline{D}$ and E. Simply draw an OR gate with the two variables as the inputs. The variable F inside parenthesis will be ANDed together with the other two expressions. Finally, to complete the circuit simply draw an AND gate with three inputs and connect them to the outputs of the two OR gates and a source of signal F. See Fig. 16.

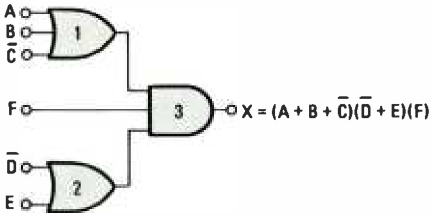


Fig. 16. The product of sums expression shown was used to generate this circuit.

Exercise problems. Here are a couple of problems for you to practice on.

1. Write the output expression of the circuit shown in Fig. 17.

2. Draw the logic diagram corresponding to the expression:

$$M = (\overline{F} + G + H)(J + \overline{K} + L)$$

Assume no inverted signals are available.

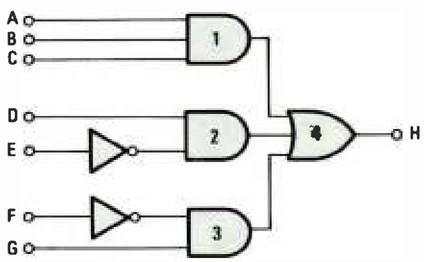
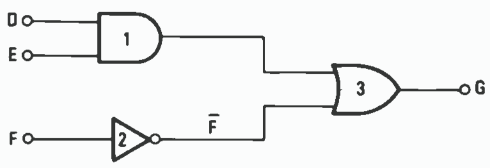


Fig. 17. Write the equation for the circuit.

Truth Tables. You have already seen how truth tables are used to define all possible combinations of inputs and outputs for the various logic elements. Truth tables, however, can also be used to describe larger, more complex logic circuits. The nice thing about a truth table is that it gives you a complete picture of what's going on in the circuit for any set of input states.

Developing a truth table for any logic circuit is relatively easy. All you have to do is write out all the possible input states, and for each one compute the output state for every gate in the circuit until the final output is derived. Let's take a couple of simple examples to show how you can evaluate the output state for a given set of inputs.

Take a look at the circuit shown in Fig. 18A. Where N is the number of in-



A

INPUTS			OUTPUTS		
D	E	F	GATE 1 DE	INVERTER 2 $\overline{F}$	GATE 3 G
0	0	0	0	1	1
0	0	1	0	0	0
0	1	0	0	1	1
0	1	1	0	0	0
1	0	0	0	1	1
1	0	1	0	0	0
1	1	0	1	1	1
1	1	1	1	0	1

B

Fig. 18. The possible outputs for circuit A can be displayed in a truth table like B.

puts, the total number of different input states is 2^N. The circuit shown has three inputs, so with three inputs, there are:

$$8 = 2^3$$

Those eight possible combinations are the binary numbers 000 (decimal 0) through 111 (decimal 7). Therefore, we will make a truth table with eight possible input states as shown in Fig. 18B.

The remainder of the truth table will contain the outputs at each element in the circuit. For example, note that we have the output of AND gate 1, the output from inverter 2, and the output from OR gate 3. Knowing how each of the logic gates work, you can then determine the output of each gate given the various combinations of inputs, and record those values in the table. For example, the input to gate 1 is D and E. Since it is an AND gate, the only time it will produce a binary-1 output is when both D and E are binary 1's. Simply locate those states in the inputs and record binary 1's beside them. All of the other entries in the DE column will be binary 0. The $\overline{F}$ column is created by simply inverting the F column.

You now know both inputs to OR-gate 3. The DE and $\overline{F}$ columns can then be ORed together to produce the final output, G. Again, remembering that an OR gate produces a binary-1 output if either or both of its inputs are binary 1, you can complete the G column.

Be sure you go through the circuit and the truth table carefully so that you understand exactly what is going on in each column.

Let's take one more example to be sure you know how to develop the truth table from a given logic circuit. Refer to Fig. 19A. That circuit has four different inputs, therefore, it will have:

$$2^4 = 16$$

possible input combinations. Those are the four-bit binary numbers 0000 (decimal 0) through 1111 (decimal 15). They are illustrated in the truth table shown in Fig. 19B.

The remaining columns in the truth table are the output of gate 1 (A + B); the output of gate 2 (C + D); and the final output, F. Again, using the input states, develop the output for gate 1 and then gate 2. Those are OR gates, and so produce a binary-1 output when either or both inputs are binary 1. For gates 1 and 2 simply search through the table for those rows where binary 1's occur at the inputs of the gates and record binary 1's in the corresponding output column. Once you have done that for both gates, you will have the inputs to gate 3. Gate 3 is an AND gate, so its output is 1 when the output columns for gates 1 and 2 are both binary 1. Again look through all of the columns in the truth table to be sure you understand how they apply to the circuit.

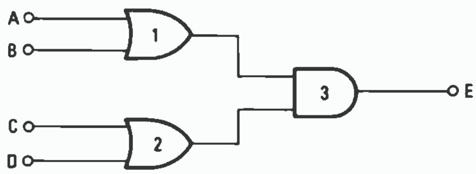
Exercise Problem. To see if you can do this yourself, try the following problem.

3. Draw the circuit for the Boolean expression:

$$Z = Y(VW + \overline{X} + \overline{V}X)$$

Assume only the inputs V, W, X and Y are available. Develop the truth table showing the outputs for all inverters and gates.

Writing from a Truth Table. In many cases, you will start with a truth table and develop the Boolean expression from it. That is what usually happens when you are designing a digital circuit. Typically, you will define a desired



A

INPUTS				OUTPUTS		
A	B	C	D	GATE 1 (A + B)	GATE 2 (C + D)	GATE 3 (E)
0	0	0	0	0	0	0
0	0	0	1	0	1	0
0	0	1	0	0	1	0
0	0	1	1	0	1	0
0	1	0	0	1	0	0
0	1	0	1	1	1	1
0	1	1	0	1	1	1
0	1	1	1	1	1	1
1	0	0	0	1	0	0
1	0	0	1	1	1	1
1	0	1	0	1	1	1
1	0	1	1	1	1	1
1	1	0	0	1	0	0
1	1	0	1	1	1	1
1	1	1	0	1	1	1
1	1	1	1	1	1	1

B

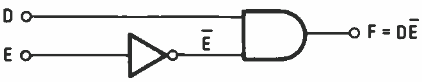
Fig. 19. You must use all possible input combinations for the circuit A for the table, B.

output condition that is generated when specific input states occur. To develop your design, you build a truth table filling in the columns with the desired output states for the given inputs. Then, the truth table can be used to help write the Boolean equation, and the logic circuit itself, can be deduced from the equation. Once the logic circuit is drawn, it can be implemented with ICs or other components.

A simple example of that is a design where we have two inputs and want a specific output to occur. For example, perhaps you want the output F to be binary 1 when input D is equal to 1 and input E is equal to 0. For all other input states, we want the output to be binary 0. That set of conditions can be drawn in a truth table as shown in Fig. 20A. With two inputs, there are four possible input combinations. We want the output to be a binary 1 when D is equal to 1 and E is equal to 0. All other input states produce a binary 0 output. The truth table shows that set of conditions.

INPUTS		OUTPUT
D	E	F
0	0	0
0	1	0
1	0	1
1	1	0

A



B

Fig. 20. A truth table (A) must be generated from a circuit (B) before deriving the Boolean equation.

Now to derive the Boolean expression from the truth table, we look at the output column F and note where binary 1's occur. Next, we look at the input states that produce that output. Then we write an expression that is the product of the input variables. For example, in the truth table of Fig. 20A, the equation becomes:

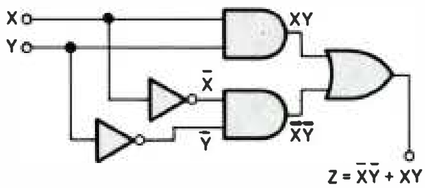
$$F = D\bar{E}$$

We write the D because a binary 1 appears in the D column. We write $\bar{E}$ because a zero exists in the E column. That simple equation, of course, can be implemented with a single two input AND gate. An inverter is be needed to produce $\bar{E}$ if only the E input is available. The resulting circuit appears in Fig. 20B.

Now let's take a more complex example. Suppose that we want to develop a simple circuit for comparing two bits. We would like the output of the circuit to be binary 1 when the two bits are equal, and binary 0 when they are different. That is described in the truth table shown in Fig. 21A. The two inputs are X and Y, therefore, the four possible input combinations are listed. We want the output Z to be binary 1 when the bits are alike. So we write a binary 1 when both bits are 0 and when both bits are 1. The remaining input states produce a binary 0 output.

INPUTS		OUTPUT	
X	Y	Z	
0	0	1	← $\bar{X}\bar{Y}$
0	1	0	
1	0	0	
1	1	1	← XY

A



B

Fig. 21. The truth table, A, generates a sum of products equation for circuit B.

Now we can write the equation for the circuit. We look at the output column and note the places where the binary 1's occur. Then we write an AND ed expression using the inputs. The first binary 1 output occurs if X = 0 and Y = 0. Therefore, the equation for that state is:

$$Z = \bar{X}\bar{Y}$$

The other binary 1 output occurs when X = 1 and Y = 1. Therefore, the input expression is:

$$Z = XY$$

To complete the Boolean expression, we simply OR the two AND expressions together. That is because the output becomes binary 1 under either condition. The resulting output expression:

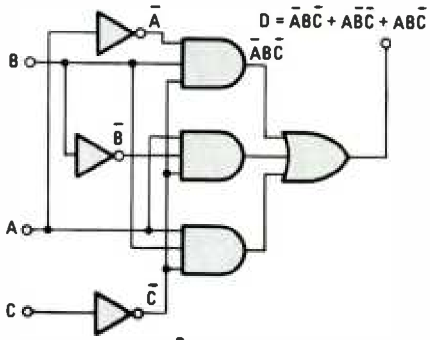
$$Z = \bar{X}\bar{Y} + XY$$

The resulting circuit is illustrated in Fig. 21B.

Let's take it one step further, and develop a more complex circuit. Suppose we have three inputs and the desired outputs are indicated by the binary 1's in the truth table of Fig. 22A. To develop the output expression for the truth table, write an AND expression using the input variable for each place where a binary 1 appears in the output. The first AND expression is $\bar{A}B\bar{C}$. The variable with the NOT sign is used when a binary 0 appears at the input, and the variable itself is used when a binary-1 state occurs.

INPUTS			OUTPUT	
A	B	C	D	
0	0	0	0	
0	0	1	0	
0	1	0	1	← $\bar{A}B\bar{C}$
0	1	1	0	
1	0	0	1	← $A\bar{B}\bar{C}$
1	0	1	0	
1	1	0	1	← $AB\bar{C}$
1	1	1	0	

A



B

Fig. 22. The conditions for a binary 1 output (A) must be ORed together to produce the Boolean equation (B).

The other two conditions that produce a binary-1 output are $A\bar{B}\bar{C}$ and $AB\bar{C}$. Finally the output expression is built by ORing together the three input conditions that cause a binary 1 to appear:

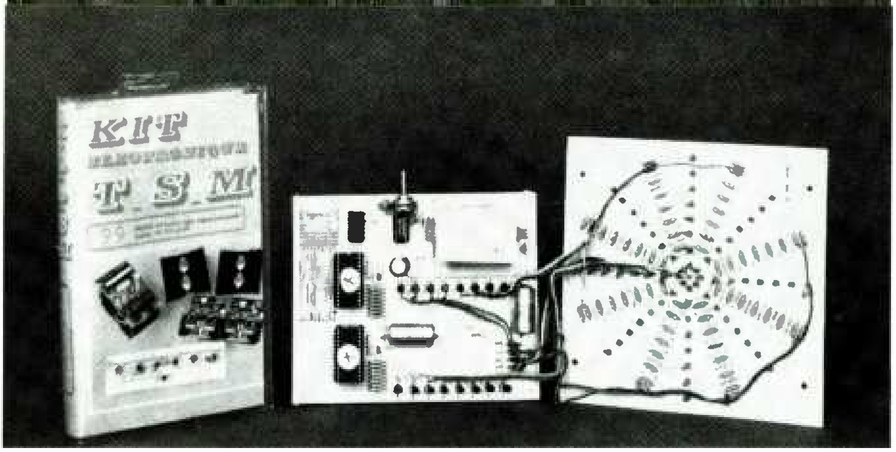
$$D = \bar{A}B\bar{C} + A\bar{B}\bar{C} + AB\bar{C}$$

The corresponding circuit is shown in Fig. 22B.

That procedure works regardless of the number of inputs used. As the number of inputs increases, the Boolean expressions become far more complex. As it turns out, most of the larger more complex networks can be simplified by the use of Boolean rules. In the next installment, we will introduce the Boolean rules and show you ways to turn complex circuits into simpler ones.

