

BUILD A MULTIPLAYER LED RACING GAME

14278

Popular Electronics®

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE

MARCH 1977/\$1.25

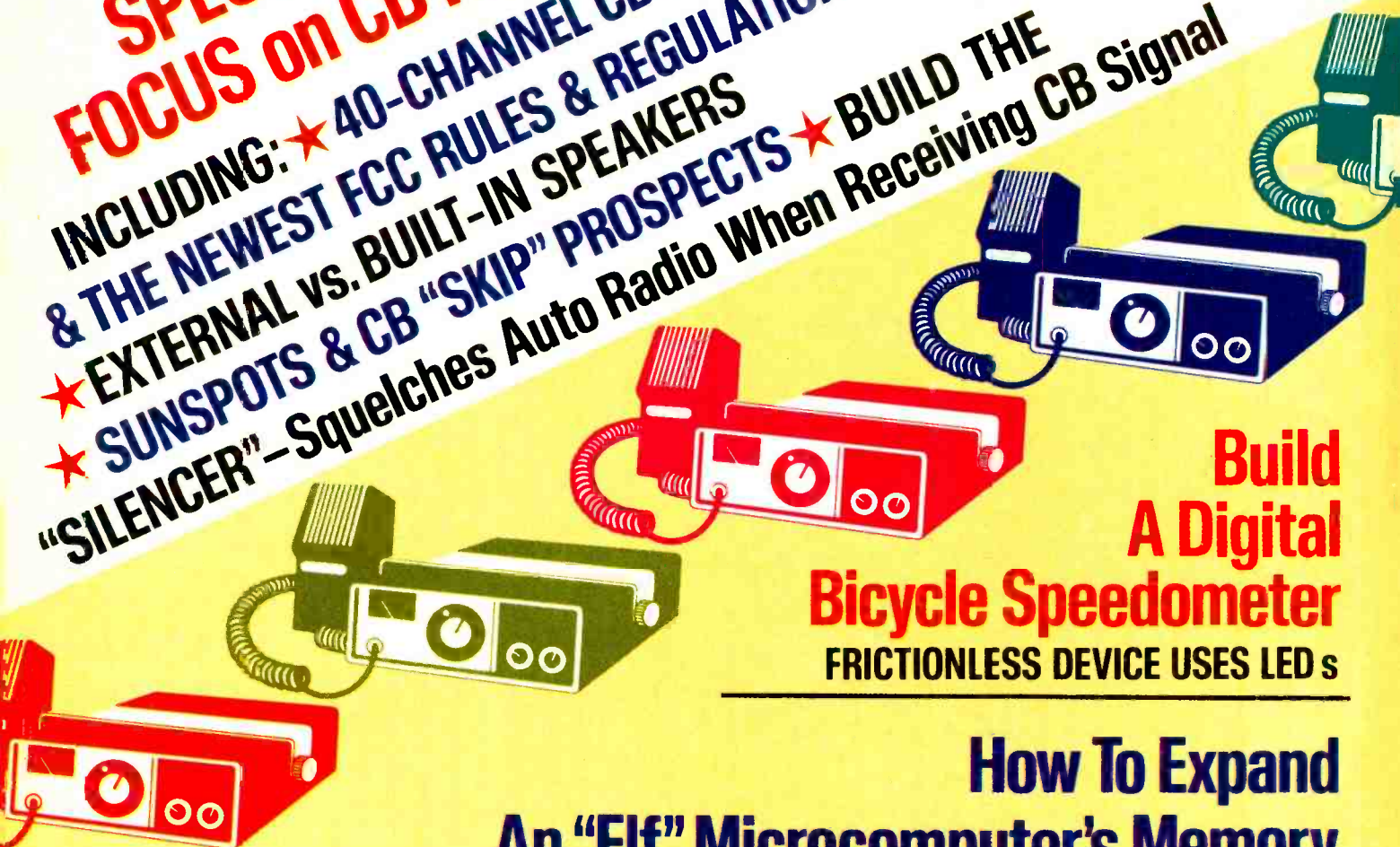
16-PAGE BONUS!

SPECIAL FOCUS on CB RADIO

INCLUDING: ★ 40-CHANNEL CB RIGS & THE NEWEST FCC RULES & REGULATIONS

★ EXTERNAL vs. BUILT-IN SPEAKERS

★ SUNSPOTS & CB "SKIP" PROSPECTS ★ BUILD THE "SILENCER" - Squelches Auto Radio When Receiving CB Signal



Build A Digital Bicycle Speedometer
FRICTIONLESS DEVICE USES LED S

How To Expand An "Elf" Microcomputer's Memory

Build A 10-Hz To 1-MHz EPUT Meter

TEST REPORTS

★ Sherwood S-7910 Stereo FM/AM Receiver

★ Empire 698 Manual Turntable

★ Ballantine 1010A Oscilloscope



The 40-channel Cobra 29XLR. From the sleek brushed chrome face to the matte black housing, it's a beauty. But its beauty is more than skin deep. Because inside, this CB has the guts to pack a powerful punch.

The illuminated 3-in-1 meter tells you exactly how much power you're pushing out. And pulling in. It also measures the system's efficiency with an SWR check. In short, this Cobra's meter lets you keep an eye on your ears.

The Digital Channel Selector shows you the channel you're on in large LED numerals that can be read clearly in any light. There's also switchable noise blanking to reject short-pulse noise other systems can't block. The built-in power of DynaMike Plus. Automatic noise limiting

and Delta Tuning for clearer reception.

And the added protection of Cobra's nationwide network of Authorized Service Centers with factory-trained technicians to help you with installation, service and advice.

The Cobra 29XLR. It has 40 channels. And it has what it takes to improve communications by punching through loud and clear on every one of them. That's the beauty of it.



Punches through loud and clear.

Cobra Communications Products
DYNASCAN CORPORATION
6460 W. Cortland St., Chicago, Illinois 60635

Write for color brochure
EXPORTERS: Empire • Plainview, N.Y. • CANADA: Atlas Electronics • Toronto
CIRCLE NO. 15 ON FREE INFORMATION CARD

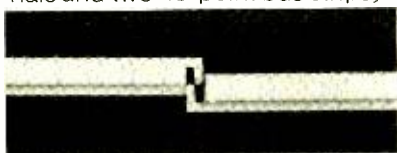
PUNCH AND BEAUTY



ANNOUNCING THREE NEW BREAKTHROUGHS IN SOLDERLESS BREADBOARDING.

Whether you design or build circuits for fun or for profit, you owe it to yourself to discover how fast and easy CSC solderless breadboarding can be. Now, more than ever. Because of three new breakthroughs in breadboard design. And our new EXPERIMENTOR™ sockets** that make the most of them.

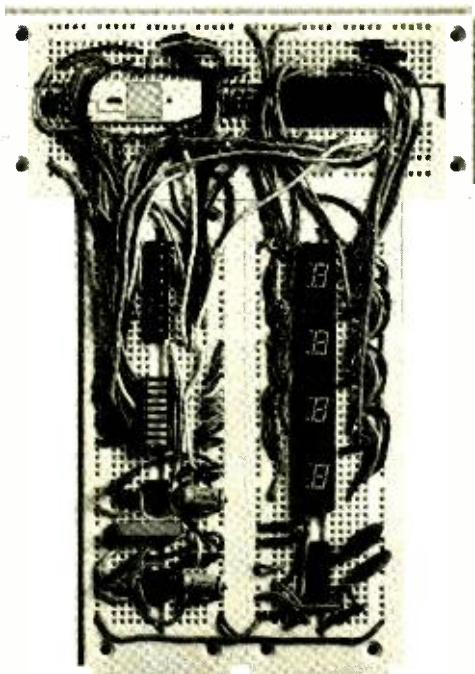
1. Price Who says a quality breadboard has to be expensive? For as little as \$9.95, CSC's EXPERIMENTOR sockets let you design, assemble and modify circuits as fast as you can push in—or pull out—component leads. On a rugged one-piece socket with 550 solderless tie-points (94 five-point terminals and two 40-point bus strips).



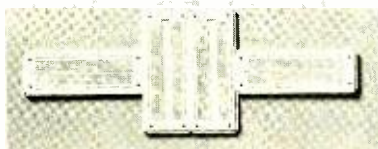
Sockets lock together, snap apart to handle any size circuit with ease.

But don't let the low price fool you: EXPERIMENTOR sockets are precision-molded of durable, abrasion-resistant material, and feature CSC's non-corrosive, prestressed nickel-silver contacts for positive connections and longer life. All contacts are identified, too... with molded-in designations for easier circuit assembly and diagramming.

2. Compatibility CSC EXPERIMENTOR sockets end the "big-chip blues." They're the only ones with full fan-out capabilities for microprocessors and other larger DIP's, as well as 4-16-pin units. EX-



PERIMENTOR 600's 6/10" center is ideal for microprocessor's, clock chips, RAM's, ROM's, PROM's, etc. While EXPERIMENTOR 300's smaller 3/10" center is perfect for smaller DIP's. Both units, of course, accept transistors, LED's, resistors, capacitors, pot's—virtually all types of components with plug-in ease. As well as #22-30 solid hook-up wire for interconnections. Eliminating heat and lead damage to expensive components. And saving you more money, on parts.



Mix or match both models; arrange them vertically or horizontally.

3. Flexibility With CSC EXPERIMENTOR sockets, you can arrange your breadboard to suit your circuit... instead of vice versa. An exclusive snap-together inter-

locking system lets you instantly connect them. Vertically or horizontally. So you can mix or match 3/10 and 6/10" centers... expanding or contracting to meet your requirements.

CSC EXPERIMENTOR sockets can be used alone, or mounted on any convenient flat surface, thanks to molded-in mounting holes and vinyl insulation backing that prevents shorts. You can mount them with 4-40 flat-head screws from the front, or 6-32 self-tapping screws, from the rear. But however you use them, EXPERIMENTOR sockets are an unbeatable way to build and test twice the projects in half the time.



Both models feature 94 five-point terminals (vertical lines) and two 48-point bus strips (one strip shown).

WHY WAIT? CSC EXPERIMENTOR sockets are available now from your CSC dealer, or by phone from CSC, at \$9.95* for the 300 and \$10.95* for the 600. Call 203-624-3103 (East Coast) or 415-421-8872 (West Coast)—major credit cards are accepted.

*Manufacturer's suggested list price
Prices subject to change without notice
U.S. Pat. No. D235,554

CONTINENTAL SPECIALTIES CORPORATION



44 Kendall Street, Box 1942, New Haven, Ct 06509
203-624-3103/TWX 710-465-1227
West Coast office: Box 7809, San Francisco, CA 94119
415-421-8872/TWX 910-372-7992

Convenience is only half the story.