But first, another exercise problem can be found on page 94. Why not turn there now to check your understanding. The answers to all of problems in this month's installment can be found there. ■

(Continued on page 94)



CIRCLE 35 ON FREE INFORMATION CARD

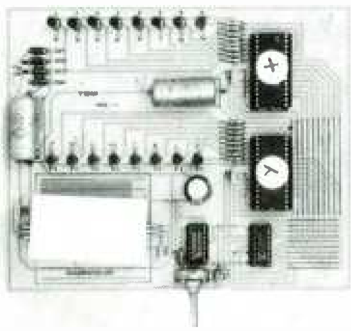
TSM VEGAS KIT

It's a star burst, cartwheel, chase light... it's everything 64 LEDs can do to entertain!

The TSM Vegas Kit (TSM-99) is a festive light display. When assembled, the Vegas Kit is a fascinating hypnotic lighting device which can be both relaxing and amusing. A long sequence of changing light patterns gives the display a dancing quality that appears to have motion and depth. A speed control can be set to suit the mood of the observer.

The two-board kit holds the light-emitting diodes on one board—eight radials of red and green LEDs (eight LEDs per radial)—and all the electronics on the other board. The circuit board contains a diode bridge for rectifying 9-volts AC. Its output is passed through two 5-volt regulators. Two pre-programmed ROMs contain the lighting sequences and are used to control 16 switching transistors.

Construction. The light display goes together with a minimum of trouble. By following the simple instructions, the two boards can be wired quickly. Connecting the LEDs may take some effort because there are 64 of them—that's 132 solder connections. Each LED has a series current-limiting resistor which means an additional 132 solder connections. Get past that phase and the rest is a piece of cake.

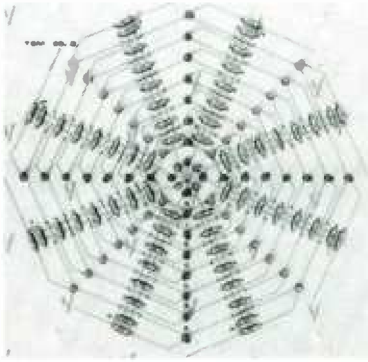


This is the circuit board that contains the "brains" for the Vegas Kit. Two pre-programmed ROMs (marked X and Y) provide almost 800 different patterns.

A ribbon cable is supplied with the kit to use as long jumpers and for interconnecting the two boards. Unfortunately, the individual wires were stranded. I discarded the cable and used one from my junk box that was a bit more colorful and had solid wire. The solid wire would help me avoid twisting and pre-soldering of the wire ends and the trouble of fitting the processed ends into the small drilled holes in the printed-circuit board.

Power-Supply Confusion. There was some confusion generated by the kit instructions in regards to the power supply required to operate the Vegas Kit. On the first page of the instructions it was indicated that a 12-volt DC, 1-ampere power supply (not included) was required to power the unit. The circuit board, however, indicated that a 9/12-volt AC, 1-ampere power source was required. That made more sense since a diode-bridge circuit was included on the circuit board. Somewhat later in the instructions two sentences cleared up the confusion. Yes, a 12-volt, AC supply was required; however, in its place a 12-volt DC supply can be used, provided it is connected across filter capacitor C2 on the circuit board. No further mention was made about 9-volt sources.

With those options open, a telephone step-down transformer, normally used to power the lights in a home phone, was used to provide the AC power. The transformer was rated at 8.5-volts AC and most probably rated less than 1 ampere, but I decided to use it anyway. It did do the job, although it was warm to the touch after



The LEDs are arranged in a cartwheel fashion with four radii of red LEDs and four radii of green LEDs. The colors of the radii alternate.

one-hour's use. Once the power was applied to the Vegas Kit, the LED display started and amazed those who saw it.

Looks Great. The assembled Vegas Kit found its place in a Christmas-decorated window in a home. Next to a moving mechanical Santa Clause, the LED display was the most stared-at item in the window. Children and adults were fascinated by the varying light-patterns presented by the 64 LEDs.

The display can find its place anywhere inside the house too. It'll perk up a child's room. Set between parallel mirrors it has an Infinity-Mirror effect that makes it suitable in any room.

The Vegas Kit is a project for beginners and gadgeteers who like novel and unusual items to assemble and use. The actual number of applications is unlimited. You can purchase the Vegas Kit (Order No. TSM-99) for $130.00. You can contact the TSM headquarters, at 2065 Boston Post Road, Larchmont, NY 10538 for the TSM distributor nearest you. ■

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Antique Radio

CABINET REFINISHING

By Marc Ellis

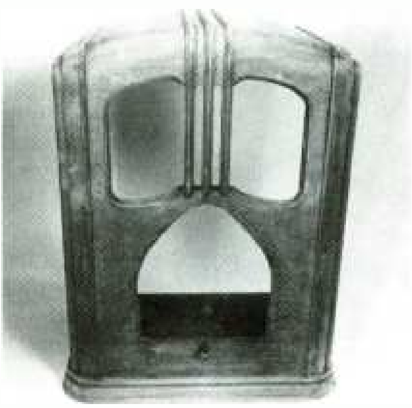
Last month, we completed the restoration of a Zenith Model 7S232 "shutter-dial" chassis that was begun in the August issue. I certainly enjoyed doing the work, and I hope that you all enjoyed reading about it. Unfortunately, the set's cabinet also requires quite a bit of attention. (And cabinet refinishing is my least favorite radio-restoration activity.) The radio was damaged in a small, but violent, gas-furnace explosion while it was possessed by its previous owner—which is the only reason he was willing to sell it!

Besides blowing out the speaker cone (which has since been repaired) and charring the grille cloth, the explosion also completely ruined the finish on the 7S232's cabinet. It looked as if it had been almost vaporized, exposing a rough, light-colored, wood surface. The wood seemed virtually grainless, suggesting that the grain had been a photographic one—as was common in sets of that era—and was lost along with the finish.

Down to Basics. That was discouraging, but obviously the only thing to do was to strip off the remains of the old finish and reassess the situation. I hoped that, once cleaned up, the cabinet would take stain nicely so that a presentable replacement finish could be applied. Being grainless, it would lack the beauty of the old one. But it would at least be fresh and new, providing an attractive setting in which to install the restored chassis.

I used a methylene-chloride-based chemical stripper—the kind that applies as a heavy gel so that it will stick to the wood surface and do its work without dripping off. That stuff takes off old paint or varnish coatings as quickly as anything I know. And it's pretty nasty if you get it on your hands. It's not caustic like lye or acid, but will definitely sting, burn, and redden the skin.

I find it difficult to strip furniture while wearing gloves, so I try to work near a water tap. By rinsing my hands frequently, I can avoid most of the ill effects. It's also wise to use that type of stripper outside or in a well-ventilated area. While not noxious, the fumes are definitely not good for you—and can leave you with an unpleasant, hang-over-like feeling the next morning.



Shown here is the 7S232 now stripped of its finish. Much to my surprise and delight, the grain was not photographic, but really in the wood—just waiting to be brought out by an application of stain.

Under the Sludge. That type of chemical stripper turns the old finish to a kind of gummy sludge. The idea is to remove as much as possible with a broad putty knife, being careful not to scratch the wood surface as you work. The remains of the sludge are then mopped up with a cloth moistened in solvent—leaving behind a clean-as-a-whistle surface.

As soon as I began the first mop-up operation, I received a very pleasant surprise. A beautiful wood-grain pattern was being exposed; the grain was real after all! What had looked—prior to stripping—like an almost-bare grainless, wood surface was really a layer of old varnish, decomposed and whitened in some way by the effects of the explosion.

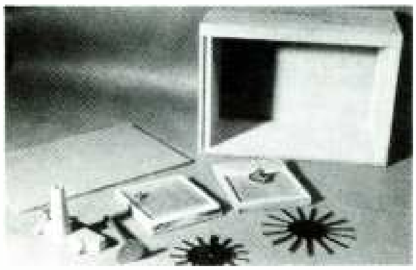
Working a little more enthusiastically, now, I quickly removed the rest of the old finish. Stripping may be a smelly, messy job, but it really doesn't take long to complete even for a large cabinet like this one.

I had noticed too late, by the way, that the recommended "mop-up" solvent for the particular stripper I was using was lacquer thinner. I didn't have any handy, but made do with mineral spirits instead. That worked fairly well, but tended to leave behind little grains of solid sludge. Those remaining grains were easily brushed off once the cabinet had dried, but I assume that they would have been dissolved and removed during mop-up had I used the correct solvent.

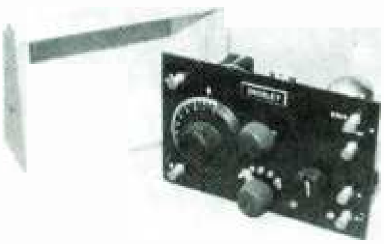
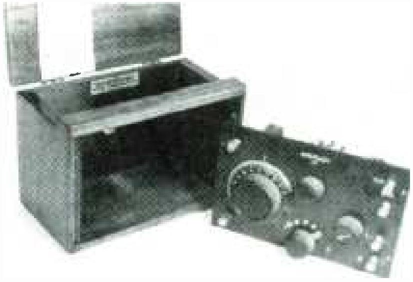
When I had finished, with the cabinet still damp from stripper and solvent, it looked almost as if I could apply the new finish without re-staining. But after overnight drying, the picture looked quite a bit different. The stripper had definitely removed quite a bit of the old stain, resulting in a pale, splotchy appearance. A new coat of stain would definitely be required, possibly with a preliminary bleach to even out the variations in color intensity. I'll report on my progress next month.

Several readers have written me interesting letters during the course of the Zenith restoration, and this seems like a good time to catch up with them. So let's open the mailbag!

7S232 Clones. One of the first communications I received was from John W. White, II, who says he has a Zenith 6S233 set that's very similar to my 7S232. The cabinet on his was warped, so he had to discard most of it. But he enjoys the set so much that he keeps the bare chassis on a bedside table for evening listening. John doesn't miss the cabinet too much, because he likes to



This is the preliminary stage in the construction of Dan Damrow's Crosley 50 replica. The fabricated parts for the coils and "book" condenser are in the foreground.

Compare the front of Dan's replica (left) with a similar shot of an actual Crosley 50 (right). Note the remarkable resemblance between the two!

watch the glow of the tubes at night.

Can anyone help John with a schematic for a "National Dobro Amplifier Model 6107A?" It was built by Webster Electric of Racine, WI and uses the following tubes: one 5Z3, two 2A3's, a 79, and a 56. He'd probably also be interested in a cabinet for his Zenith. Contact him at RD 3 Box 217, Claysville, PA 15323.

Frank De Stasi has another set very similar to mine, a Zenith 9S262. By a strange coincidence, his is also a bare chassis job. Like John, he doesn't allow the lack of a cabinet to keep him from enjoying the radio. But if you can supply a cabinet for Frank's set, write him at 769 Sybil Ave., San Leandro, CA 94577.

Frank enclosed a schematic of the set, which has a larger speaker than mine and a couple of extra tubes. Frank's set also boasts a motor tuning drive that allows him to go from one end of the dial to the other in seconds. And since the tuning dials on those radios are geared way down for good vernier action, I imagine that the motor drive comes in very handy.

Frank tells me that he purchased the 9S262 schematic, and many others, from Howard W. Sams & Co. Photofact Tech Services, PO Box 7092, Indianapolis, IN 46206. He reports that they can come up with schematics for many antique radios for a price of $1.00 per copy and a $2.50 handling charge (I assume the latter is a "per order" rather than "per copy" fee).

Helping Hands. John Fitzgerald (Middleton, WI) informed me that a copy of the 7S232's schematic can be found in Supreme Publications' *Most Often Needed 1926-1938 Radio Diagrams* on page 228. That useful book, as well as many of the other Supreme publications, is available as a reprint. Write ARS Enterprises, PO Box 997, Mercer Island, WA for a free catalogue. Here's another tip from John: He's found that Omnitron Electronics, 770 Amsterdam Ave., New York, NY 10025 is a good source of hard-to-find tubes and other parts.

Keenan Whitley joins the growing group of people (see last month's column) who have written to say that the Zenith dial glass and dial belt that I was looking for could be obtained at Antique Electronic Supply, 688 W. First St., Tempe, AZ 85281. And he took the trouble to photocopy the entire A.E.S. catalogue for me.

Keenan went on to say that those with cabinet restoration problems might like to read *The Complete Manual of Wood Finishing* by Frederick Dieghton. He says that it's an excellent book, and even contains a chapter on faking woodgrain finishes (in case you've lost a photographic one, as I suspected that I had before stripping my Zenith cabinet). It's published by Stein and Day, Scarborough House, Briarcliff Manor, NY 10510.

It's even more impressive to compare the rear view of the replica (top) to the actual set's (bottom). Except for the tube, Dan made every one of his parts from scratch.

Finally, Keenan suggested that I restore a really impossible set in the column, perhaps one with extensive lightning damage. Having just devoted several months worth of columns to a restoration, I'd like to deal with some other kinds of subjects for a while. But Keenan's suggestion did give me a terrific idea.