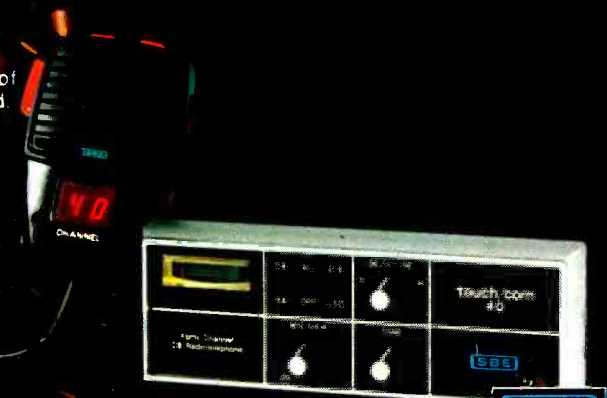
SBE TOUCH/COM 40

SBE adds the ultimate luxury to 40-channel operation, the convenience of microphone control that puts all CB functions right in the palm of your hand.

Quickly scan up or down through all 40 channels, or move channel by channel with the 2-speed channel selector. Identify your channel with the extra-large, high-intensity LED readout, clearly visible even in bright daylight. Adjust volume and squelch with the flick of a finger. And to transmit, simply push the "Press-to-Talk" control. It's all on the microphone.

But the convenience of TOUCH/COM 40 is only half the story. With such sophisticated features as SBE's "Speech Spander" voice-operated modulation level control, "Anti-Blast" audio burst protection circuit, 4-pole IF filter, delta tune, and MIC gain control, Touch/Com 40 offers top performance under the toughest operating conditions, plus dependability backed by 100 per cent quality control.

And that's the half of the story that is the most important to you.



SBE-43CB



Better Communications through Creative Technology



For complete information, visit your nearest SBE Dealer, or write SBE, Inc. 220 Airport Blvd., Watsonville, CA 95076

INTERNATIONAL OFFICES: U.S. - 3000 Marketing Court, Montreal, Canada; Linear Systems S.A. Geneva, Switzerland

CIRCLE NO. 51 ON FREE INFORMATION CARD

www.americanradiohistory.com

Popular Electronics®

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE

FEATURE ARTICLES

COSMAC "ELF" MICROCOMPUTER Joseph Wiesbecker	63
<i>Part 3—Programs and memory expansion.</i>	
CLASSES OF AUDIO AMPLIFIERS Len Feldman	74
<i>What the various types mean to today's audiophiles.</i>	
ENGLISH-LANGUAGE SHORTWAVE BROADCASTS FOR MAR. & APR. Richard E. Wood	103
OPERATIONAL AMPLIFIER QUIZ William E. Parker	111

CONSTRUCTION ARTICLES

BUILD A DIGITAL BICYCLE-SPEEDOMETER George W. Randig	39
BUILD THE V-4 VCO FOR ELECTRONIC MUSIC James Barbarello	42
<i>Generates sine, triangle, and square waves and pulse outputs.</i>	
BUILD A 10-Hz TO 1-MHz EPUT METER John F. Hollabaugh	68
<i>Inexpensive events per unit time instrument.</i>	
MULTIPLAYER LED RACING GAME W. J. Prudhomme	77
<i>Use skill and chance in the game of "Strategy."</i>	

SPECIAL FOCUS ON CB RADIO

CB RULES CHANGES FOR 1977	45
PROS AND CONS OF CB FREQUENCY-GENERATION METHODS Wilfred M. Scherer	46
WILL SUNSPOTS AFFECT CB COMMUNICATIONS? Stanley Leinwoll	51
HOW EXTERNAL SPEAKERS CAN IMPROVE MOBILE CB PERFORMANCE Stephen R. Davis	54
BUILD A SILENCER Roland Miles	57
<i>Squeezes operating radio or tape player when CB signal begins.</i>	

COLUMNS

STEREO SCENE Ralph Hodges	20
<i>The House That Hi-Fi Built.</i>	
SOLID STATE Lou Garner	86
<i>Tachometer-Speed Switches.</i>	
EXPERIMENTER'S CORNER Forrest M. Mims	96
<i>Flip-Flops and Decade Counters, Part 2.</i>	
HOBBY SCENE Q&A John J. McVeigh	99
DX LISTENING Glenn-Hauser	102
<i>The Soviet Pulser.</i>	
COMPUTER BITS Hal Chamberlin	107
<i>Memory Testing.</i>	

JULIAN HIRSCH AUDIO REPORTS

MEASURING AND INTERPRETING TURNTABLE RUMBLE	24
EMPIRE MODEL 698 RECORD PLAYER	26
SHERWOOD MODEL S-7910 STEREO RECEIVER	29

ELECTRONIC PRODUCT TEST REPORTS

OK MODEL WSU-30 WIRE-WRAP TOOL	100
BALLANTINE MODEL 1010A OSCILLOSCOPE	101

DEPARTMENTS

EDITORIAL Art Salsberg	4
<i>Ma Bell Stalls.</i>	
LETTERS	6
NEW PRODUCTS	8
NEW LITERATURE	16
NEWS HIGHLIGHTS	32
OPERATION ASSIST	112
ELECTRONICS LIBRARY	114

POPULAR ELECTRONICS, March 1977, Volume 11, Number 3, Published monthly at One Park Avenue, New York, NY 10016. One year subscription rate for U.S., \$9.98; U.S. Possessions and Canada, \$12.98; all other countries, \$14.98 (cash orders only, payable in U.S. currency). Second Class postage paid at New York, NY and at additional mailing offices. Authorized as second class mail by the Post Office Department, Ottawa, Canada, and for payment of postage in cash.

POPULAR ELECTRONICS including ELECTRONICS WORLD, Trade Mark Registered. Indexed in the Reader's Guide to Periodical Literature.

COPYRIGHT 1977 BY ZIFF-DAVIS PUBLISHING COMPANY. ALL RIGHTS RESERVED

Ziff-Davis also publishes Boating, Car and Driver, Cycle, Flying, Modern Bride, Popular Photography, Skiing and Stereo Review.

Material in this publication may not be reproduced in any form without permission. Requests for permission should be directed to Jerry Schneider, Rights and Permissions, Ziff-Davis Publishing Co., One Park Ave., New York, NY 10016.

Editorial correspondence: POPULAR ELECTRONICS, 1 Park Ave., New York, NY 10016. Editorial contributions must be accompanied by return postage and will be handled with reasonable care; however, publisher assumes no responsibility for return or safety of manuscripts, art work, or models.

Forms 3579 and all subscription correspondence: POPULAR ELECTRONICS, Circulation Dept., P.O. Box 2774, Boulder, CO 80302. Please allow at least eight weeks for change of address. Include your old address, enclosing, if possible, an address label from a recent issue.

EDGAR W. HOPPER
Publisher

ARTHUR P. SALSBERG
Editorial Director

LESLIE SOLOMON
Technical Editor

JOHN R. RIGGS
Managing Editor

STEPHEN B. GRAY
Senior Editor

ALEXANDER W. BURAWA
Feature Editor

EDWARD I. BUXBAUM
Art Director

JOHN McVEIGH
Associate Editor

ANDRE DUZANT
Technical Illustrator

PATRICIA GIRRIER-BROWN
Production Editor

Contributing Editors
HAL CHAMBERLIN, LOU GARNER
GLENN HAUSER, JULIAN HIRSCH
RALPH HODGES, ART MARGOLIS
FORREST MIMS, RAY NEWHALL
SOL PRENSKY, WILFRED SCHERER

JOSEPH E. HALLORAN
Advertising Director

JOHN J. CORTON
Advertising Sales

LINDA BLUM
Advertising Service Manager

PEGI McENEANEY
Executive Assistant

STANLEY NEUFELD
Associate Publisher

ZIFF-DAVIS PUBLISHING COMPANY
Popular Electronics
Editorial and Executive Offices
One Park Avenue New York, New York 10016
212-725-3500

Hershel B. Sarbin, President
Furman Hebb, Executive Vice President
John R. Emery, Senior Vice President, Finance and Treasurer
Philip T. Heffernan, Senior Vice President
Edward D. Muhfeld, Senior Vice President, Sports Division
Philip Sine, Senior Vice President
Frank Pomerantz, Vice President, Creative Services
Arthur W. Butzow, Vice President, Production
Lawrence Sporn, Vice President, Circulation
George Morrissey, Vice President
Sydney H. Rogers, Vice President
Sidney Holtz, Vice President
Albert S. Traina, Vice President
Philip Korsant, Vice President
Paul H. Chook, Vice President
Edgar W. Hopper, Vice President
Charles B. Seton, Secretary
William Ziff, Chairman
W. Bradford Briggs, Vice Chairman

Midwestern Office
The Pattis Group, 4761 West Touhy Ave.,
Lincolnwood, Illinois 60644, 312 679-1100
GERALD E. WOLFE, THOMAS HOCKNEY
Western Office
9025 Wilshire Boulevard, Beverly Hills, CA 90211
213 273-8050, BRadshaw 2-1161
Western Advertising Manager, BUD DEAN

Japan: James Yagi
Oji Palace Aoyama, 6-25, Minami Aoyama
6 Chome, Minato-Ku, Tokyo 407-1930/6821,
582-2851



Member Audit Bureau
of Circulations



The publisher has no knowledge of any proprietary rights which will be violated by the making or using of any items disclosed in this issue.



Editorial

MA BELL STALLS

Last March I happily noted here that the FCC had finally bypassed AT&T and its local telephone companies by permitting end users to install interconnect equipment to Ma Bell's lines without necessarily renting an interconnect modem. The FCC's Docket No. 19528 prescribed a free, simple registration program and technical requirements for making one's own inexpensive interface.

I concluded this column with a farewell to acoustic couplers and an invitation to authors to resubmit those hard-wire telephone projects that we had formerly rejected. Unfortunately, Ma Bell's legal eagles have been running it all through the courts since then, with one challenge after another. Thus far, all court decisions have upheld the FCC decision and its power to make it.

At this writing, though, Bell is before the U.S. Court of Appeals, persisting in its claim that customer-owned equipment must be interfaced only with a device rented from Bell to prevent damage to its lines from faulty equipment. Thus, project builders of equipment that uses telephone lines cannot yet legally bypass renting an interface device with full confidence for the future. This may not be of any consequence to independent suppliers of telephone equipment that connects to Bell's lines or to large businesses, but to electronics hobbyists it means that there is still a monthly rental charge for a dinky little circuit that will cost them, say, \$60 per year.

The FCC certification program for privately owned interface devices, which included issuance of an FCC registration number that would be sent by the user to the local telephone company for information purposes only, was wise and long overdue. We all thought, in our innocence, that this capped the 1968 FCC decision that permitted phone equipment to be purchased from suppliers rather than rented from Bell. The FCC observed last year that the Carterfone Decision placed the burden of proof of harm to telephone installations by interconnect equipment upon the carrier, not the users. It's hoped here that the Appeals Court will share this view.