How about a contest where you readers submit photos and descriptions of your most messed-up radios? The one judged to be the best (worst, that is) would be restored in the column and then returned to the owner. Let me know what you think, but hold your entries. It will be several months before I'd consider doing that.

Mike Schulsinger (Springfield, OH) wrote to correct a boo-boo I made in the September column. I referred to the broadcast band dial of the 7S232 as covering a range of 55-170 kilohertz; the range is really 550-1700 kilohertz. Thanks for the correction, Mike!

Waltons Reruns. I finally received the 7S232 comment that I was hoping someone would send! It comes from Bill Morris (13901 Oakridge Dr., Carmel, IN 46032). Some years ago, I had seen a Zenith set that looked very much like mine used as a recurring prop in a TV situation comedy series. I wanted to mention it in the column, but couldn't quite remember the series name. Bill writes that the series was *The Waltons*, so keep an eye open for reruns in your area. You may be lucky enough to spot the Zenith, too.

Bill included quite a want list of sets and parts, and I'll see if I can fit them all in. Please contact him if you can help! He'd like to locate a Zenith Transoceanic Model 7G605 (1942 model); servicing information, an owner's manual, door assembly, and AM wave magnet for a Transoceanic Model 1000 (1957 model); Fisher 800B receiver; antenna coils for an Echophone EC-2; any Zenith shortwave receiver of the 1960's; and he wouldn't mind locating a 7S232, either!

Criticism Accepted. George Bidwell (La Jolla, CA) wrote to remind me that I still haven't discussed the reader comments received in response to the columns on the Crosley 50 (January and February 1988 issues). At the time, I postponed the discussion on that one-tube regenerative receiver; there was such a backlog of reader mail that the

(Continued on page 102)

Circuit Circus

By Charles D. Rakes

UNUSUAL USES FOR TRANSDUCERS

This month's Circus starts the new year off with a number of solid-state piezo-transducer circuits. Those critters can be heard chirping their little hearts out in just about every kind of equipment that uses an electronic sounder.

We wake up to the beep-beep sound of our digital clock. Then as we get into our automobile, a beep reminds us to buckle up. And on through the day we hear a beep here, a chirp there, directing our attention from one place to another. With all of the racket created by the piezo sounders, you'd think there's nothing else they can do. Well, it's just not so!

Fixed-Frequency Generator. The circuit shown in Fig. 1 is self-oscillating; in it, a piezo element is used as the frequency-determining component. The circuit produces a tone output that can be used as an encoding signal for remote control or any other application where a fixed-frequency tone signal is required.

An unusual function of that tone-encoding generator is that both an audible tone and a signal are generated at the same time. The circuit's operation is simple. A single op-amp (one fourth of an LM324 quad op-amp) is configured as a standard inverting amplifier.

At power-up, a positive voltage is applied to the non-inverting input of U1 (via R3), forcing its output high. That high travels along three paths. The first path is the tone output. Along the second path, by way of R5, that high is used as the drive signal for BZ1.

In the third path, the high output of U1 is fed back, via R4, to the inverting input of U1. That forces the output of U1 to go low. And that low, when fed back to the inverting input of U1, causes the op-amp output to again go high, and the cycle repeats itself. As configured, U1 provides a voltage gain of 4.7 (gain = R4/R1).

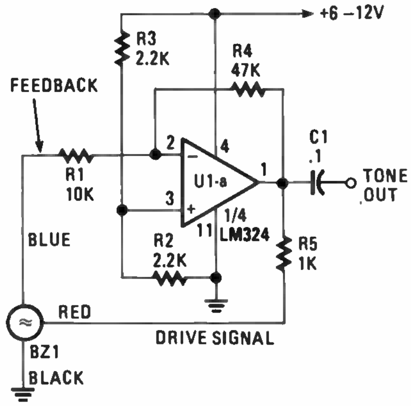


Fig. 1. This self-oscillating circuit uses a three-terminal piezo transducer as the frequency-determining component.

There are a number of "orphan" piezo transducers available on the surplus market. Several three-terminal piezo transducer elements were tried in the circuit and all performed well. The transducer specified in the Parts List comes with three short colored-coded (red, blue, and black) lead wires as indicated in Fig. 1. With the aid of the piezo-transducer pinout shown in Fig. 2, you should have little trouble in connecting any transducer to the circuit.

The outer ring of the piezo element is usually connected to circuit ground. The large, inner circle serves as the driven area, and the small, elongated

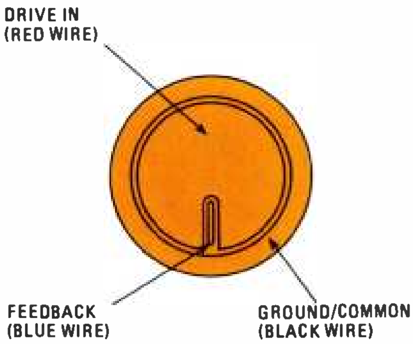


Fig. 2. Here is the pinout diagram for the three-terminal piezo transducer. The outer ring is usually connected to ground; the large inner circle is the driven area, and the elongated section is the feedback.

PARTS LIST FOR THE FIXED-FREQUENCY GENERATOR

U1—LM324 quad op-amp, integrated circuit
R1—10,000-ohm, ¼-watt, 5% resistor
R2, R3—2200-ohm, ¼-watt, 5% resistor
R4—47 000-ohm, ¼-watt, 5% resistor
R5—1000-ohm, ¼-watt, 5% resistor
C1—0.1-µF, ceramic disc capacitor
BZ1—Piezo fixed-frequency transducer, Radio Shack 273-064 or similar
Printed circuit or perfboard materials, enclosure, IC sockets, battery and battery holder, wire, solder, hardware, etc.

section supplies the feedback signal. Resistor R5 sets BZ1's output-volume level. That level can be increased by decreasing R5 (say, to 470 ohms). To decrease the volume, increase R5 to about 2.2K, or so.

Resistors R2 and R3 set the bias for op-amp U1's positive input (pin 3) to half of the supply-voltage level. That allows for a maximum voltage swing at U1's output. Although a quad op-amp is specified in the Parts List, almost any similar low-cost single or dual op-amp will work for U1-a.

Sound-Activated Decoder. Turning our attention to Fig. 3, we see a piezo transducer performing double duty in that it operates as a sound-pickup device as well as a frequency-selective filter. Transducer BZ1, is connected to op-amp U1-a just as in the previous circuit, but with one notable exception—a gain control, potentiometer R3, has been added.

By controlling the gain of the op-amps, the oscillator circuit can be transformed into a sensitive and frequency-selective tone-decoder circuit. With the gain of U1-a set just below the point of self oscillation, the transducer becomes sensitive to acoustically coupled audio tones that occur at (or near) its resonant frequency.

The circuit's operation is comparable to an early and popular type of radio receiver in which regeneration was used to achieve super-high gains using relatively low-gain amplifying vacuum tubes. Regeneration is obtained by adding a controllable positive-feedback path between the receiver's input and output circuitry. And it was the gain obtained via regeneration in receivers of the 1920s that turned a simple one-tube set into a world-wide receiving station.

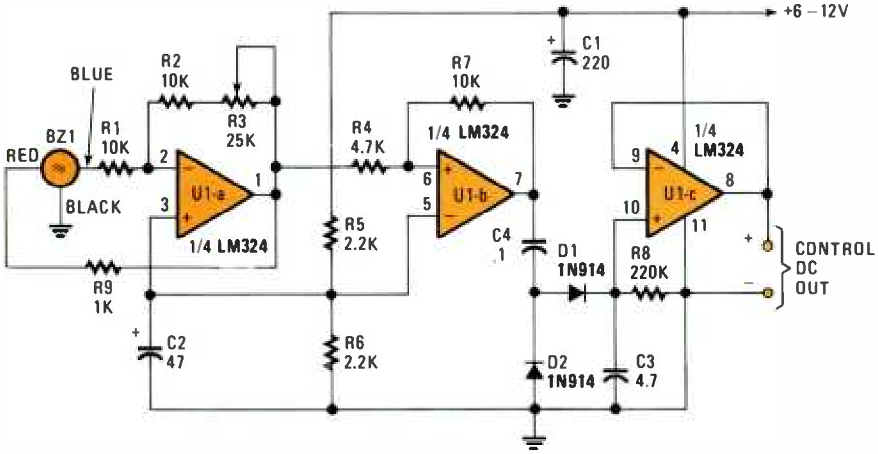


Fig. 3. In the Sound-Activated Decoder, the piezo transducer performs double duty, in that it operates as a sound-pickup device and a frequency-selective filter.

PARTS LIST FOR THE LOW-FREQUENCY CRYSTAL FILTER

U1—LM324 quad op-amp, integrated circuit
R1—47,000-ohm, ¼-watt, 5% resistor
R2–R5—10,000-ohm, ¼-watt, 5% resistor
R6, R7—2200-ohm, ¼-watt, 5% resistor
R8—100,000-ohm, ¼-watt, 5% resistor
C1, C2—0.1-µF ceramic-disc capacitor
C3—47-µF 16-WVDC electrolytic capacitor
C_X—See text
BZ1—Piezo transducer, Radio Shack #273-073 or similar
Printed circuit or perfboard materials, enclosure, IC sockets, battery and battery holder, wire, solder, hardware, etc.

PARTS LIST FOR THE SOUND-ACTIVATED DECODER

U1—LM324 quad op-amp, integrated circuit
D1, D2—1N914 general-purpose small-signal diode
R1, R2, R7—10,000-ohm, ¼-watt, 5% resistor
R3—25,000-ohm potentiometer
R4—4700-ohm, ¼-watt, 5% resistor
R5, R6—2200-ohm, ¼-watt, 5% resistor
R8—220,000-ohm, ¼-watt, 5% resistor
C1—220-µF, 25-WVDC electrolytic capacitor
C2—47-µF, 25-WVDC electrolytic capacitor
C3—4.7-µF, 25-WVDC electrolytic capacitor
C4—0.1-µF, ceramic-disc capacitor
BZ1—Piezo fixed-frequency transducer, Radio Shack #273-064 or similar
Printed circuit or perfboard materials, enclosure, IC sockets, battery and battery holder, wire, solder, hardware, etc.

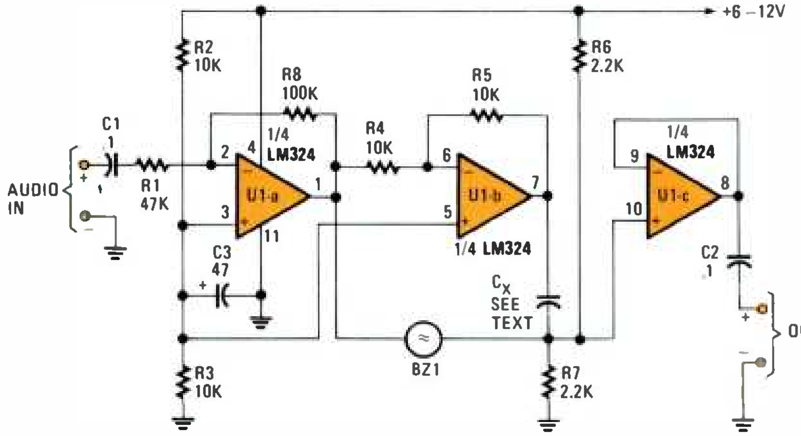


Fig. 4. In this circuit, the piezo transducer functions like a low-frequency, quartz crystal in a narrow band, crystal-filter circuit.

In-band audible tones reaching the transducer's surface cause the transducer to vibrate in step with the incoming sound wave. The regenerative action of the circuit then causes the signal to be amplified to a 1½- to 2-volt level. The output of U1-a is fed to U1-b, where the signal is doubled. The boosted signal is then fed across a dual-diode rectifier circuit to the input of a voltage follower, consisting of U1-c only.

The circuit's output can be used to activate optocouplers, drive relay circuits, or to control almost any DC-operated circuit. The DC signal at the output of U1-c varies from zero to over six volts, depending on the input-signal level. One unusual application for the Sound-Activated Decoder would be in extremely high-noise environments, where normal broadband microphone pickup would be useless. Because piezo transducers respond *only* to frequencies within a very narrow bandwidth, little if any of the noise would get through the transducer

Low-Frequency Crystal Filter. Another interesting job that the piezo transducer can perform is to function like a super low-frequency, quartz crystal in a narrow-band crystal-filter circuit. The circuit shown in Fig. 4 is the piezo equivalent of a super-selective crystal filter.

In a typical crystal-filter circuit, the crystal's internal capacitance is electronically canceled to keep unwanted and out-of-band signals from getting through and showing up at the filter's output. Internal capacitance normally runs in the low picofarad range for crystals and in the 20- to 30,000-pF range for the piezo transducers.

In a quartz circuit, a small trimmer capacitor is used to tweak out the capacitance effect, but to use the same approach for the piezo filter, you'd need to gang at least 100 broadcast-band tuning capacitors together to achieve the same effect.

With our piezo-transducer circuit, op-amp U1-a doubles the level of the input signal. That magnified signal is fed to one leg of BZ1, while at the same time being fed to the inverting input of U1-b. Op-amp U1-b, with a voltage gain of one, inverts the signal's waveform, which is next fed through capacitor C_X and then to the other side of the piezo element.

If the value of C_X equals the internal capacitance of the piezo element, the transducer's capacitance effect is canceled out. Several piezo transducers come with a list of their electrical characteristics, including their internal-capacitance figure. If the information isn't available, it can be determined with the aid of a capacitance decade-box or a capacitance meter.

(Continued on page 97)

Computer Bits

By Herb Friedman

AN ELECTRONIC ROSETTA STONE

For many hundreds of years, the language of ancient Egypt had been a riddle to scholars. But in 1799, a French officer discovered a stone carved with a decree of Ptolemy V, the king of Egypt from 203 to 181 B.C.. The decree was carved in three languages: ancient hieroglyphics, Demotic—the popular language of Egypt at that time, and Greek. A scholar was able to translate the Demotic from the Greek, which then permitted translation from Demotic to hieroglyphics. The door to ancient Egypt was literally thrown wide, and scholars could now read the literature of ancient Egypt.

Now what has all that got to do with computers? Simple. At last count there were more than 1500 word-processing programs for personal computers. Of them all, about two dozen are *biggies*; and of the biggies, virtually none are interchangeable. That means that if you started out in personal computing back in the pioneer days you might be using *WordStar*—20% of the word-processing programs sold are WordStar; but your office might be using *Multimate*, your college probably uses *WordPerfect*, your child's high school might use *PFS: Write* or *IBM Writing Assistant*, and your lab-partner might be using *Volkswriter*.

A Tall Tower. Basically, what we have is a word-processing Tower of Babel, because the most popular, most frequently used word-processing programs can't read the text files of the other programs.

For example, I use XyWrite, the word-processor of choice for magazine editors. Why is it the word-processor of choice for editors? Because its text files are *pure* ASCII. They are read directly by our typesetting computer, and its files can be read by any program that reads pure ASCII files—and that's a very large list of software.

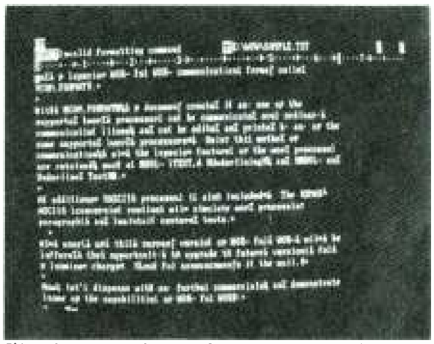


Fig. 1. A WordStar file read on a different word-processor will produce a screen of what resembles hieroglyphics, as will most documents that were prepared on non-ASCII word-processors.

But if I try to read an author's disk that was written in WordStar, I get the "hieroglyphics" shown in Fig. 1, which is caused by WordStar having the high bit set.

While there are several programs that "strip" the high bit to create readable text from WordStar files, a "stripper" doesn't untangle WordStar's formatting codes for such things as boldface, indent, underline, etc. Just as with virtually any other word-processor, I would still have to muck my way through to change all the page-formatting commands to the commands of my word-processor—and on a large document, that might take an hour or more.

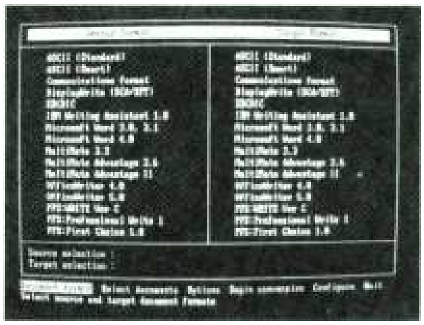


Fig. 2. Word For Word can be command-line or menu-driven. This is the opening menu. You page down for more formats.

The Electronic Rosetta. What was needed to untangle the incompatibilities of word-processors was an Electronic Rosetta Stone, something that could translate one word-processed document—including the page-formatting commands—into the format used by another word-processor. That meant, for example, that if I were translating a Multimate text file into a XyWrite file, the Multimate page-formatting commands would automatically be converted to XyWrite commands; thereby saving me an hour or so of dull, boring, manual format conversions.

Well, we now have an Electronic Rosetta Stone. It's called *Word For Word* (Design Software, Inc., 1275 West Roosevelt Rd., West Chicago, IL 60185), and it translates both the text and the major formatting features—such as line spacing, tabs, boldface, underline, etc.—of the most-popular word-processors. When Word For Word cannot make a format translation, it will print out a list of the non-translatable locations so that the user can step right to the problem(s) and key in the correct format command(s).

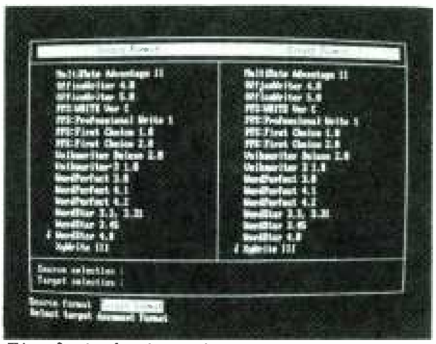


Fig. 3. A check mark appears adjacent to the selected source and target formats.

Word For Word can be either command-line or menu driven. Command-line is what is usually called the "expert mode," meaning a single line of commands gets the computer to do a series of steps. For example, with Word For Word, the command-line WFW WS XY3 SAMPLE.TST SAMPLE.TXT is all that it takes to convert a WordStar file called SAMPLE.TXT to a XyWrite file called SAMPLE.TXT.

But you can also use menu-driven commands until you become an expert, or if you use the program so infrequently that you can't remember the translation commands.

The program comes up with the menu shown in Fig. 2. Both sides of the screen are identical, listing those

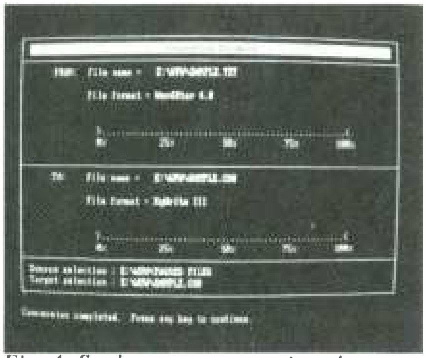


Fig. 4. So that you don't get bored, or think something's gone wrong if the translation takes several seconds, Word For Word keeps you entertained with a screen display of the translator's progress.

word-processors that you selected during the initial installation. (Figure 2 shows only part of the total.)

As shown in Fig. 3, checkmarks indicate the source and target formats. You then select the source file, enter the name you want to use for the target file, and you end up with the screen display shown in Fig. 4.

Basically, Fig. 4 is entertainment to keep you amused as the translation takes place. A series of travelling dots tells you what percentage of the source was "read in," and a similar series of dots tell you what percentage of the translation was written to disk.

Figure 5 is the translation of the hieroglyphics shown in Fig. 1. Notice that Fig. 5 is now in pure XyWrite format, right down to the on-screen displays for boldface and underline. But there is a problem. Because of the original WordStar file's line formatting, the inter-word spacing varies between one and two spaces. But no problem. A quick automatic search/and replace of one space for two (CIA / / /) gives us the almost-perfect screen display

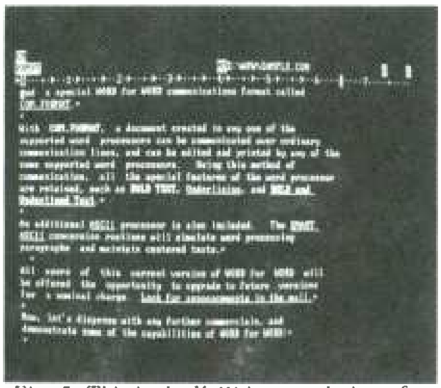


Fig. 5. This is the XyWrite translation of the WordStar file shown in Fig. 1. All formatting is correct, but there are single and double spaces between the words.

shown in Fig. 6. The only manual clean-up that's necessary is to remove the extra space between the second and third paragraph (the space in front of the left-pointing arrow that signifies a line space).

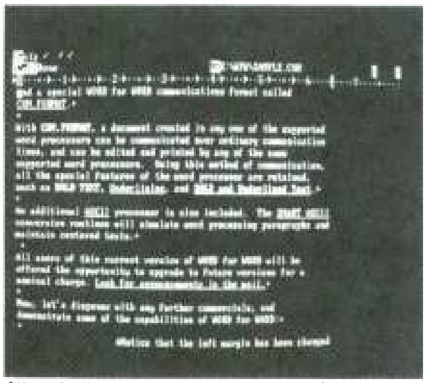


Fig. 6. An automatic search-and-replace eliminates the extra spaces between the words. In less time than it takes to read this caption, the "Electronic Rosetta Stone" has given us a perfect translation of the WordStar file shown in Fig. 1.

Smart ASCII. Now if you're up on software you know that many word-processors save, or can save their files in ASCII format, which is transportable to other word-processors. The problem, however, is that either all page-formatting is stripped off, or the target computer hasn't the vaguest idea what the page formatting commands mean. Either way, the translation is neither complete nor accurate, and translations can prove to be a real time-waster. For example you could probably make lunch in the time it would take some programs to page-format a 2000-word ASCII document.

Word For Word gets around the problem by having both ASCII and Smart-ASCII translations. Generally, conventional ASCII contains no page formatting of any kind; the file contains only text characters. Smart-ASCII contains ASCII text characters and the page-formatting commands. However, keep in mind that a non-word-processed document—such as a spreadsheet—should be converted in conventional ASCII. ■

DX Listening

GLASNOST AND DX'ING

By Don Jensen

DX'ers here often tune in *Radio Moscow*, or other Soviet shortwave broadcasters like *Radio Kiev* or *Radio Yerevan*. But what about the reverse? Can SWL's in the Soviet Union listen to broadcasts from the west?

Yes, indeed, according to a Soviet listener writing in the Danish Shortwave Clubs International's "Short Wave News." Listening to foreign stations has not been a crime since the death of Joseph Stalin, says Igor Sannikov, but neither was SWL'ing encouraged because some western stations engage in what he calls ideological warfare.

In 1982, some Russian SW enthusiasts sought to have DX'ing recognized by the Radio Sport Federation as a part of the amateur-radio hobby, but the request was rejected. However, with today's official policies of *"peristroika"* and *"glasnost,"* more Soviet citizens are discovering SWL'ing.

Still, Sannikov estimates, there are only your 100 active SWL's in the entire USSR, with its population of 280 million. That's mostly due to a previous lack of publicity about DX'ing as a hobby.

That, too, is changing. Sannikov says that in Lithuania, for example, there already have been two articles published on the listening hobby. Soviet SWL's also have been asked to participate in DX'ing programs aired by *Radio Tashkent* and *Radio Vilnius*.

Most Soviet listeners belong to the "Radio Budapest SW Club" (Hungary), he notes, but that there are some local clubs developing within Russia. As early as the 1970's, club bulletins were published by two small organizations known as "Baltika DX Club" and "DX-Club 77." There also was an English-language publication called the "Ukrainian DX Review Summary" in 1982.

The problem for small Soviet clubs is the lack of copying equipment. Xerox-type machines are not for public use. Most bulletins are simply typed in limited numbers, although computer printers are becoming available. Some active listener clubs are the "DX Circle Leningrad" (founded over two years ago by three SWL's from that city) and a newer organization, the "Soviet DX Club," which has published a bulletin called "World DX News" since mid-1987.

While those bulletins surely would be of interest to U.S. and Canadian SWL's, so far, they are intended for Soviet listeners and are written entirely in Russian. In the future, though, look for greater contacts between DX hobbyists in the USSR and the West.

A Fine Romansch. On shortwave, one can hear all sorts of obscure languages and dialects, from the Eskimo Inukitut (Canadian Broadcasting Commission's Northern Quebec Service) to Pidgin (the National Broadcasting Commission of Papua, New Guinea).

It is interesting to note, as you tune the SW bands, the many different and varied *lingos* of the world. Consider Romansch, for instance. Along with French, Italian, and Swiss-German, it is one of the four official languages of Switzerland.

You won't find it among the 200-name list of principal languages of the world—languages spoken by more than a million persons. There are more people in West Africa (some 2 million) who speak Ijaw than there are Swiss (about 50,000) who consider Romansch their mother tongue. And each census shows that the number of Romansch-speaking persons is decreasing.

In the eastern canton of Graubunden, less than half of the population now can speak the language. Few visitors to the ski resorts of St. Moritz even realize that the native language of the region is Romansch, not the commonly heard Swiss-German.

Romansch, linguists say, is probably the closest living language to the ancient Latin vernacular spoken during the time of the Roman Empire. Clearly, Switzerland's curious "fourth" language is dying!