It might seem strange to many people that independent suppliers of telephone equipment can sell phone gear that's more sophisticated than Bell's standard equipment at enormous savings to businesses with, say, six or more telephones.

The free enterprise system is what makes it happen. Bell has to charge businesses more money in order to make up for losses it sustains to support residential service, some of which is very unprofitable. Outside suppliers, on the other hand, don't have to run phone lines to the boondocks; they can focus on a single area and, as they have proved, whip Bell at every turn. Furthermore, the company enjoys a 10 percent tax credit in the purchase year. For these people, the annual connection fee is peanuts.

For the electronics hobbyist, not paying a \$60 per year modem rental charge for each device connected to the telephone lines would be a boon to both the hobbyist and Ma Bell. After all, sending and receiving computer data, TV pictures, et al, over the lines would add to Bell's revenue as the minutes tick away. This is phone-line time that would not ordinarily be used.

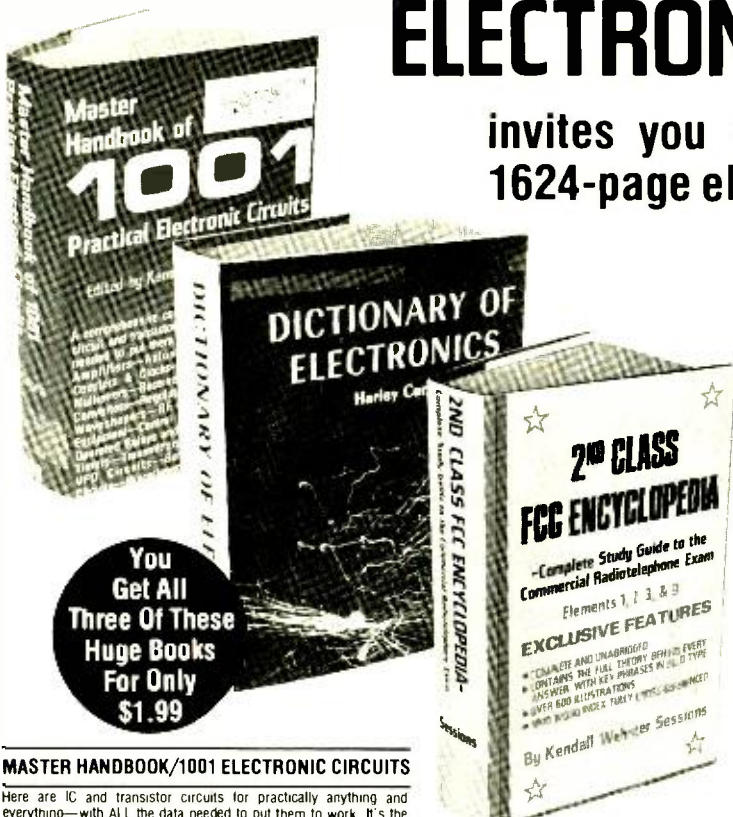
Of course, AT&T and other telephone companies still have an ace in the hole on all of this. It's called the "Consumer Communications Reform Act," which could overthrow legislatively the FCC rules on interconnecting modems. I hope, however, that this does not come to pass.

Art Salsberg

ELECTRONICS BOOK CLUB

invites you to take this
1624-page electronics library
for only

\$ **1.99**



You Get All Three Of These Huge Books For Only \$1.99

- ✓ Only \$1.99 for all three!
- ✓ Regular List Price \$33.85.
- ✓ Top-Quality Hardbinding
- ✓ Features huge quick-find index
- ✓ Over 2300 illustrations
- ✓ Contains over 800,000 words
- ✓ 1624 data-packed pages

with a Trial Membership in the Book Club that Saves you 25% to 75% on a wide selection of electronics books

MASTER HANDBOOK/1001 ELECTRONIC CIRCUITS

Here are IC and transistor circuits for practically anything and everything—with ALL the data needed to put them to work. It's the ideal schematic sourcebook for all active technicians, engineers, experimenters, amateurs—for anyone who must occasionally or regularly construct or adapt electronic circuits for any purpose whatsoever. Each circuit diagram has every component carefully labeled, and every schematic is accompanied by all the info you need to construct the circuit for use in your own individual application. If there are coils to be wound, you'll find full and complete coil-winding details right there on the spot. If special parts are required, you won't have to invest a lot of time and effort before the fact, for it's all there before you in condensed captions. The circuits included are completely up-to-date, and have been designed, built, tested, reworked as necessary, and perfected. You'll find any circuit you've ever likely to need in the pages of this rich volume. Includes an ultracomplete 22-page cross-reference index so you can quickly find the circuit you need. The schematics are classified according to general application. If you're in the business of servicing/repairing commercially built electronic equipment, you're going to especially appreciate the comprehensive Appendix of IC substitutions, which includes base diagrams for most popular ICs, and gives you all the info you need to adapt the IC packages of one manufacturer to the circuit applications of another. 602 pps., over 1250 illus.

2ND CLASS FCC ENCYCLOPEDIA

Truly a one-volume electronics library all by itself—a 602-page supercourse in electronics that belongs on the bookshelf of everyone in electronics. It's as sweeping and all-encompassing as the FCC exam itself. It's a "quick-guide" to learning the answers to the 2nd and 3rd Class FCC exams (plus Element 9, for the broadcast endorsement), as well as an intensive, no-nonsense series of courses that can make you the master of any field related to radio communication. A special feature of this unique guide is the short-form, long-form answer format to hundreds of FCC-posed questions. Whenever possible the answer to a question is divided into the shortest answer needed to satisfy the FCC requirements, a longer answer then shows how any similar question may be answered, and is included for reference or for more complete understanding. Questions appear in italicized type. A boldface type section in most answers enables you to immediately extract from the detailed discussion that portion which directly answers the specific question. These theory packets amount to an extremely comprehensive educational approach to the FCC exam, and are just one of the many ways in which this book is one of the easiest-to-use of all radio courses. An extremely complete 5000-word index, fully cross-referenced, provides instant access to any rule, formula, circuit diagram, or technical explanation. 602 pps., over 600 illus.

DICTIONARY OF ELECTRONICS

This huge, quality dictionary is a handy reference that will serve most of your needs—extremely useful in whatever connection you have with electronics. Defines most all of the electronic terms you will run across in your everyday reading—from alpha particles through zoom lens—including those found in radio, TV, communications, radar, electronic instrumentation, broadcasting, industrial electronics, etc. The concise but clearly written definitions from all the various branches of electronics are of value to technicians, engineers, hobbyists, experimenters, and students. It provides full, complete and easily understandable explanations of thousands of specific electronics terms. A unique feature is the cross-indexing, whereby key words contained in the definitions (words that are defined more fully elsewhere in the book) are printed in small capitals so the user is not left in the dark by any definition. Appendices provide you with still more data—an extensive list of units and abbreviations, graphic symbols used in schematics, component color codes, db conversion tables, data on the electromagnetic spectrum, tube base diagrams, etc. 420 pps., 487 illus.

Let us send you these three practical, time-and-money-saving books as part of an unusual offer of a Trial Membership in Electronics Book Club.

Here are quality hardbound volumes, each especially designed to help you increase your know-how, earning power, and enjoyment of electronics.

These handsome, hardbound books are indicative of the many other fine offerings made to Members—important books to read and keep—volumes with your specialized interest in mind.

Whatever your interest in electronics—radio and TV servicing, audio and hi-fi, industrial electronics, communications, broadcasting, electronics as a hobby—you will find Electronics Book Club will help you get the job you want, keep it, improve it or make your leisure hours more enjoyable. With the Club providing you with top quality books, you may broaden your knowledge and skills to build your income and increase your enjoyment of electronics, too.

This Special Offer is just a sample of the help and generous savings the Club offers you. For here is a Club devoted exclusively to seeking out only those titles of direct interest to you. Members are annually offered over 50 authoritative books on all phases of electronics.

This extraordinary offer is intended to prove to you, through your own experience, that these very real advantages can be yours—that it is possible to keep up

with the literature published in your areas of interest—and to save substantially while so doing. As part of your Trial Membership, you need purchase as few as four books during the coming 12 months. You would probably buy at least this many anyway without the savings offered through Club Membership.

To start your Membership on these attractive terms, simply fill out and mail the coupon today. You will receive the 3-volume Electronics Library for 10-day inspection. YOU NEED SEND NO MONEY! If you are not delighted, return them within 10 days and your Trial Membership will be cancelled without cost or obligation.

ELECTRONICS BOOK CLUB, P.O. Box 10, Blue Ridge Summit, Pa. 17214

- TYPICAL CLUB SELECTIONS (and List/Club prices)**
- Microprocessor Microprogramming Handbook \$9.95 \$5.95
 - VHF/UHF Fire, Police, Ham Scanners Service Manual \$9.95 \$5.95
 - Modern Guide To Digital Logic \$9.95 \$5.95
 - CB Radio Schematic Servicing Manuals—3 Volumes \$26.85 \$9.95
 - Color TV Trouble Factbook \$9.95 \$4.95
 - CBer's Handbook Of Simple Hobby Projects \$6.95 \$3.95
 - Modern Electronics Mail \$12.95 \$8.95
 - Electronic Music Circuit Guidebook \$9.95 \$5.95
 - Build Your Own Working Robot \$8.95 \$5.95
 - Intro to Medical Electronics \$9.95 \$6.95
 - 21 Simple Transistor Radios You Can Build \$6.95 \$3.95
 - Ham Radio Advanced Class License Study Guide \$8.95 \$4.95
 - Aviation Electronics Handbook \$11.95 \$7.95
 - Practical CB Radio Repair \$8.95 \$5.95
 - Radio Astronomy for the Amateur \$8.95 \$5.95

Facts About Club Membership

- The 3 introductory books carry a publishers retail price of \$33.85. They are yours for only \$1.99 (plus postage and handling) with your Trial Membership.
- You will receive the Club News describing the current Selection, Alternates and other offerings, every 4 weeks (13 times a year).
- If you want the Selection, do nothing! It will be sent to you automatically. If you do not wish to receive the Selection, or if you want to order one of the many Alternates offered, you simply give instructions on the reply form (and in the envelope) provided, and return it to us by the date specified. This date allows you at least 10 days in which to return the form. If, because of late mail delivery, you do not have 10 days to make a decision and so receive an unwanted Selection, you may return it at Club expense.
- Personal service for your account—no computers used!
- To complete your Trial Membership, you need buy only four additional monthly selections or alternates during the next 12 months. You may cancel your Membership any time after you purchase these four books.
- All books—including the Introductory Offer—are fully returnable after 10 days if you're not completely satisfied.
- All books are offered at low Member prices plus a small postage and handling charge. Prepaid orders shipped postpaid.
- **Continuing Bonus:** If you continue after this Trial Membership, you will earn a Dividend Certificate for every book you purchase. Three Certificates, plus payment of the nominal sum of \$1.99 will entitle you to a valuable Book Dividend of your choice which you may choose from a list provided Members.