Curious SWL's can get a brief sample of Romansch on *Swiss Radio International* (SRI), notes Harold Sellers, writing in the Ontario DX Association's bulletin, "DX Ontario," on Tuesdays and Fridays, at 0315 UTC on 6.135, 9.725, 9.885 and 12.035 kHz.

Feedback. Your letters are always welcome. Send details of your SWL'ing, your comments, or questions to *DX Listening*, **Popular Electronics**, 500-B Bi-County Blvd., Farmindgale, NY 11735.

Donald Callahan, Gray, ME, writes to say that he's very new to DX'ing and uses an older Lafayette shortwave receiver. "I hear quite a bit," he says, "but I am particularly interested in a signal I'm hearing from the Yukon." Donald says he'd like to eliminate interference from Latin America and wonders if a dipole antenna will do the trick.

First, Don, I think you must be listening to a ham on one of the amateur-radio bands. There are no shortwave broadcasting stations—that is, stations that broadcast programs—in the Yukon Territory, although there are hams operating from the Canadian far north.

One of the commercial amateur-radio beam antennas on a rotor could

(Continued on page 95)

This gentleman is not only a shortwave listener and a licensed ham-radio operator—9IMC—but is also the chief engineer for Radio Nepal. Readers who have received QSL's from this exotic Asian station have Krishna B. Khatry to thank for those replies.

*Credits: Harold Sellers, ONT; Jack Jones, MS; Alan Laves, TX; Ivan Grishin, ONT; Paul Buer, FL; Ed LeBlanc, ONT; Henry Loewer, OH; Tom Manley, ONT; Paul Brouilette, IL; Tom Laskowski, IN; Richard Eckman, CA; Ontario DX Association, PO Box 161, Station A, Willowdale, ONT, Canada M2N 5S8; North American SW Association, 45 Wildflower Rd. Levittown, PA 19057.

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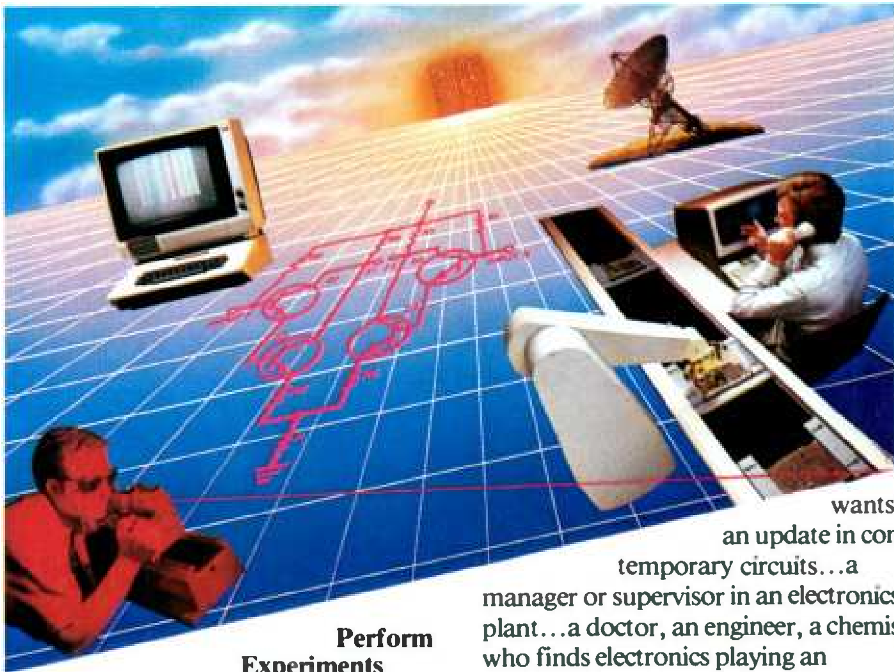

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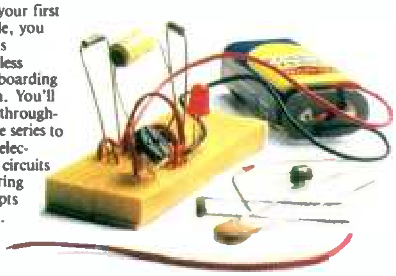

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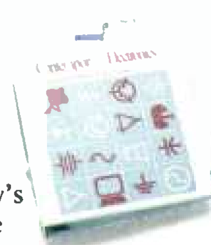

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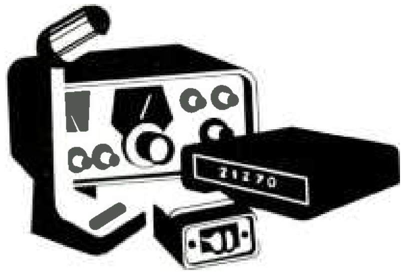


Ham Radio

By Joseph J. Carr, K4IPV

MYTHS AND MISINTERPRETATIONS

We radio amateurs sometimes toss around facts, figures, numbers, and parameters without giving much thought to what they mean. As a result, some plain old-fashioned nonsense creeps into our daily language. This month we will devote this column to looking at a couple of myths, or semi-myths, frequently found in amateur-radio (as well as CB) circles.

Signal Strength Reports. Most of our receivers are equipped with S meters to indicate the strength of the received signal. The S meter (Fig. 1) allegedly measures input-signal strength in a rigorously defined manner. The truth, however, is that receiver manufacturers can't even decide on what constitutes the correct definition of an "S unit." Note how the S meter is calibrated. The lower two-thirds or so of the meter is calibrated in the nearly arbitrary "S units." The S scale is logarithmic. The upper one-third of the meter face is calibrated in decibels (dB), so it, too, is logarithmic.

Now let's consider what some of those S units are supposed to mean. Table 1 shows the subjective meanings given to the signal-strength portion in the standard amateur-radio RST (readability, strength, tone) scale for CW, or RS system in voice modes. Note that "S9" corresponds to a subjective determination of an *extremely strong signal*. Hold that thought for a moment (S9 = extremely strong).

Recently I heard a guy on 20 meters tell a DX station that he was "60 dB over S9." Wonderful report (most amateur receivers only go up to +40 dB/S9). If you work out the arithmetic for voltage decibels—dB = 20 log (V1/V2)—we find that 60 dB is a ratio of 1000:1. In other words, a report of 60 dB over S9 means that other station was one-thousand times louder than an extremely strong signal!

Perhaps what he really meant was power decibels...which means that the other guy was a real "blazing blowtorch:" 60 dB over S9 means 1,000,000 times as much signal power at the receiver's antenna terminals as an S9 signal. Surely, such a signal qualifies as a long-range death ray! The Pentagon should take note.

So what is an S9 signal? According to some manufacturers, an S9 signal is a 50-μV signal across the 50-ohm input. Others require a 100-μV signal across a 50-ohm input to make the meter deflect to S9. In other words, there is at least a 2:1 ratio between voltage levels that supposedly qualify as S9.

The S unit is traditionally given the subjective definition of being the minimum signal-level change that an appreciable number of standard, grade-A average listeners can perceive...whatever that means, or whoever that person is. As a result, the usual definition makes each S unit worth a 6-dB change in voltage level, or a 3-dB change in power level (which is the same thing mathematically). A 3-dB power change has a ratio of 2:1. In other words, if you double the RF-output power from your rig, the S meter at a distant station will increase one S unit.

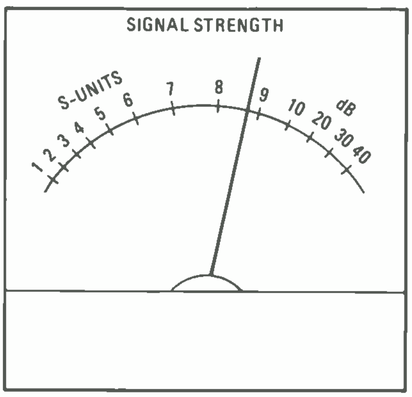


Fig. 1. Most receivers are equipped with S meters to indicate the strength of the received signal.

So, why is that important? What difference does it make to know what it takes to blast an S meter one digit higher? The answer is simple: it tells us what to expect if we increase power.

How Much Station Power? Most of us are enamored of high-power linear amplifiers for boosting our signal. In nearly 30 years of hamming, I've owned a one-kilowatt linear amplifier only in the last five or so years. Yet I only occasionally suffered from power levels that were too low. Even today I run "barefoot" more often than not, which is in accordance with the FCC requirement to use the minimum power required to do the job.

High power brings problems that must be considered. For example, you can expect an increased probability of TVI (television-interference) and BCI (broadcast-interference) problems. Antenna tuners must be the more costly heavy-duty types. Also, little annoying anomalies, such as RF "bites" on the microphone due to poor grounding or "RF in the shack," are more severe with a kilowatt. So where's the benefit?

TABLE 1—DEFINITIONS OF S-UNITS

S1	Faint signals, barely perceptible
S2	Very weak signals
S3	Weak signals
S4	Fair signals
S5	Fairly good signals
S6	Good signals
S7	Moderately strong signals
S8	Strong signals
S9	Extremely strong signals

Linear amplifiers come in three basic power levels (all of which are called "kilowatt" in advertisements): 600-watt CW, 1000 watts, and 1500 watts. Let's see if running a power amplifier is worth it in your case, and which power level is best for you.

Assume that you have a 250-watt HF transceiver. A 600-watt linear (also called "1200-watts PEP") is little more than 2:1 increase, so it is about 3 dB. That means that a station at the other end will just about hear an S-unit change. If you were S6 before, you might be S7 now. But if you bought a 1000-watt linear, then there would be a two S unit change. And that begins to be worthwhile.

Now consider what happens if you own a 100-watt transceiver (or one of

(Continued on page 101)

Scanner Scene

By Marc Saxon

NEW FREQUENCIES?

It looks as though the FCC is responding to frequency congestion in the Business Radio Service by considering the possibilities of adding 12 new channels for use in the VHF "high band" (152 to 162 MHz). Another possibility the FCC is thinking about in order to open up new frequencies in the Business Radio Service (BRS) is to create new channels offset 15 kHz above and below existing Business Radio frequencies in the 152- to 162-MHz portion of the spectrum. BRS channels presently exist on 151.655, 151.685 and 151.715 MHz; under such a new plan (if approved), that portion of the BRS allocations would expand to become: 151.64, 151.655, 151.67, 151.685, 151.70, 151.715, and 151.73 MHz.

Questions to be dealt with relate to the amount of interference that might be expected to BRS and other service licensees, should those new channels be created. The Taxicab Radio Service, in particular, may be on the receiving end of signals that will be flying around from transmitters established on such newly created frequencies.

The FCC may also open up a nationwide Automated Maritime Telecommunication System (AMTS) service in the 216- to 220-MHz band. AMTS has been in use by Mississippi River System tugs and barges since 1981, providing automated voice and data communications similar to a cellular phone system. The FCC had originally been concerned that AMTS might cause interference to Channel 13 TV reception; however there haven't been any complaints along those lines.

If approved on a nationwide basis, licensing of individual coastal transmitters in the service areas of Channel 13 TV stations would probably be subject to anti-interference precautions and restrictions. Just for the record, in case you want to get set for scanning those stations, there are 80 channels. Coast station channels start at 216.0125 MHz and progress upwards, in frequency in steps of 25 kHz, to 217.9875 MHz. The paired ship channels run from 218.0125 through 219.9875 MHz. Individual coastal stations each operate on 20 consecutive channels from the overall allocation, with the channels numbered from 101 to 180.

Scanner Market. AOR scanners got their name after the callsign of the company's founder, JA1AOR. AOR has brought out no less than three new scanners within the past few months, giving it a well-deserved place in the array of monitoring equipment available to monitoring enthusiasts of North America.

The AR-900 handheld scanner offers complete public-service band coverage, and features a priority channel, BNC antenna connector, backlit LCD display; there are lockouts, a scan delay, and other standard features along with rechargeable batteries, an AC adaptor/charger, and two antennas, all for a suggested retail price of $299.

The latest entry from AOR is their AR-900 handheld scanner—a small unit that offers complete public-service band coverage, including 27 to 54 MHz, 208 to 174 MHz, 406 to 512 MHz, and the hot-new, high interest 830- to 950-MHz band. The AR-900 can operate on channels in 12.5-, 25-, and 30-kHz increments.

Twenty-five front-panel keys allow programming of five banks of 20 channels, for a total of 100 channels. All information is retained in three state-of-the-art permanent memories that won't get "amnesia," even if the batteries are removed or become drained.

Other features of the unit include a priority channel, BNC antenna connector, and a backlit LCD display with 22 separate prompts to aid in programming and to show the status of channels. Of course, there are lockouts, a scan delay, and other standard features along with rechargeable batteries, an AC adaptor/charger, and two antennas. The unit has a suggested retail price of $299. For more information, write to the sole American source for those units; Ace Communications (a subsidiary of AOR), 10707 East 196 Street, Indianapolis, IN 46256.

Fishy Business. A newsy note from Alex W. McIlwain, Lakeland, FL clues us into some strange goings-on that are probably nationwide in scope. Alex reports that some of the newer VHF-FM marine-band radios provide their owners with channels designated as 1 to 5 and 60 to 64. The 10 frequencies that correspond to those channel numbers are spaced at 25-kHz increments between 156.025 and 156.25 MHz.

The problem is that even though transceivers using those frequencies are sold for use in the U.S., the 10 channels are for simplex use in overseas areas and aren't permitted for maritime use in American waters.

Alex observes that the temptation to use those "forbidden" frequencies in American waters has apparently proven too much for some boat owners seeking uncrowded yakking frequencies. In fact, he points out that some frequencies among that group are set aside by the FCC for police and other public service purposes.

In Alex's own area, illegal maritime use of those channels hasn't been without strange consequences. The High-
(Continued on page 106)

E-Z MATH

(Continued from page 79)

Exercise Problem. Try this yourself to be sure you understand the concepts presented.

4. A logic circuit has four inputs A, B, C, and D. Binary outputs occur when *any* three inputs are simultaneously binary 1, but not when all inputs are 1. Write the truth table, develop the Boolean output equation F, and draw the resulting circuit.

Answers to Exercise Problems

1. $H = ABC + D\overline{E} + \overline{F}G$

2. See Fig. 23.

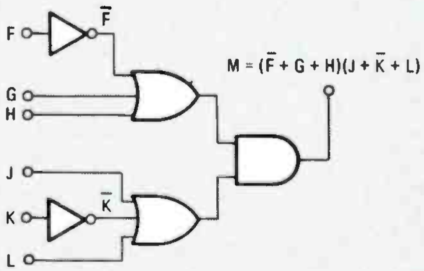
3. See Fig. 24.

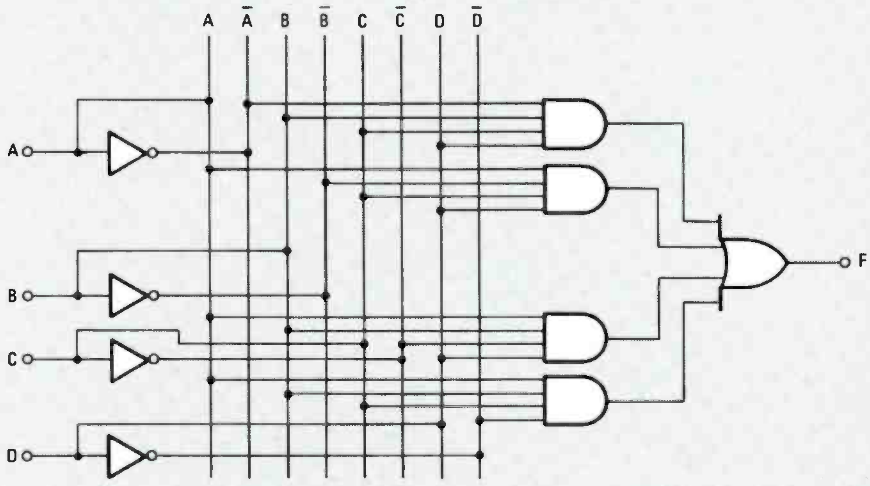
4. See Fig. 25.

INPUTS				OUTPUT	
A	B	C	D	F	
0	0	0	0	0	
0	0	0	1	0	
0	0	1	0	0	
0	0	1	1	0	
0	1	0	0	0	
0	1	0	1	0	
0	1	1	0	0	
0	1	1	1	1	← $\overline{A}BCD$
1	0	0	0	0	
1	0	0	1	0	
1	0	1	0	0	
1	0	1	1	1	← $A\overline{B}CD$
1	1	0	0	0	
1	1	0	1	1	← $AB\overline{C}D$
1	1	1	0	1	← $ABC\overline{D}$
1	1	1	1	0	

$$F = \overline{A}BCD + A\overline{B}CD + AB\overline{C}D + ABC\overline{D}$$

A

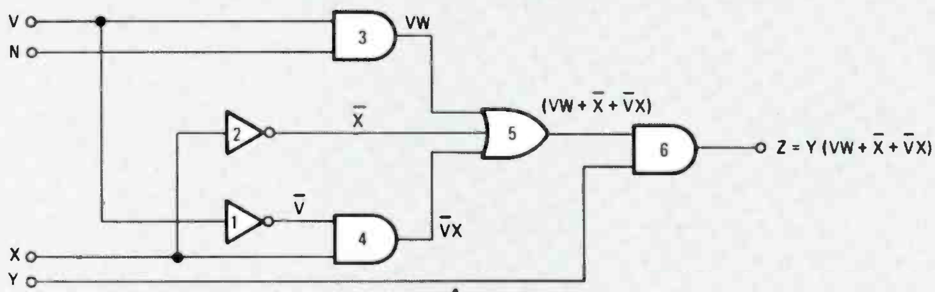




B

Fig. 23. Your solution to problem 2 should look like this, if not recheck your logic.

Fig. 25. When solving problem 4, you should've started with a truth table, generated an equation (A), and drawn the final circuit (B) as shown.



A

INPUTS				OUTPUTS					
V	W	X	Y	INVERTER 1 $\overline{V}$	INVERTER 2 $\overline{X}$	GATE 3 VW	GATE 4 $\overline{V}X$	GATE 5 $(VW + \overline{X} + \overline{V}X)$	GATE 6 Z
0	0	0	0	1	1	0	0	1	0
0	0	0	1	1	1	0	0	1	1
0	0	1	0	1	0	0	1	1	0
0	0	1	1	1	0	0	1	1	1
0	1	0	0	1	1	0	0	1	0
0	1	0	1	1	1	0	0	1	1
0	1	1	0	1	0	0	1	1	0
0	1	1	1	1	0	0	1	1	1
1	0	0	0	0	1	0	0	1	0
1	0	0	1	0	1	0	0	1	1
1	0	1	0	0	0	0	0	0	0
1	0	1	1	0	0	0	0	0	0
1	1	0	0	0	1	1	0	1	0
1	1	0	1	0	1	1	0	1	1
1	1	1	0	0	0	1	0	1	0
1	1	1	1	0	0	1	0	1	1

B

Fig. 24. Problem 3 should've tested your ability to generate the circuit in A and the table in B from the equation.

DX LISTENING

(Continued from page 88)

give you what you want (enhanced reception from the Yukon), while attenuating interference from the side or back. But such a setup will be rather costly. A simple dipole might help, but don't expect too much from it in the way of rejecting unwanted signals.

Donald also has a question about converting *E*astern *S*tandard *T*ime (EST) to the worldwide broadcasting standard, Coordinated *U*niversal *T*ime (UTC).

Coordinated Universal Time—which is based on a 24-hour clock system—is five hours ahead of EST (or four hours ahead of Eastern Daylight Time during the summer months). For example, When it's 1 AM EST, it is 6 AM, or 0600 UTC. At 5 AM in Maine, it is 1000 UTC; 12-noon EST equals 1700 UTC, and 2 PM EST is 1900 UTC.

If it is 8 PM EST on a Monday night, for instance, the UTC time is five hours later or 0100 UTC, but remember that conversion has taken it past midnight into the next day. So both time and date can be affected, Don, when you convert to or from UTC.

The easiest way to get used to the time conversion is to keep a separate clock set to UTC, or make a simple reference chart.

Down The Dial. What are you hearing on the SW bands? How about letting the rest of us know. Send your loggings to the above address. Now, here are some of the catches recently reported by other DX'ers.

Alaska—6,150 kHz. *KNL*, a missionary broadcaster, is the only way to hear a shortwave station from Alaska. That station is reported with English programming, religious talk and classical musical, beginning at 0800 UTC.

Canada—6,000 kHz. *CFCX* is the shortwave version of one of the oldest broadcasting stations in North America. The SW outlet relays the medium wave signal, which is why you may hear it announced as "AM radio in Montreal." It has been noted with a call-in program at 0845 UTC.

Costa Rica—13,660 kHz. A curious station with a very serious mission is *Radio for Peace International* (RPI), which transmits from Costa Rica in Central America. It has been logged here at 2200 UTC with a talk in English on U.S. arms spending.

Greece—9,420 kHz. The *Voice of Greece* (VOG) offers some of the best ethnic music on shortwave, to my way of thinking. Tune it in at 0200 UTC. You can't miss it with its haunting and melodic interval signal. Programming in Greek follows.

Israel—12,077 kHz. Here is where you can find *KOL Israel* broadcasting from Jerusalem, with world music and pops, beginning at 2130 UTC.

Mexico—17,765 kHz. The government-operated shortwave station, *Radio Mexico International* (RMI) has been reported on this frequency with Spanish-language programming, including Mexican music and identifications, at around 0415 UTC.

New Guinea—4,890 kHz. The National Broadcasting Commission of Papua, New Guinea's shortwave outlet at Port Moresby has been logged on this frequency at 1000 UTC, first with an English newscast, then the news read in the native language.

Peru—4,9966 kHz. Tuning this 60-meter band frequency during the early morning hours, around 1000 UTC, may turn up *Radio San Miguel* (RSM), transmitting from the ancient Incan city of Cusco in Peru. Radio San Miguel has been heard in the U.S. with Spanish programming and rustic sounding Andean music, called *huaynos*.

Poland—7,270 kHz. *Radio Polonia*, Poland's shortwave service, last May canceled its English programs directed to North America at 0200 and 0300 UTC. That remains the situation as of this writing and future plans are now unclear. ■

ABBREVIATIONS

CKFX	C is prefix for Canadian SW station call signs (CKWX, CKVP, CFRB, CFCX, etc.)
DX	long distance (over 1000 miles)
DX'er	listener to shortwave broadcasts
DX'ing	listening to shortwave broadcasts
EST	Eastern Standard Time
kHz	kilohertz (1000 hertz or cycles per second)
RMI	Radio Mexico International
RPI	Radio for Peace International
RSI	Radio Sweden International
RSM	Radio San Miguel
SRI	Swiss Radio International
SW	shortwave
SWL('s)	shortwave listener('s)
US	United States
USSR	Russia (Union of Soviet Socialist Republics)
UTC/GMT	Universal Time Code/ Greenwich Mean Time
VOG	Voice of Greece

ROCKET STROBE

(Continued from page 33)

does not need any heatsink. Different types of mini transformers and component tolerances may necessitate a small heatsink on Q1 if it gets too hot to comfortably hold. Sometimes, due to winding differences, you will need to increase C4 to 470 µF or 680 µF in order for the PWM circuit to work efficiently. A 16-volt capacitor is satisfactory for use with a 9-volt battery.

Build the PWM part of the circuit first. You should test it before installing the hex FET and T1. That is easily accomplished by using a small speaker with a 10-µF capacitor attached to one lead. Connect the other lead to ground, and the free end of the capacitor to pins 6, 8, 10, and 12 of U1. By adjusting R4, you will be able to hear the volume of the tone getting louder or quieter as R4 varies the pulse width. Once the PWM circuit works, attach the mini transformer, using Figs. 2 and 3 as a guide to polarity. Use proper precautions to minimize static, and install Q1. The +300-volt output may be tested with a neon lamp. Resistor R4 varies the brightness of the lamp somewhat.

Put together the strobe section of the circuit (see Fig. 4) keeping in mind the high-voltage output of T2. Once you have all the parts assembled, it is a good idea to give the finished board and components several light coats of an insulating spray to prevent shorts and high-voltage arcing. A product such as "Acrylic Coating" (which has a dielectric strength of 2,000 volts per .001 inch) or other material for coating printed-circuit boards works well. Don't coat R4, or it won't work anymore! Also, don't spray anything on the flash lamp, although you may insulate the ends to prevent arcing outside the flash tube.

Testing. Before installing the electronics in the rocket, and gluing everything down, check to see that the Strobe is operating correctly. With a 9-volt input and using the parts specified, you should see a flash every 4 seconds on the high setting, and about every 30 seconds on the lowest setting of R4. You'll note the first flash takes quite a while to appear—usually, about 10–15 seconds on high, and a few minutes on low.

The reason for that is that C7, the large electrolytic that stores the energy to light the flash lamp, has to "polarize" if it has been sitting idle for long while. Leakage within the capacitor is maximum when voltage is first applied, and it has to charge and discharge several times before leakage subsides and absorbs less power. If that problem exists, run the Strobe from another 9-volt battery before launch, and wait until the flash rate goes up. Then, you may install your flight battery, and let 'er rip.

If you can get accurate specifications, select C7 for low leakage. Most miniature, recent-style capacitors work fine. In our prototype Strobe, we left out an on/off switch, opting instead to simply install the 9-volt battery when launching. You may install a switch, or leave it out as desired.

Finally, remember to observe sensible practices when flying your rocket. If it gets caught in a power line, or high in a tree, leave it! No project is worth risking one's life! Fly in clear areas, especially for night launches, and observe wind direction, launch angle, expected trajectory, and landing site to optimize your chances of successful recovery. Happy Flying! ■

CIRCUIT CIRCUS

(Continued from page 85)

Either a two- or a three-wire piezo transducer works well with the circuit. If a three-wire transducer is used, connect the driven and common sections to the circuit (see Fig. 2 for pinout), using it as a two-wire device.