ELECTRONICS BOOK CLUB

P.O. Box 10
Blue Ridge Summit, Pa., 17214

Please open my Trial Membership in ELECTRONICS BOOK CLUB and send my 3-volume Electronics Library, invoicing me for only \$1.99 plus shipping. If not delighted, I may return the books within 10 days and owe nothing, and have my Trial Membership cancelled. I agree to purchase at least four additional books during the next 12 months, after which I may cancel my Membership at any time.

Name _____ Phone _____

Address _____

City _____

State _____ Zip _____

(This offer valid for new Members only. Foreign and Canada add 10%.) PL-3/77

Empire's Blueprint For Better Listening

No matter what system you own, a new Empire phono cartridge is certain to improve its performance.

The advantages of Empire are threefold.

One, your records will last longer. Unlike other magnetic cartridges, Empire's moving iron design allows our diamond stylus to float free of its magnets and coils. This imposes much less weight on the record surface and insures longer record life.

Two, you get better separation. The small, hollow iron armature we use allows for a tighter fit in its positioning among the poles. So, even the most minute movement is accurately reproduced to give you the space and depth of the original recording.

Three, Empire uses 4 poles, 4 coils, and 3 magnets (more than any other cartridge) for better balance and hum rejection.

The end result is great listening. Audition one for yourself or write for our free brochure, "How To Get The Most Out Of Your Records." After you compare our performance specifications we think you'll agree that, for the money, you can't do better than Empire.



EMPIRE

Already your system sounds better.

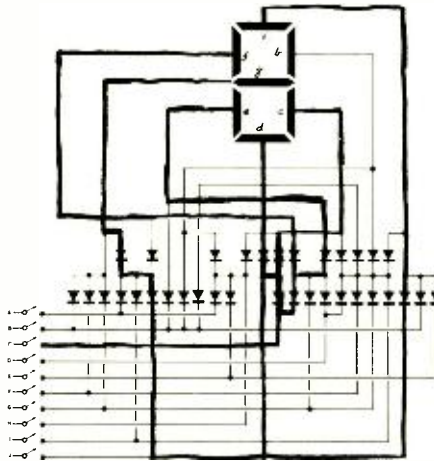
Empire Scientific Corp.
Garden City, New York 11530



Letters

HOW C = 6

I can't get the numeral 6 following the C switch line in January 1977 "LED Circuit Quiz." The only segments I can see that light up are c, d, e, and f. What am I doing wrong?—Anthony W. Wallace, Portage, IN.



A number of readers are having the same problem. The correct solution is shown by the accented lines in the drawing.

PIONEER 10 AND TV

In the November 1976 Letters column, J.M. Lagerwerff stated that SECAM 60 color TV equipment was carried on Pioneer 10. Neither Pioneer 10 nor Pioneer 11 carried SECAM 60, PAL, or NTSC TV equipment. The imaging equipment in both cases is called an Imaging Photopolarimeter (IPP), which used separate Bendix Channeltron detectors for the visible red and blue colors. The IPP uses a spin-scan technique of imaging. The spacecraft is spin-stabilized, rotating at approximately 5 rpm, which forms one axis of a two-dimensional scan field. The second axis is formed by stepping a telescope in discrete increments as the spacecraft rotates.

The data from the red and blue channels were encoded to six-bit PCM and transmitted to earth at 1024 bits per second for Pioneer 10 and 2048 bps for Pioneer 11. These rates are far too slow for direct display. Under contract to NASA, I designed, built, and operated the conversion equipment that converted this very slow rate to NTSC color TV, which was then broadcast to the TV networks. The conversion was accomplished with a special slow-scan video disc recorder. Since green is a substantial portion of NTSC color video, I devised a means of synthesizing the green

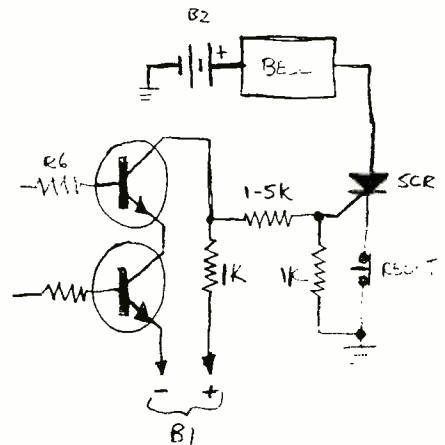
from the red and blue data. Once all three color signals were mixed together, they were fed to an NTSC encoder.

I consider Mr. Lagerwerff's comments on the Pioneer pictures a compliment, as SECAM 60 is a very fine color TV system. —L. Ralph Baker, Optical Sciences Center, The University of Arizona, Tucson, AZ

WANTS TO HEAR BELLS

I find that the Sonalert® in my "Low Cost Apartment Burglar Alarm" (July 1976) puts out a sound of insufficient volume. In the article, it was suggested that a higher-power bell or siren could be substituted for the Sonalert. Could you please tell me how to accomplish this? Also, why the connection from the OFF contact of S1 to the negative side of B1, and what is the significance of the -V on the anode side of D1 and pin 8 of IC4?—S. Possner, Lauderdale Lakes, FL

To answer your last two questions first, there should be no connection between B1(-) and S1 (although it makes no difference to circuit operation if this connection is made as shown), and -V at D1 and pin 8 of IC4 means that these two points must be connected together. To add a bell or siren to the circuit, replace the Sonalert with a 1000-ohm resistor and add an SCR control system as shown in the diagram. The value of the



1000-to-5000-ohm resistor will depend on the gate requirements of the SCR selected. You may wish to use a separate high-current battery (B2) for the bell or siren. The RESET switch is required to turn off the SCR in the event the alarm is tripped.

Out of Tune

In "An 'RFI-Free Solid-State Thermostat,'" January 1977: R4 in the parts list should be a 2,000-ohm, 1-watt, linear taper, 10% tolerance potentiometer; R7 in the upper left (connected on one side to the cathode of D1) should read R9, a 470-ohm resistor. All fixed resistors should be 5% tolerance components.



THE PREMIER FAMILY
OF STEREO SOUND REPRODUCERS
SHURE



The Test of Time.

Critics were most generous in their praise when the Shure V-15 Type III phono cartridge was first introduced. The ultimate test, however, has been time. The engineering innovations, the uniform quality and superb performance of the V-15 Type III have made it the audiophile's choice as the source of sound for the finest music systems both here and abroad.

Consider making the relatively modest investment of a new cartridge to upgrade the

performance of your entire hi-fi system. It will make a difference you can hear!

The original manuscript by J. S. Bach shown is reproduced by kind permission of the Trustees of The British Museum.

Shure Brothers Inc.
222 Hartrey Ave.
Evanston, IL 60204
In Canada:
A. C. Simmonds & Sons Limited

TECHNICORNER
MODEL V-15 TYPE III
Tracking Force Range: ¼ to 1¼ grams
Frequency Response: 10 to 25,000 Hz
Typical Tracking (in: cm/sec peak recorded velocity at 1 gram):
400 Hz: 26 cm/sec 1,000 Hz: 38 cm/sec
5,000 Hz: 35 cm/sec 10,000 Hz: 26 cm/sec
Channel Separation (Minimum): 25 dB at 1 KHz; 15 dB at 10 KHz
Stylus: Model VN35E Biradial Elliptical, 5 x 18 microns (.0002 x .0007 inches)
Also available: Model V-15 III G with the VN3-G Spherical stylus, 15 microns (.0006 inches)
Model VN78E Biradial Elliptical stylus, 13 x 63 microns (.0005 x .0025 inches) for mono 78 rpm



MANUFACTURERS OF HIGH FIDELITY COMPONENTS, MICROPHONES, SOUND SYSTEMS AND RELATED CIRCUITRY.

MARCH 1977

CIRCLE NO. 55 ON FREE INFORMATION CARD

7

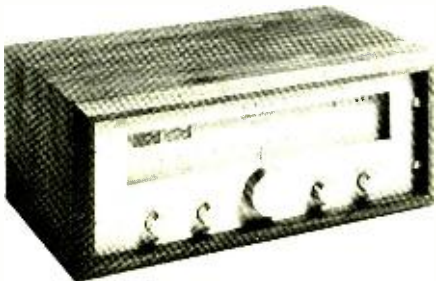


New Products

Additional information on new products covered in this section is available from the manufacturers. Either circle the item's code number on the Reader Service Card inside the back cover or write to the manufacturer at the address given.

PHASE LINEAR FM TUNER

The Model 5000 is the first FM tuner to be put into the Phase Linear line of separate hi-fi components. The tuner features a built-in dynamic range expander specifically designed for FM to improve dynamic range up to 9 dB.



Lesser amounts of expansion can be selected while receiving those broadcasts that have small amounts of compression. Other features include: fully variable muting; LED multipath indicators; fixed and variable output signal levels; signal-strength and center-channel tuning meters that can be user calibrated; 75/25- μ s deemphasis switch; and panel light dimmer. Size is 19"W \times 10"D \times 7"H (48.3 \times 25.4 \times 17.8 cm). \$499.00.

CIRCLE NO 91 ON FREE INFORMATION CARD

TELEX CB HEADSET

Telex's new lightweight CB headset, the Model CB-88, has a noise-cancelling microphone for clear, crisp voice transmission even where wind, traffic, and engine noise normally interfere with sound quality. The mike has a variable-gain amplifier and is mounted on a pivoting boom. A soft eartip



carries incoming signals directly to the ear. The eartip can be worn in either ear, with or without the headband. An adapter is furnished to allow the earpiece to be clipped to a user's eyeglasses. The push-to-talk switch has a clip for attachment to shirt or blouse. Below \$70.

CIRCLE NO. 92 ON FREE INFORMATION CARD

GOLD LINE FIELD-STRENGTH METER

The Gold Line Model 1101 is a compact field-strength meter with a frequency range of 20 to 160 MHz, for both base and mobile CB and marine operations. The meter features a



mini-antenna and a multi-color dial designed for easy reading. Measures 2 $\frac{3}{4}$ "W \times 1 $\frac{1}{2}$ "H \times 1 $\frac{1}{2}$ "D (7 \times 3.8 \times 3.8 cm), weighs about half a pound (0.25 kg). \$9.95. Address: Gold Line Connector, 25 Van Zant St., East Norwalk, CT 06855.