The filter's output is coupled to a voltage follower, U1-c, isolating the transducer from the output load. If the capacitance value of the transducer used in the circuit isn't known, substitute a capacitance decade-box in place of C_x and set it to about .015 microfarads to start.

Apply power to the circuit and a signal generator to the input; set the generator's frequency to about 1 kHz above the resonant frequency of the transducer, and its output level at about 500 millivolts. Connect a oscilloscope or an AC voltmeter to the filter's output. Adjust the oscilloscope's gain so that the filter's output signal covers about 70% of the vertical screen.

Adjust the capacitance decade-box for a minimum output signal. Remove the decade box and connect a capacitor of the same value in its place. Slowly sweep the audio generator to the transducer's resonance frequency and observe the output level and the bandwidth of the filter.

The gain of U1-a can be raised or lowered as needed to work with just about any level of input signal: the gain is calculated: gain = R8/R1. Don't change the unity gain of op-amp U1-b because its only function in the circuit is to invert the output of U1-a.

The output of U1-c can be fed to a dual-diode rectifier circuit (as was done in Fig. 3) to provide a DC output to drive a variety of circuits.

Encoder/Decoder. The transducer circuit shown in Fig. 5—consisting of a 567 phase-locked loop (PLL), a piezo transducer, LED, and a few support components—can be operated as either a tone encoder or decoder by changing the position of S1. The operating frequency of that dual-purpose circuit is determined by C3 and R2. Capacitors C1 and C2 are not critical and can be of almost any value between 1 and 5 microfarads. When the circuit is receiving an on-frequency signal, LED1 lights.

Although a two wire-piezo transducer, with a resonance frequency of 2500 Hz, was used in the circuit (see the Parts List) any piezo unit should work as long as the values of C3 and R2 are selected to tune to the transducer's operating frequency.

With power on and S1 in the "B" position, adjust R2 for the loudest tone output. The circuit should be tuned to the resonance frequency of the transducer. In that position, the circuit can be used as an acoustical or tone signal encoder. Next, switch to the "A" position and aim an on-frequency audible tone toward the transducer; the LED should light, indicating a decoded signal.

The LED can be replaced by an optocoupler or relay to control just about anything that's electrically operated. A single op-amp audio amplifier can be added between the transducer and U1 to detect weak audio tones. Use the U1-a amplifier circuit shown in Fig. 4, and select R1 and R8 to set the amp's gain as needed. ■

PARTS LIST FOR THE ENCODER/DECODER

- U1—567 phase-locked loop (PLL), integrated circuit
- LED1—light-emitting diode (any color)
- R1—1000-ohm, ¼-watt, 5% resistor
- R2—25,000-ohm potentiometer
- C1, C2—4.7-µF, 16-WVDC electrolytic capacitor
- C3—0.02-µF ceramic-disc capacitor
- BZ1—Piezo transducer, Radio Shack 273-073 or similar
- Printed-circuit or perfboard materials, enclosure, IC sockets, battery and battery holder, wire, solder, hardware, etc.

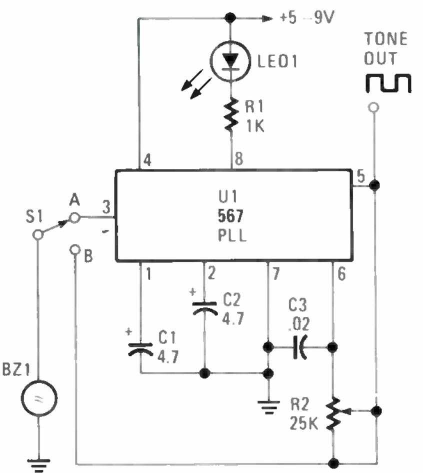


Fig. 5. This transducer circuit—consisting of a 567 phase-locked loop (PLL), a piezo transducer, LED, and assorted components—can be operated as a tone encoder or decoder, depending the position of S1.

The Electronic Industries Association/Consumer Electronics Group has recently completed the first in a series of videocassette training tapes.

EIA/CEG ANNOUNCES COMPLETION OF NEW "BASIC CAR AUDIO INSTALLATION" VIDEO TAPE

If you are thinking of "cashing in" on the profits in the ever growing car audio service business, the troubleshooting–service–installation–and removal of car audio products is a large, non-competitive profit center for your service facility. This thirty minute video introduces you to the ever increasing complex world of car stereo installation. It guides the new installer or owner in the correct layout and design of a car stereo installation facility, covering basic as well as specialized tools needed for the installation business.

This informative videotape is also an excellent aid to the electronics technician in that it gives the correct procedure for removing and replacing "any" car radio from the dashboard of any car and shows the installer's, salesperson's and customer's role in the installation and sale of car audio products.

KEY TOPICS COVERED IN THIS VIDEO

- The design and layout of a car stereo installation center.
- Basic and specialized tools needed for car audio installation work.
- Safety in the shop.
- How to treat the customer's car, from pre-installation checkout to demonstrating to the customer the completed job.
- The proper procedure for installing car audio equipment.
- The technical resources available for information about specific types of vehicles, dashboard dismantling, speaker sizes and antenna locations.
- Speaker wiring types found in the automobile. Common and floating ground systems—how to differentiate. Proper wiring procedures used in the car.

The cost of the videocassette is $30.00. Use the order form below to order yours now!

Send to: EIA/CEG, Department PS, P.O. Box 19100, Washington, D.C. 20036

ORDER FORM

Basic Car Audio Installation	Quantity	Amount	Total Enclosed
Videocassette	________	$30.00 each	________

VHS ☐ BETA ☐

Name

Title

Firm

Address

City State Zip

SOUND-ACTIVATED KALEIDOSCOPE

(Continued from page 68)

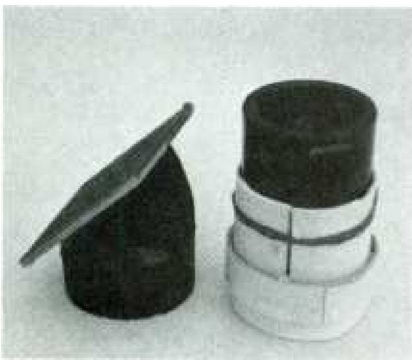
should be somewhat diffused. Diffusion can be accomplished using a small piece of frosted plastic held in the top of the kaleidoscope between the flashlight and the particles in the tube.

If you wish, you can take a small piece of clear plastic and roughen it with fine sandpaper. The diffusion medium is held on a triangular tube that just slips about .4 inch into the top of the kaleidoscope tube. The tube is then held in position with a slightly larger strip of cardboard glued around it. (See Fig. 7.)

You may want to try is to convert the unit for use with a video camera. That requires only a few changes in the unit, but you'll need to do a little engineering to mount the light source for proper illumination. The fleeting images of the kaleidoscope can be captured on video tape and the programs replayed with the assurance that it will be what is planned. For video taping or projecting the image, it is desirable to use two speakers—one speaker is used as the audio source, while the other is used to produce the changing patterns of the kaleidoscope.

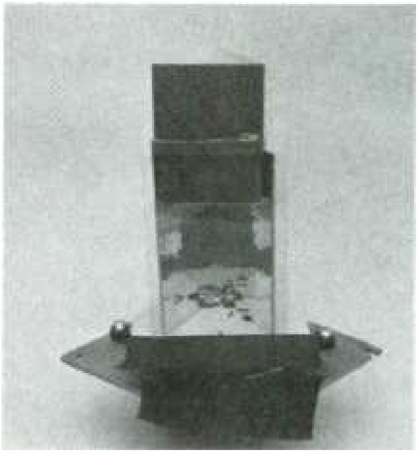
The automatic exposure control of the typical home video camera does not function properly if a black background is used. For video purposes, use either a neutral gray or a pale-blue background. If you have some light-color spray paint available, use it and see for yourself what works to your satisfaction.

For video work, illumination of the particles is done from above, with the camera mounted on a tripod at an angle determined by the optics of the particular video camera. Here again, what you have available dictates what you can do. I have close up lens attachments for my video camera and find that a lens with about a 2-inch focal length is quite satisfactory for use with a kaleidoscope.



A mirror mounted atop the cardboard tube at a 45 degree angle and fitted over the projection lens allows the kaleidoscope images to be projected on a wall screen.

The usual kaleidoscope pattern owes much of its fascination to the completely unpredictable patterns that come and go on the screen. I prefer a variety of patterns that are completely unpredictable for certain applications; but for demonstration purposes, a pre-recorded program is frequently desirable.



For video taping, a defusion panel (consisting of frosted clear plastic) can be fitted over the viewing window of the kaleidoscope.

I am currently building a unit that will project the pattern on the ceiling of a bedroom, which is the easiest mode of projection. Combined with soothing music, it may have some therapeutic value. For either video taping or projection, you will need to hold the speaker invariably level. That can be accomplished by mounting the speaker in a piece of ⅛-inch plywood. The plywood, in turn, has three threaded bolts long enough to serve as feet.

I have built many variations of the unit described in this article since I built the first one in the early 1960's. I am always looking for improvements and would be very pleased to hear from anyone who has improvements or refinements to suggest. (Write to me in care of **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735.) The advent of the video camera has given me a renewed interest in building variations to take advantage of this exciting technique. ■

GRAPHER.BAS
(Continued from page 64)

bit), that means that each graph must occupy:

89,600/8 = 11,200 bytes

of the computer's random-access memory.

Based on the above calculations, we see it turns out that the old cliche is wrong. As far as Grapher is concerned, a picture is not worth simply a thousand words; a picture is worth 5,600 *words*!

Printing Graphs. If you would like to send the graphs you generate with the program to your computer's printer, you can do so using the PC's <SHIFT> <PRINT SCREEN> keystroke sequence. However, because the graphs are displayed on the high-resolution screen of the PC, you must execute the Graphics.Com file before you enter BASIC. The graphics program will cause the picture to be rotated by 90 before being sent to the printer to account for the differing aspect ratios.

That file, which can be found on one of the DOS disks that came with your computer, gives the computer the "intelligence" to use <SHIFT> <PRINT SCREEN> for graphics as well as text screens. For more information on using that command, please consult your DOS reference manual. ■

TABLE 1—PROGRAM BREAKDOWN

Line(s)	Functions(s)
1000–1040	Clear variables, set to 80-column text mode, clear screen, and define Pi.
1060–1280	Display instructions.
1300–1320	Wait for key press. If E is pressed, end the program.
1370	Place computer in high-resolution graphics mode and clear screen.
1380–1420	Draw horizontal and vertical axis.
1440	Get graph values from subroutine.
1460–1560	Print graph and axis titles.
1580–1690	Label the axis.
1730	Calculate the horizontal step size.
1750–1830	Graph both functions–one pixel at a time.
1850–2880	Wait for an E to be pressed, then exit the program.

LISTING 2—GRAPHER.BAS MODIFICATION

```
7000 '========== PLACE CONSTANT VALUES HERE ===============
7010 '
7020 YMIN = 0       'minimum y value
7030 YMAX = 10      'maximum y value
7040 'place y-axis title below (18 characters, max.)
7050 YS = "VOLTAGE - Volts"
7060 '
7070 XMIN = 0       'minimum x value
7080 XMAX = 5       'maximum x value
7090 'place x-axis lable below (60 characters, max.)
7100 XS = "TIME (in seconds)"
7110 '
7120 'place two title lines below (60 characters, max.)
7130 T1S = "EXPONENTIAL FUNCTIONS"
7140 T2S = "(For the second example)"
7150 '
7160 RETURN
7170 '
7180 '
8000 '========== PLACE FUNCTION #1 BELOW =================
8010 '
8020 Y = 10 - 10 * EXP(-X)
8030 '
8040 RETURN
8050 '
8060 '
9000 '========== PLACE FUNCTION #2 BELOW =================
9010 '
9020 Y = 10 * EXP(-X)
9030 '
9040 RETURN
```

HAM RADIO

(Continued from page 92)

those 60-watt solid-state "novice" transceivers). For those people, a 600-watt linear is a 6:1 change, which is a gain of nearly 8 dB—almost three S units. For that person, the 600-watt lightweight linear is a good bet, and keeps TVI at minimal levels. The 1000-watt linear yields a 10:1 increase, representing 10 dB (more than three S units) Such a change is surely worthwhile.

Power is not everything in amateur-radio communications. Increasing power enables you to communicate in marginal situations. But it also brings other problems. If you have only enough money to sink into either a good antenna or a linear power amplifier (and no way to own both), then sink the money into the antenna system. Such an investment pays rich dividends. If you get an optimized three-element beam antenna, the forward gain will be around 8 dB, which is the same as buying a linear amplifier that increases power by about sixfold.

But power increase is not the main reason why an amateur needs a good beam antenna for marginal communications. The main reason involves reception! The directivity of a beam allows you to notch out interfering signals from certain directions. On the east coast, we are overwhelmed with W6 stations when chasing European and African DX.

Placing the notch on the back of the beam facing the west reduces the problem considerably. Even if the main lobe of the beam is not directly on the DX station, they'll still hear you loud and clear. Take advantage of the beam-steering capability of the antenna to null out the competition...and the DX is yours.

By the way, remember the days when CB'ers "souped-up" their 5-watt rigs to "get out better?" A typical modification boosted the power to an *illegal* 7 watts. That change wasn't even a single S unit! Not only that, they typically did not modify the modulator, so the percentage of modulation went down as well.

Sadly, we've come to the end of the space allotted to us for this month, but be sure to "tune in" next time. In the meantime, if you have any tips, comments or suggestions for this column, write to *Ham Radio*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■

AUDIO COUPLER

(Continued from page 65)

flame. Solder a 10-ohm resistor to one end of the coil. Before soldering, wrap 3 or 4 turns of the burned-enamel wire around the resistor lead. Solder the other end of the resistor to one lead of the wire or cable that will exit the cartridge. It would be a good idea to connect the inner conductor of the cable to the resistor, leaving the shield conductor for the other end of the coil. That will protect your scanner, handi-talkie, etc. in the event that the coil should get scuffed and make contact with grounded metal objects. Solder the other end of the coil to the other wire lead.

Finishing Up. You should now have a coil and resistor connected in series (see Fig. 1). At this point you may want to check your completed circuit with an ohmmeter to be sure all connections are good. Now secure the resistor and wire so that they will not come into contact with the rotating spindles of the tape player. You could just glue them securely or wrap them around some of the tape guide pins located in the corners of most cartridges. Route the wire through the exit hole and carefully re-assemble the cassette cartridge. If the piece of equipment you wish to amplify has an auxiliary-output jack (such as for headphones or earphones), connect the appropriate plug to the end of the wire. If the equipment in question does not have such an output, you will have to connect the wire to the internal speaker terminals of the unit.

Before putting the cartridge into a tape player to test it, carefully examine the newly created coil. In particular, check to be sure that the ends of the coil (or anything else) will not get snagged on any of the mechanisms inside the tape player.

To use the device, simply pop it into a tape player and plug or connect the Audio Coupler to the unit needing amplification. The tape player must be in the play mode, just as if you were ready to listen to a tape. Adjust the volume control of the tape player and the volume control of the signal source to your liking. If you have a 40-watt booster on your tape player, you can really bring that little handheld unit to life! I have made three of these devices and they all work just great. I'm sure your's will too! ■

ANTIQUE RADIO

(Continued from page 83)

entire June and July 1988 columns had been devoted to it—and I still hadn't gotten to the Crosley material. Although they were interesting columns indeed, I felt that I should introduce more new material before discussing the remainder of the letters from the readers.

The Zenith restoration, just being concluded, was begun in August. A couple of months into the restoration—just as I had begun to dissect the dial assembly to make the necessary repairs—George lost his patience. He accused me (writing tongue-in-cheek, I hope) of evading a good subject, the Crosley, in order to make a massive attack on a Zenith dial.

Well, George, I agree with you. The Crosley is a good subject, and the letters I've received about it (including your own long one) were very interesting indeed. And finally their time has come! We'll get started right now, and present a few more of them next month, and go on into the following month if necessary.

Wonderful Re-Creation. I think the best way to get everyone back into a Crosley 50 mood is to show you the pictures Dan Damrow (Burbank, IL) sent me illustrating his incredible re-creation of that little set. And I'm also including matching photos of my own real Crosley 50 so that you can see just how faithful to the original this model is.

Every major component in the reproduction—with the exception of the vacuum tube—was built from scratch. That includes the "book-type" tuning condenser, with its hardwood leaves; the mica-and-bakelite bypass condensers; the grid leak; the tube socket (made of PVC pipe sprayed black); the "spiderweb" coils; and even the filament-control rheostat!

Dan likes building replicas because he feels that they have a clean, neat look that no 60-year-old set could ever attain. And when you realize that he retired after twenty-one years as an electronic technician for Argonne National Laboratories (the well-known atomic research facility), you'll understand that he has plenty of skills to support his hobby.

I've run pictures of Dan's sets in the column before. In fact, he was one of the first readers to respond to the column when I first began writing it a few years ago. And I hope I'll have the opportunity to show you more of his meticulous recreations in the future.

So Long. If you are one of the several people who wrote in response to the two Crosley articles, stay tuned for next month's column. I'll probably be quoting you then! In the meantime, keep those cards and letters coming. Your comments and ideas are always welcome. Write to Marc Ellis, *Antique Radios*, C/O **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■

FREQUENCY COUNTER

(Continued from page 61)

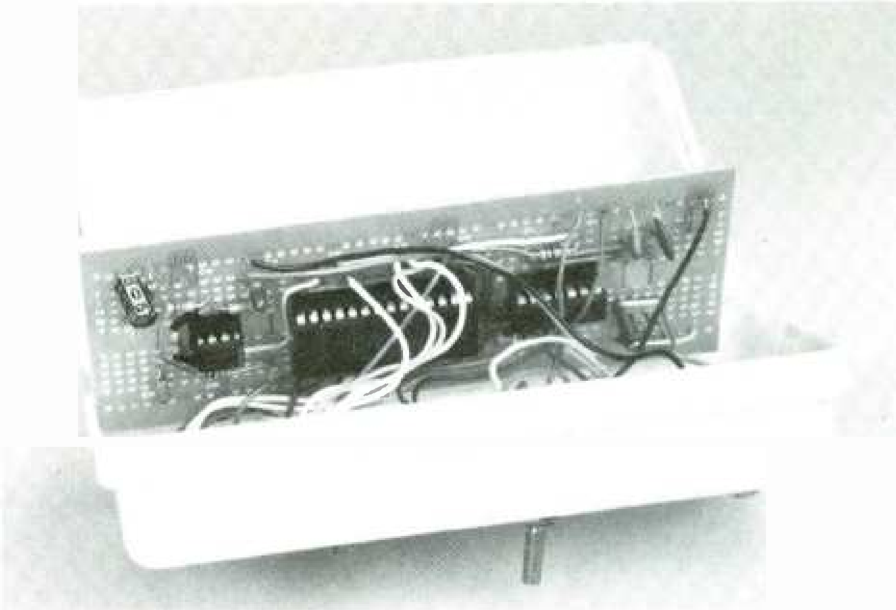
measured, the initial readout will be the previous frequency that was latched in the counters. Wait for two or more count periods for the circuit to stabilize on the new frequency. Optionally, the RESET switch (S2) may be pressed to reset the display to "00," and then released.

The display is basically jitter free and all digits are significant. If the frequency itself is somewhat unstable, D1 may vary by one or two counts.

Notes. The input signal voltage must not overshoot the +5V to ground limits, and rise and fall times may not exceed 10 nanoseconds. Integrated circuit U3 provides those safeguards, so do not be tempted to apply random signals directly to U1 pin 12. For special circumstances, knowledgeable builders may substitute other signal conditioning circuits for the CA3130, U3. Do not substitute a ICM7207 for the newer ICM7207A used in the circuit, and use only the 5.24288-MHz crystal specified.

You can use the Counter to perform numerous functions, including: Measure the input and output frequencies of digital devices, measure the speed of motor shafts, precisely adjust the output of signal generators, set audio signals to the exact pitch, determine the exact values of RC timing components, and measure any frequency between 1 Hz and 10 MHz.

It's a sure bet that once you've used your counter for a while, you won't be able to get along without it. ■



Assembled on a universal printed-circuit board, the Counter requires several jumper wires to complete the circuit paths.

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1A TITLE OF PUBLICATION: HANDS-ON ELECTRONICS
1B PUBLICATION NO: 0 7 4 3 2 9 6 8
2 DATE OF FILING: 9/30/88
3 FREQUENCY OF ISSUE: MONTHLY
3A NO. OF ISSUES PUBLISHED ANNUALLY: 12
3B ANNUAL SUBSCRIPTION PRICE: $21.95
4 COMPLETE MAILING ADDRESS OF KNOWN OFFICE OF PUBLICATION: 500-B BI-COUNTY BLVD. FARMINGDALE, N.Y. 11735
5 COMPLETE MAILING ADDRESS OF THE HEADQUARTERS OF GENERAL BUSINESS OFFICES OF THE PUBLISHER: 500-B BI-COUNTY BLVD. FARMINGDALE, N.Y. 11735
6 FULL NAMES AND COMPLETE MAILING ADDRESS OF PUBLISHER, EDITOR, AND MANAGING EDITOR (This item MUST NOT be blank)
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EDITOR (Name and Complete Mailing Address): Editorial Director ARTHUR KLEIMAN 500-B BI-COUNTY BLVD. FARMINGDALE, N.Y. 11735
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LAWRENCE STECKLER	500-B Bi-County Blvd. Farmingdale NY 11735

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SCANNER SCENE

(Continued from page 93)

way Department in Polk County, FL has a repeater with the output on 159.135 MHz. The input (receive) frequency that's 159.045 MHz, is just a mere 5 kHz away from one of those frequencies, 156.05 MHz.

The repeater manages to pick up illegal maritime transmissions on 156.05 MHz, and repeats them (slightly distorted) on 1599.135 MHz. That results in no small amount of fishing boat chatter being blasted throughout the county, thanks to the powerful Highway Department repeater!

Looks like it's probably worth putting your scanner into the search/scan mode between 156.025 and 156.25 MHz to see if any of that activity is going on within receiving range of your station.

Cellular Reception. Several readers have written to share the news that reception on the factory-omitted 800-MHz cellular channels is easily accomplished on the Uniden Bearcat BC-200/205XLT. All you do is program in frequencies exactly 21.7 MHz above the cellular channels and you're in business via the "IF image" reception method. To search the 870- to 896-MHz band, set your BC-200/205XLT to search 891.7 MHz through 917.7 MHz.

Once again we've reached the end of the space allotted to us for the month, but be sure to tune us in next month when we'll present another assortment of scanner tidbits. In the meantime, be sure to send your scanner-related comments, questions, tips, loggings, and suggestions to *Scanner Scene*, **Popular Electronics**, 500-B Bi-County Boulevard, Farmingdale, NY 11735. ■

THINK TANK

(Continued from page 27)

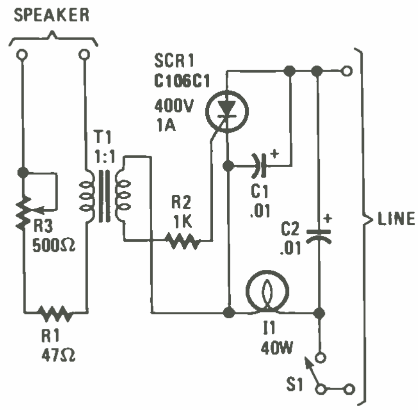

Fig. 7. This light-control circuit uses the audio out of your stereo to provide trigger current for the SCR.

24-volt transformer and lower rated lamps. Then you can ground one pole of the lamp circuit, or the center tap of the transformer. The two capacitors shown are used as interference suppressors for SCR1. The values of the capacitors are not critical and they can vary somewhat from what's shown, but be sure they have a .5- to 1-kilovolt rating. I hope you like it, and that it earns me a copy of the Fips book.
—Fred Bergmann, Chicago, IL

Okay Fred. I've got good news for you. The Fips book is on its way to you now. Enjoy!

Okay guys, that's it for this month. Send your schematics with complete descriptions (please) to *Think Tank*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. If your idea or circuit is a good one, there might be a free copy of the Fips book in your future! ■

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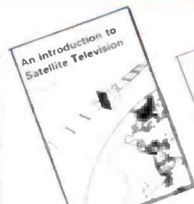

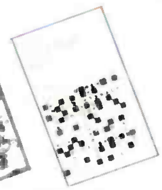

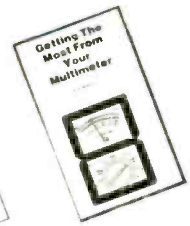

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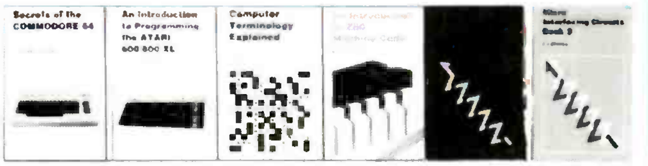

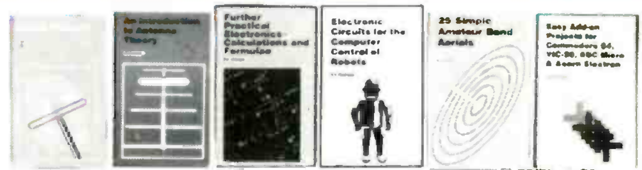

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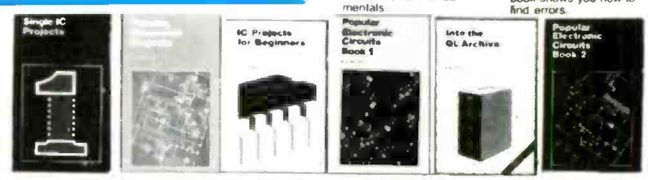

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