NATIONAL SC/MP KEYBOARD KIT

The National Semiconductor SC/MP Keyboard Kit is an inexpensive hand-held terminal for use with the 8-bit SC/MP microprocessor kit to eliminate the need for a costly Teletype terminal. It has a 6-digit hex display and features simple μ P control to allow the user to evaluate the SC/MP CPU and direct object code program manipulation for development of a variety of applications software. The heart of the kit is a ROM firmware package (512 bytes) that replaces the Kit Bug ROM originally supplied with the SC/MP kit and allows the use of the hex keyboard to modify or examine the contents of memory and the SC/MP registers and to monitor program performance. The kit comes complete with manual, all IC's, resistors, keyboard display cable connector assembly, Wire Wrap connectors, precut wires, and a manual Wire Wrap tool. \$95.00.

CIRCLE NO. 93 ON FREE INFORMATION CARD

BOSHEI OPEN-REEL TAPE DECK

The Model IT-1000 tape deck from Boshei Enterprise Co., USA features four heads, three motors, full-logic solenoid-actuated tape motion, 10" (25.4-cm) reel capacity, and large VU meters. Separate microphone and line inputs and a digital tape counter are also



provided. An Auto Reverse feature provides the convenience of cassettes in an open-reel tape deck, allowing up to 8 $\frac{1}{2}$ hours of uninterrupted stereo listening. The transport operates at 7 $\frac{1}{2}$ or 3 $\frac{3}{4}$ ips (19.05 or 9.53 cm/s). At 7 $\frac{1}{2}$ ips, wow and flutter is rated at 0.06% or less, S/N ratio at 55 dB, and frequency response at 30 to 20,000 Hz \pm 3 dB.

CIRCLE NO 94 ON FREE INFORMATION CARD

SWAN SSB HAM TRANSCEIVER

A new 700-watt PEP single-sideband Amateur Radio transceiver is now available from Swan Electronics as the Model 700CX. It features up to 10 channels for MARS operation with the optional Model 510-X plug-in crystal-controlled oscillator. Frequency coverage includes the 80-, 40-, 20-, 15-, and 10-meter bands. USB, LSB, and CW modes of operation are switch selectable, as are the 25- and



100-kHz calibration frequencies from the built-in calibration oscillator. The audio band-pass is 300 to 3000 Hz. A dual-ratio planetary control scheme is used for the tuning system. The receiver's sensitivity is 0.5 μ V at 50 ohms for 10 dB (S + N)/N. Audio output is rated at 4 watts into 3.2 ohms. Size is 13"W \times 11"D \times 5 $\frac{1}{2}$ "H (33 \times 28 \times 14 cm) and weight is 17 $\frac{1}{4}$ lb (7.8 kg). \$649.95.

CIRCLE NO 95 ON FREE INFORMATION CARD

SONY AM/STEREO FM RECEIVER

Sony's Model STR-3800 AM/stereo FM receiver is said to offer a high degree of flexibility in a moderately priced receiver. The amplifier is rated at 25 watts/channel minimum rms into 8 ohms from 20 to 20,000 Hz with no more than 0.5% THD. The tuner section fea-



POPULAR ELECTRONICS

tures a PLL (phase-locked loop) IC in the multiplex section, FET r-f amplifier, permanently aligned i-f filters. Other ratings include 2- μ V IHF sensitivity, 50-dB selectivity, 1.5-dB capture ratio, 68-dB S/N in stereo, and 35-dB stereo separation at 1000 Hz. A stereo indicator, twin tuning meters, and switchable muting are provided. The preamplifier section features a direct-coupled, two-stage phono equalizer for a \pm 1-dB RIAA tracking and 68 dB S/N ratio. The S/N in the high-level input mode is 90 dB. Size is 19"W \times 12 $\frac{1}{8}$ "D \times 5 $\frac{3}{4}$ "H (48.2 \times 32.7 \times 14.6 cm) and weight is 23 lb (10.5 kg). \$280.00.

CIRCLE NO 96 ON FREE INFORMATION CARD

EICO SOLID-STATE ENGINE ANALYZER

Eico's Model 885 Tunemaster solid-state engine analyzer performs up to 16 different automotive tests and analyses. Among them are: ignition points test; dwell test; dwell variation; low rpm (tachometer); high rpm (tach); battery test; accessory current drawn; charging system output; output test (regulator by-



pass); voltage-loss test; ballast resistor test; spark-plug wire test; capacitor test; alternator test; and fuse test. The large 6" (15.2-cm) meter has multi-range, color-coded scales. Controls include a cylinder selector switch and a mode selector. The tester operates on power from the vehicle's battery. The instruction manual provided with the instrument details step-by-step tune-up information for all domestic and foreign cars. \$49.95.

CIRCLE NO 97 ON FREE INFORMATION CARD

MIDLAND 40-CHANNEL CB TRANSCEIVER

The Midland Model 77-882 40-channel mobile CB transceiver features both switchable automatic noise limiter (anl) and noise blanker, Delta tuning and a variable squelch control. The dual-conversion superheterodyne receiver has a tuned r-f stage, active agc; the transmitter is rated to deliver 4 watts of output power. All-channel operation is obtained with a phase-locked-loop (PLL) synthesizer. Oth-



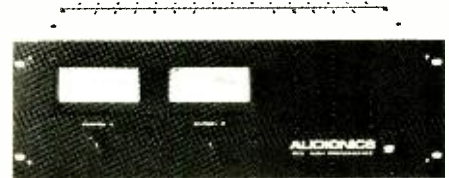
MARCH 1977

er features include: a PA switch that delivers 3 watts of audio power, a warning light that indicates antenna mismatch or failure; an S/r-f meter, and an external CB switch that directs received CB signals to an external speaker.

CIRCLE NO 98 ON FREE INFORMATION CARD

AUDIONICS STEREO POWER AMPLIFIER

The Model PZ3 HP is the second-generation version of the original Audionics Model PZ3 power amplifier. Offered with optional peak-indicating VU meters and input level controls, the new amplifier is rated at 100 watts/channel minimum rms into 8 ohms from 20 to



20,000 Hz at 0.03% maximum THD. Input sensitivity is rated at 1.0 volt for full output. The frequency response at \pm 0.5 dB is from 20 to 20,000 Hz (5 to 70,000 Hz at -3 dB). Hum and noise are rated at more than 95 dB below the rated output, damping factor at 1000 Hz into 8 ohms is 50, and output impedance is 4 ohms to infinity. The amplifier

Looking for an ultimate standard of listening?

D-150A

D-60

DC-300A

Many hi-fi enthusiasts bought a Crown DC-300A power amplifier because they were impressed by its performance specs, and by the quality of its "listening" performance. It was, for them, the "ultimate" amplifier.

Why not do what they did? Compare the specs for the Crown DC-300A with those of any other amplifier. Compare the clean,

pure DC-300A sound that comes from low-distortion circuitry and plenty of headroom. And especially compare the DC-300A with its smaller relatives, the Crown D-150A and D-60. Same clean, pure sound, less power, but maybe just what you need.

Use your own judgment. You could find your ultimate listening standard in Crown.

DC-300A Stereo Amp
155 watts per channel min.
RMS into 8 ohms
(1-20,000 Hz), no more than .05% total harmonic distortion.

D-150A Stereo Amp
80 watts per channel min.
RMS into 8 ohms
(1-20,000 Hz), no more than .05% total harmonic distortion.

D-60 Stereo Amp
32 watts per channel min.
RMS into 8 ohms
(20-20,000 Hz), no more than .05% total harmonic distortion.

Fast playback coupon

Send directly to Crown for fast info on amps.

When listening becomes an art,

Name _____

Address _____

City _____

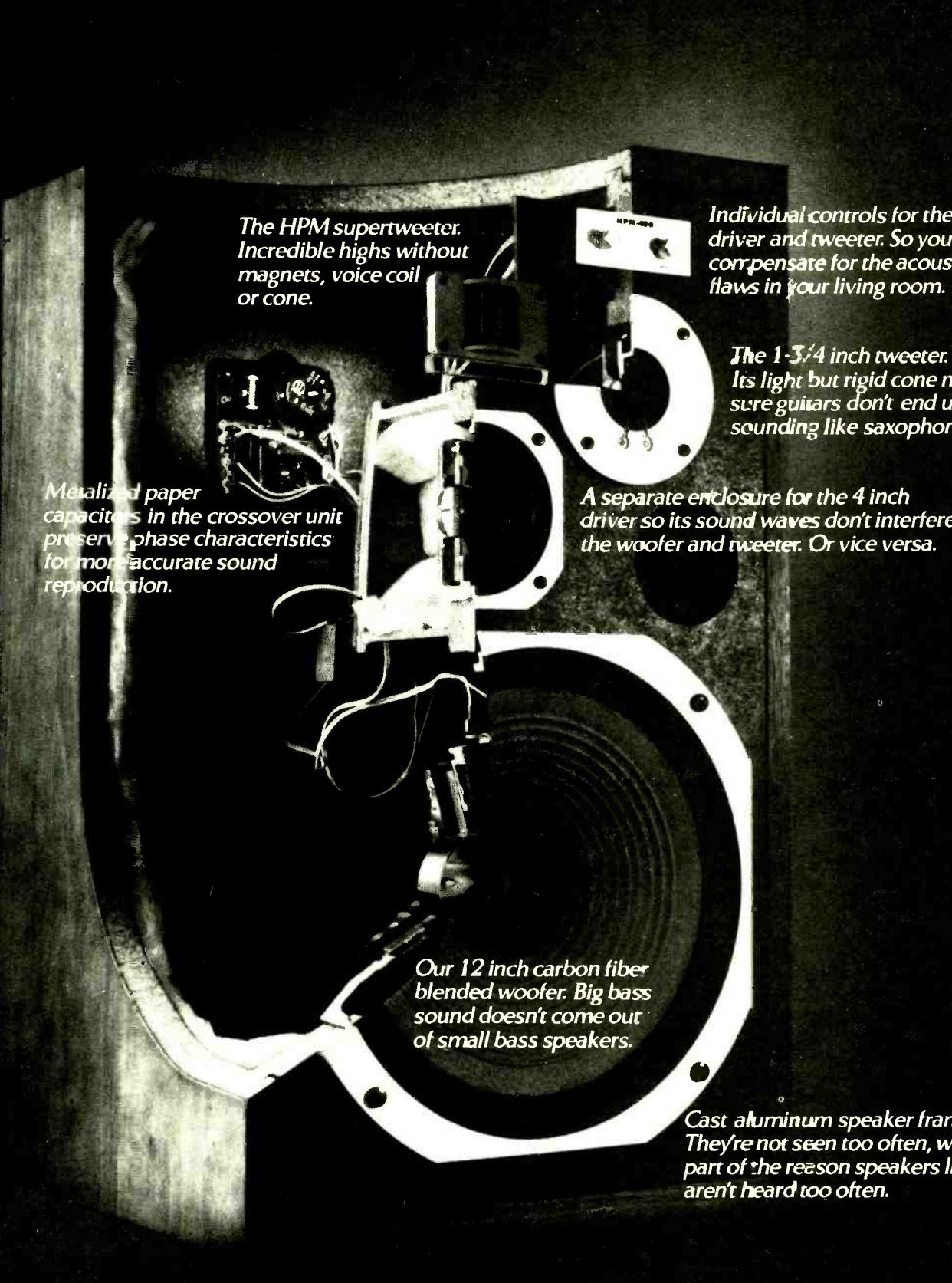
State _____ Zip _____



CROWN

Box 1000, Elkhart IN 46514

CIRCLE NO. 20 ON FREE INFORMATION CARD



The HPM supertweeter. Incredible highs without magnets, voice coil or cone.

Individual controls for the driver and tweeter. So you can compensate for the acoustic flaws in your living room.

The 1-3/4 inch tweeter. Its light but rigid cone makes sure guitars don't end up sounding like saxophones.

Metallized paper capacitors in the crossover unit preserve phase characteristics for more accurate sound reproduction.

A separate enclosure for the 4 inch driver so its sound waves don't interfere with the woofer and tweeter. Or vice versa.

Our 12 inch carbon fiber blended woofer. Big bass sound doesn't come out of small bass speakers.

Cast aluminum speaker frames. They're not seen too often, which is part of the reason speakers like this aren't heard too often.

WHEN YOU BUILD A SPEAKER TO SOUND GREAT ON EVERY PART OF THE MUSIC, YOU CAN'T CUT CORNERS ON ANY PART OF THE SPEAKER.

A single HPM-100 weighs almost 60 pounds.

The fact it weighs more than a Large Advent speaker, Bose 901 or JBL L100 is not an accident.

Our speaker frames are made of heavy cast aluminum instead of the usual stamped metal, so you hear only the speakers vibrating and never their frames.

Our magnets are oversize to spare your ears needless distortion.

And our cabinet is made out of special compressed wood that's denser and heavier than ordinary wood. So the sound is forced out of the cabinet instead of being absorbed by it.

Of course, not everything that adds to the sound of an HPM-100 also adds to its weight.

Our supertweeter uses nothing but a piece of High Polymer Molecular film to produce incredibly clear and crisp high frequencies.

Our midrange driver and tweeter have cones that are light enough to give sharp response, but rigid enough not to distort.

And our 12 inch woofer has a long throw voice coil and unique carbon fiber blend cone (instead of the more typical cardboard cone) that work to produce the kind of realistic bass you not only hear, but feel.

Naturally, we could go on. About our 12-1/2 feet of damping material. Or about the aluminum screws that keep our speakers from falling out. They're ordinarily used to keep airplanes from falling apart.

But we figure at this point you'd rather hear our speakers in person than hear any more about them from us. **HPM-100™**
The all-around great speaker.

FREE

McIntosh CATALOG and FM DIRECTORY

Get all the newest and latest information on the new McIntosh Solid State equipment in the McIntosh catalog. In addition you will receive an FM station directory that covers all of North America.



MX 113

FM/FM STEREO - AM TUNER AND PREAMPLIFIER

**SEND
TODAY!**

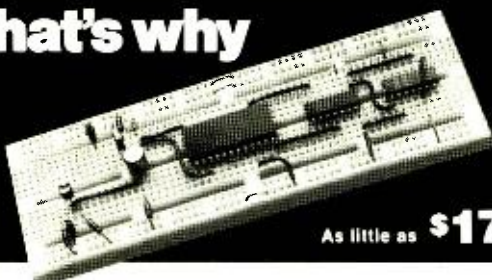
McIntosh Laboratory, Inc.
East Side Station P.O. Box 96
Binghamton, N.Y. 13904
Dept. PE

NAME _____
ADDRESS _____
CITY _____ STATE _____ ZIP _____

If you are in a hurry for your catalog please send the coupon to McIntosh.
For non rush service send the *Reader Service Card* to the magazine.

CIRCLE NO 38 ON FREE INFORMATION CARD

**It's faster, easier and less
expensive. That's why
we call it
Super-Strip.**



As little as **\$17**

This versatile mini breadboard features the same superior contacts, materials and construction we use in our full-scale ACE All Circuit Evaluators. Any solid hookup wire up to #20 plugs right in to connect DIPs, discretes and almost any components you have on hand. Super-Strip gives you 128 separate five-tie-point terminals in the circuit building matrix and 8 power and signal distribution lines — enough capacity to build circuits with as many as nine 14-pin DIPs. And when you're done with your hookup, just pull it apart — everything's as good as new. Super-Strips come with your choice of nickel-silver or gold-plated terminals. Plus an instant-mount backing and quick-removal screws for fast and easy stacking or racking. Heard enough? Then stop looking and start cooking with A P Products Super-Strips.

Part Number	Model Number	Terminal Type	Price Each
923252	SS-2	nickel-silver	\$17.00
923748	SS-1	gold-plated	\$18.90

Order from your A P distributor today. Our distributor list is growing daily. For the name of the distributor nearest you call Toll-Free 800-321-9668.



Send for our complete A P catalog, The Faster and Easier Book,

A P PRODUCTS INCORPORATED
Box 110-H Painesville, OH 44077 (216) 354-2101 TWX: 810-425-2250

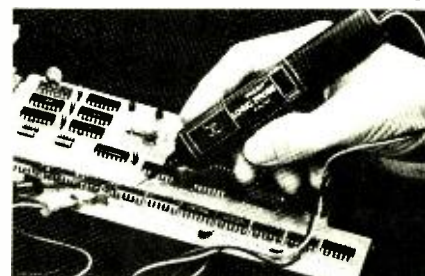
CIRCLE NO 1 ON FREE INFORMATION CARD

comes with a rack-mount front panel with black anodize finish. Size is 19"W x 15"D x 6"H (48.3 x 38.1 x 15.2 cm) and weight is 29 lb (13.2 kg) less meters or 31 lb (14.1 kg) with meters. \$429.00 without meters, \$529.00 with meters.

CIRCLE NO 99 ON FREE INFORMATION CARD

DIGITAL LOGIC PROBE

"Probit" is a new digital logic probe from Control & Information Systems, Inc. It tests TTL/DTL and CMOS logic systems and can detect pulses down to 35 ns and accurately check for valid and abnormal logic levels. The probe has greater than 200,000-ohm input impedance (at 30 MHz) to assure minimal loading on the circuit under test. Both over-voltage



and reverse-voltage protection are provided. A seven-segment display indicates "H" for a logic high, "L" for a logic low, and a decimal point for pulse detection. The display is blank for abnormal logic levels. Convenient "Micro-Hooks" are used for test connections, and the probe tip is detachable. The logic family is selected by operating a slide switch on the probe's body. Size is 5"L x 1"Dia. (12.7 x 2.54 cm). \$34.95.

CIRCLE NO. 100 ON FREE INFORMATION CARD

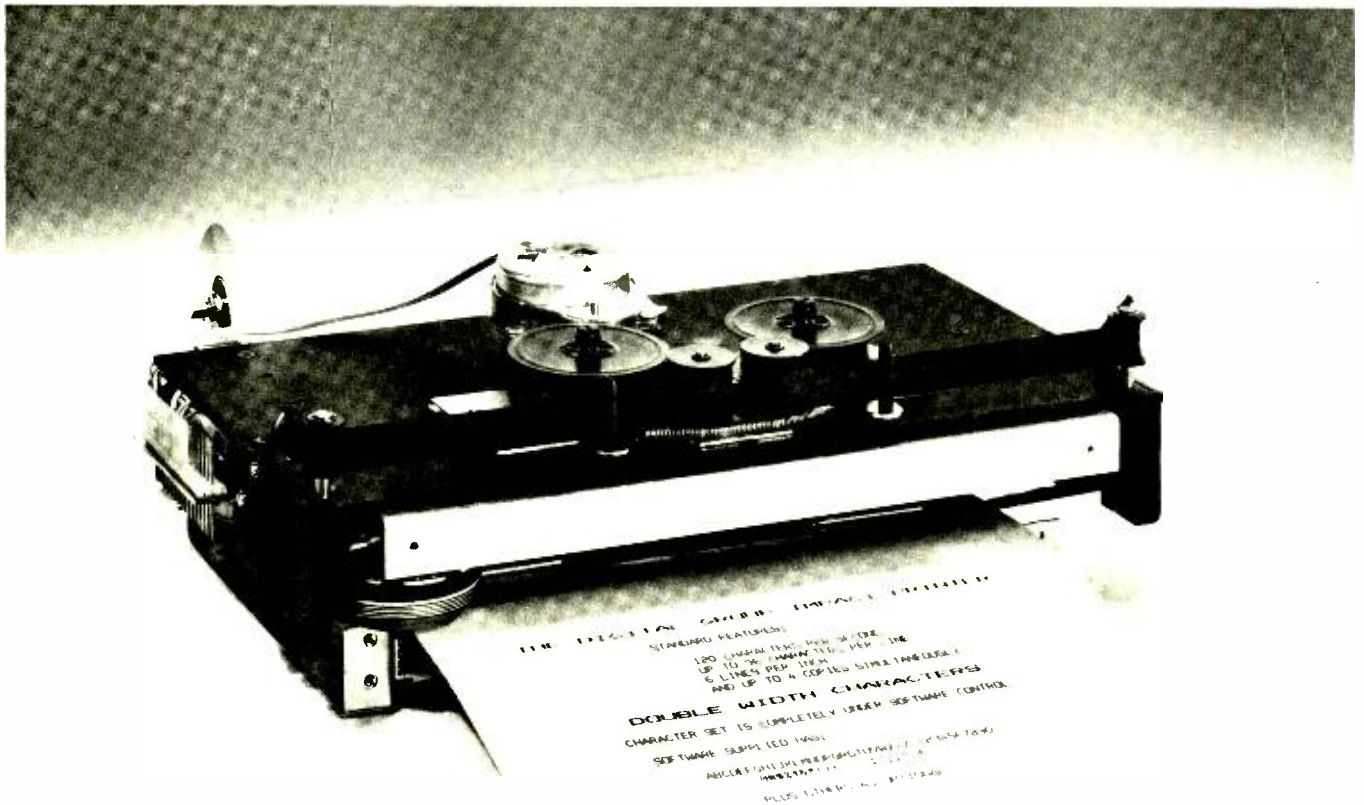
SOUTH SHORE FOLDING CB ANTENNA

South Shore Trading Corp. has announced a 102" (2.6-m) CB whip antenna that conveniently folds to a compact 15 1/2" (39.7 cm) in seconds for easy storage. The SST Whip-A-Way antenna consists of a series of hollow interlocking steel sections that are "strung"



on a spring-loaded cable and easily opened. The brass fittings automatically seat themselves and are held in place by the spring-loaded cable to insure secure mechanical and electrical connections. The antenna can be used with any heavy-duty bumper mount equipped with a standard 3/8"-24 female fitting. \$34.95.

CIRCLE NO. 101 ON FREE INFORMATION CARD



Print Your Heart Out.

With help from the Digital Group, naturally.

Now, that small computer system you own or have been considering for personal or business use suddenly becomes a lot more usable—with the addition of a full-size *impact* printer from the Digital Group. A printer designed for small computers that need big output (like yours).

With the Digital Group printer, you can print your heart out...and it won't cost an arm and a leg. The Digital Group printer is available for less than \$500. That's right—\$500.

Just look at these specifications:

- Fast—120 characters per second
- 96 characters per line
- 12 characters per inch horizontal
- 6 lines per inch
- Makes up to 4 copies simultaneously
- Character set and pitch variable under software control—double width characters, etc.
- 5 x 7 character matrix
- Ribbon has built-in re-inkers for a life of 10,000,000 characters
- Paper can be either a standard 8½-inch roll, fanfold or cut page
- Interfaces to 8-bit parallel ports

There are lots of capabilities and outstanding features of the Digital Group printer...and (as always) the best news is our price. Kit prices start as low as \$495 for the printer and interface card. It simply can't be beat.

Find out all the facts about the Digital Group printer now. Just fill in the coupon below or give us a call for the details. We think you'll find a place for our printer in your system...and in your heart.

the digital group

P.O. Box 6528
Denver, Colorado 80206
(303) 777-7133

Quick. I want to print my heart out.
Send me all the details on your full-size impact printer.

Name _____

Address _____

City/State/Zip _____

Please print.

MIDLAND

IT'S WHAT YOU GET WHEN YOU

And once you get it, it's going to be all you'll ever need. Because Midland gives you what CB is supposed to give you. The power to communicate. The power to reach out and pull in your own personal horizon. And the clarity to be understood wherever you reach.

For 1977, the power comes to you in an entirely new generation of 40 channel CB radios. Spearheaded by the remarkable Midland 838.

With it comes switchable automatic noise limiter, noise blanker and audio filter—three noise elimination systems that let you receive with greater

clarity. The 838 is also power in your hand with an automatic channel advance and volume control right on the mike. And it's the power to know exactly where you're heading with our large, bright L.E.D. digital channel indicator.





RUN WITH NUMBER 1. MIDLAND CB.™

The 838, though, is only one aspect of Midland Power.

We offer a complete line of CB's, from base stations to portables, to every kind of mobile transceiver that will put our power in your hands at a very reasonable price. Compare. We don't think anybody, anywhere will give you such quality at such an affordable price.

And we back up that quality with our Midland warranty and convenient service centers from Carolina to California.

And finally, Midland Power is the way we put our 15 years of CB experience into every set we build.

Good experience, obviously. Or we couldn't have done what we did last year. Sell over 2 million Midland CB radios, to

make us the number one selling CB in the world.

Midland Power. It's what you want from a CB.

It's what you get when you run with number 1.



MIDLAND® CB

A member of the Beneficial Corporation Family.

CIRCLE NO. 39 ON FREE INFORMATION CARD

www.americanradiohistory.com

*** PUT THE "IGNITION OF THE FUTURE" ON YOUR CAR TODAY!**
MODERNIZE and Bring Your Car "UP-TO-DATE" with the MOST EFFICIENT Ignition ever invented!

*** End "Tune-Up" Problems FOREVER**
 caused by Points and Condenser



ALLISON XR-700
 with the Exclusive... Solid-State Voltage Regulator.

The ONLY Ignition System that has COMPLETELY overcome the Problems that have baffled the Auto Industry for Years!
SO RELIABLE (99.9+%)... SO PERFECTED...
 that it will soon be STANDARD on most Future new Cars!

ALLISON Rated #1 by Official Testing Laboratory as the BEST "Fuel Saving" Ignition System of ALL the Different Ignition Systems Tested!

* The "XR-700" is a COMPLETELY NEW Ignition System employing the Most Advanced Technology, that replaces the inefficient Points and Condenser with an infrared Light Beam to Trigger the Latest type of Solid-State Power Components. Once installed... "XR-700" has NO moving Parts to wear out or adjust. It works without Friction or wear. Not affected by Dirt, Oil, Moisture, Vibration or extreme Engine Temperatures! **RUGGED and RELIABLE!**

* The "XR-700" is engineered to DUTLAST YOUR CAR!

* The "XR-700" produces the MAXIMUM "High Energy" Long Duration Spark... from your present car's Ignition Coil. This permits the Positive Firing of Spark Plugs, even under the most Adverse conditions. Also, Eliminates "Engine Misfire," resulting in more COMPLETE COMBUSTION! Thus you get IMPROVED Fuel Mileage, a HIGHER Performance Level keeps Plugs FROM FOUling and gives LONGER Plug Life!

Customers Report:

★ **"IT MORE THAN PAYS FOR ITSELF!"**

- ★ INCREASES Gas Mileage up to 30%!
- ★ SAVES Money on Costly "Tune-Ups"!
- ★ Gives Continuous PEAK Performance!
- ★ QUICKER Starting in Any Weather!
- ★ Smoother Running... Faster Acceleration!
- ★ Plugs Last Up to 4-Times LONGER!"

* Reliability PROVEN in Millions of Customer Miles to be so exceptionally GOOD... that every "XR-700" has a LIFETIME WARRANTY! FREE Repair or Replacement for as long as you OWN the Unit!... and even if you CHANGE Cars, Allison will supply you the necessary PARTS to fit ANY Point-Type Distributor... FREE! (Include \$2 for Postage & Handling)

* FITS ALL CARS. Domestic & Foreign. 4, 6 or 8-Cylinder

★ **OO-IT-YOURSELF... EASY INSTALLATION!**
 The New "XR-700" is Completely Factory Assembled... Thoroughly TESTED! New Precision "Drop-in" Mounting Bracket, with color-coded, "Snap-Together" wire connections
No Distributor Removal necessary. Protected against Incorrect Hook-up!

● Thousands sold at \$59.95 ● **ONLY \$39.95**
NOW! Allison's Production Technology offers you the same Premium Quality XR-700 COMPLETE at this SPECIAL LOW Price... (Cal. Res. add Tax)
THAT'S EVERYTHING... INCLUDING POSTAGE & INSURANCE

★ **ORDER WITH CONFIDENCE**
 install the "XR-700", and prove to your own SATISFACTION that it is as advertised, or return it within 30 days for a FULL Refund of the Purchase Price

* **SAVE! ORDER FACTORY DIRECT**
 Send Check or M.O., State Car Make, Year, No. Cylinders

* **MASTER CHARGE or BANKAMERICARD Card Holders:**
 ORDER by TOLL FREE PHONE. (800) 423-6525, Ext. 2 or Send us (1) Your Number, (2) Interbank No., (3) Exp. Date.

SEND for FREE BROCHURE and Comparison Sheet.

"CB" USERS: The "XR-700" completely ELIMINATES the Major Cause of Primary Ignition Noise! Interference.

* If you have already installed a "Capacitive Discharge" Ignition
 * Convert your "C-D" Unit to BREAKERLESS!
 INCREASE ITS EFFICIENCY with "XR-CD"... only \$29.95

* America's Oldest and Largest Manufacturer of Opto-Electronic Ignition Systems. ©

ALLISON AUTOMOTIVE CO.
 1267 - PO. East EDNA PL., COVINA, CAL. 91722



New Literature

ELECTRONIC ORGAN KIT DATA

Devtronix Organ Products is now offering illustrated literature describing different models, related accessories, and simple assembly techniques on its complete line of build-it-yourself electronic organs. Organ types range from small single keyboard practice models to instruments larger than a three-manual theater organ. A 13-minute LP stereo recording, which presents a wide variety of different types of music demonstrating voicing range capability, is also included for 50 cents. Address: Devtronix Organ Products, 5872 Amapola Drive, San Jose, CA 95129.

TOOLS CATALOG

Catalog No. 22 from Techni-Tool is full of unique and often hard-to-find tools for electronics work. Listed are 25 new tool kits for the engineer and technician. The standard lines of hand tools and accessories are listed and illustrated, with more than 10,000 different items. A "Design-A-Kit" section tells the reader how to go about putting together his own tool kit by selecting only those items he needs. Address: Techni-Tool, Inc., Apollo Rd., Plymouth Meeting, PA 19462.

COAXIAL CABLE CATALOG

A new 34-page "Essex Coaxial Cable" catalog is available from Essex Electronic Wire Products. It contains up-to-date listings of coaxial cables, photos, and charts. Sections highlight r-f transmission lines, military RG/U nomenclature, RG/U-type triaxial cable, electronic sub minax coaxial cable, two-way antenna cable, CATV drop lines, etc. Address: Essex Electronic Wire Products, 6235 S. Harlem Ave., Chicago, IL 60638.

SEMICONDUCTOR REPLACEMENT GUIDE

The Workman Electronic Products Semiconductor Catalog and Replacement Guide consists of 175 pages that list and cross-reference more than 75,000 manufacturer numbers to more than 200 Workman replacements. It also features a cross-reference to other major semiconductor manufacturers. Address: Workman Electronic Prods., Inc., P.O. Box 3828, Sarasota, FL 33578.

SOUND BROCHURES FROM SHURE

A pair of brochures from Shure describe two products that are said to reduce the complication and cost in finding room response trouble spots in sound systems and to equalize the systems to desired frequency-response curves. Brochures No. AL558 and

No. AL554 describe the Model M615AS equalization analyzer system and Model SR107 audio equalizer. Full technical details are given for each product. Address: Shure Bros., Inc., 222 Hartrey Ave., Evanston, IL 60204.

SOUND EQUIPMENT CATALOG

Argos Sound has a new 12-page, three-color catalog with photos and descriptions of its complete line of sound systems and components. Included are a large selection of sound columns, portable sound systems, baffle/speakers, wall baffles, and CB base and mobile speakers. The list of specifications includes weights and measures in the standard and metric systems. Each product is described according to its acoustical application to specific market areas. Address: Argos Sound, 600 S. Sycamore, Genoa, IL 60135.

1802 MICROPROCESSOR USER MANUAL

"User Manual for the RCA CD1802 COSMAC Microprocessor" (No. MPM-201A) is for those with a limited familiarity with computers and programming. It guides the reader through microprocessor architecture and introduces a set of comprehensive, easy-to-use programming instructions. The manual is a detailed guide to the application of the COSMAC CDP1802 microprocessor. Examples illustrate the operation and use of each of the 91 instructions. The manual illustrates methods of adding external memory and control circuits and shows the use of I/O instructions and interface lines, including DMA, interrupts, flags, commands, processor state indicators, and external timing pulses. Price is \$5.00. Address: RCA Solid State Div., Box 3200, Somerville, NJ 08876.

CALCULATOR DIGEST

"The Hewlett-Packard Personal Calculator Digest" (32 pages) is written in magazine style and describes the operation and design of hand-held and printing calculators. Subjects include thermal printing, testing, servicing, CMOS, PMOS and NMOS circuits and RPN language. A catalog section provides specification information on each of Hewlett-Packard's calculators, and charts illustrate the uses of each model. Letters to the editor and a question and answer section are also included. Address: Inquiries Manager, Hewlett-Packard Company, 1000 N.E. Circle Blvd., Corvallis, OR 97330.

LOUDSPEAKER CATALOG

"AR Guide to Loudspeakers" is a new, 36-page, full-color catalog, describing Acoustic Research's Advanced Development Division line of speaker systems. It gives detailed information concerning speaker efficiency and placement and amplifier power requirements. The design, production and testing of speakers is explained and a section on the philosophy of music reproduction is included. Price, \$1.00. Address: Acoustic Research, 10 American Dr., Norwood, MA 02062 or free from AR products dealers. A dealer list will be sent on request.

MAGAZINES AT DISCOUNT!

You SAVE up to 50%

Here's your chance for a real bargain bonanza on your favorite magazines. Select as many as five of these titles at the low introductory rates shown below—up to 50% off. Use attached card to order or write to: MAGAZINES AT DISCOUNT, A Division of Ziff-Davis Publishing Co., P.O. Box 2703, Boulder, Colorado 80322.



- BOATING (01)** You pay only \$6.00
Reg. Rate: 12 Issues for \$10.00
- CAR & DRIVER (02)** You pay only \$3.99
Reg. Rate: 12 Issues for \$7.98
- CYCLE (03)** You pay only \$3.99
Reg. Rate: 12 Issues for \$7.98
- FLYING (04)** You pay only \$6.99
Reg. Rate: 12 Issues for \$11.98
- HANDY ANDY (57)** You pay only \$5.88
Reg. Rate: 10 Issues for \$7.95
- MONEY (29)** You pay only \$9.95
Newsstand Rate: 10 Issues for \$12.50
- NEWSWEEK (44)** You pay only \$12.50
Newsstand Rate: 25 Issues for \$25.00
- PLAYBOY (34)** You pay only \$12.00
Newsstand Rate: 12 Issues for \$19.00
- POPULAR ELECTRONICS (06)** You pay only \$6.99
Reg. Rate: 12 Issues for \$9.98
- POPULAR PHOTOGRAPHY (07)** You pay only \$4.99
Reg. Rate: 12 Issues for \$9.98
- POPULAR SCIENCE (35)** You pay only \$4.50
Newsstand Rate: 12 Issues for \$9.00
- PSYCHOLOGY TODAY (08)** You pay only \$7.00
Reg. Rate: 12 Issues for \$12.00
- SPORTS ILLUSTRATED (38)**
You pay only \$9.75 for 25 Issues
Newsstand Rate: 25 Issues for \$25.00
Basic annual rate: 52 Issues for \$20.00
- STEREO REVIEW (11)** You pay only \$3.99
Reg. Rate: 12 Issues for \$7.98
- TIME (40)** You pay only \$12.50
Newsstand Rate: 25 Issues for \$25.00
- TV GUIDE (41)** You pay only \$6.35
Lowest Available Sub. Rate for 32 Issues



Stereo Scene

BY RALPH HODGES

THE HOUSE THAT HI-FI BUILT

“**L**ive music is the only standard,” we are told. “Your audio system may sound impressive, but does it sound like the real thing?” “Go to a concert before you pick out your speaker systems.” And occasionally, when our judgment in matters of sonic accuracy is being called into question: “When was the last time you listened to live music?”

Well, the definition of high fidelity implies faithfulness to something; isn't live music a perfectly natural and appropriate something? Surely. But as one who hears live music several times a week at the very least, I have a particular problem with this proposition: I can't for the life of me figure out what *live* music sounds like.

It may seem like an heretical statement, but I would hardly call a season ticket to Boston's Symphony Hall (or any other auditorium) an adequate acquaintance with the sound of live music. As proud Bostonians must be aware, the experience of hearing music in Symphony Hall is unique, and usually very rewarding. The same music heard elsewhere sounds different. In fact, of the various recordings I have that were made in this hall, there is none that does more than stir the vaguest recollections of the live experience. Perhaps this is because the recording team didn't trouble to cluster the microphones around my usual seat. (Indeed, if former practice still prevails, my usual seat is actually ripped out of the hall for recording sessions, and part of the orchestra put in its place.) But whatever the reason, the fact

remains that music in Symphony Hall does not sound very much like music in, say, New York's Carnegie Hall.

Avery Fisher Hall. Certainly music in Boston's Symphony Hall sounds different than it did in New York's old Philharmonic Hall—so different that New York concert-goers were up in arms about it for years. If you've read a newspaper since 1974, you probably know that that unfortunate situation has largely been rectified. A little over two years ago the retiring Avery Fisher, founder of Fisher Radio (which once advertised high-fidelity systems as the means to acquaint your children with the live music they might otherwise never hear), settled a handsome sum on the Lincoln Center corporation, which used the funds to totally rebuild the auditorium (duly renamed Avery Fisher Hall) from the inside out. It was truly the house that hi-fi (or hi-fi money, anyway) built. First critical reaction to the new structure was generally approving, which strongly whetted the appetites of myself and other likeminded souls to hear this wonder. However, I decided to put off my initial visit for several months to allow the orchestra time to accommodate itself to the new environment. When I did make my move, just a few days ago, it was with the most helpful cooperation of the N. Y. Philharmonic press office, which got me admitted to the morning rehearsal for a large-scale concert, and to the first performance that evening. The program (Saint-Saens' Third Symphony

and Shostakovich's Fourteenth) probably could not have been improved upon for my purposes, involving as it did the full Romantic symphony orchestra, organ (electric organ; the hall's pipe instrument went with the renovation), piano, solo voices, and the full dynamic range of which all these instruments are capable. Leonard Bernstein conducted.

Different Seat, Different Sound.

When I walked into the rehearsal, I learned that only the three upper tiers in the back of the hall were available for seating. The orchestra floor was verboten, and the side boxes were still being worked on. From the approximate front center of the first (lowest) tier, the sound of the orchestra tuning up was encouraging. Everything seemed to project, particularly the low strings, which were elusive in the old hall. But then as Bernstein, with his left side to our small audience of freeloaders, conferred for several minutes with the organist, I noted that the sibilance in his voice was all but inaudible, although the body of the speech was there.

This impression—a lack of brilliance—persisted as the music began. The low strings remained robust, but the violin choruses seemed muffled, diffuse, and somewhat wavery and unsteady in their texture. It was a most familiar effect; I have heard it and cursed it on many now-discarded “high-fidelity” systems. Was I too hasty in blaming the equipment?

Another problem: the sound was weak. On the vigorous tutti in the early minutes of the Saint-Saens my little sound-level meter (which was creating a minor sensation amongst my neighbors) showed a maximum of 94 dB (unweighted). Average level was perhaps 88 dB, which I think is too soft, especially with the hall largely unoccupied by a sound-absorbing audience. Astonishingly, the brass parts could scarcely be distinguished from the overall texture, the sound was so lacking in edge and “bite.”

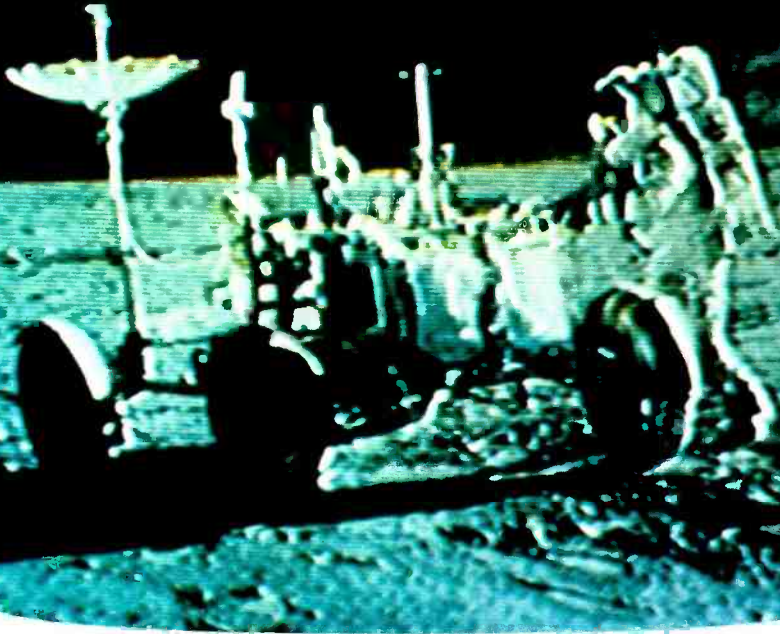
Curious about the effect of the overhanging tier on reflections from the ceiling, I then moved to the left rear corner of the first tier. The sound underwent a remarkable transformation. I'm not sure I can explain it, but I can describe it perfectly: it was the sound of a dirty stylus, without question. And mind you, this is live music!

The Second Tier. Up one story, and again front and center, there was an appreciable improvement. Now some sibilance was detectable in Bernstein's



New York's new Avery Fisher Hall.

Americans have been using Motorola 2-way radios to find campsites for years.



It's a fact that the people who first put radio on wheels also made the first radio on wheels on the moon.

But it's not surprising.

Because Motorola® makes more radios for police, firemen, taxis, and lunar rovers than anybody.

And now Motorola makes a 40-Channel CB radio that shares much more than a name with our professional 2-way radios.

The clean, uncluttered lines of the Motorola CB, for instance.

Features that many manufacturers leave on the outside of their sets (or don't offer at all) are built into a Motorola CB.

Gain control, noise limiting, audio compression, even a TV interference filter are built-in, fully automatic circuits that actually make communication better.

And operation easier.

A digital phase lock loop

synthesizer provides precise tuning (automatically, of course).

A professional-quality 3½-inch top-fire speaker gives the Motorola CB an audio quality that must be heard to be fully appreciated.

And every Motorola CB gives you the added advantage of a power mic that doesn't need batteries. That doesn't cost 50 bucks extra.

The Motorola 40-Channel CB radio.

We believe it's the most sensibly engineered CB radio on the market. We believe it will deliver years of service at a level of performance few could match.

Put a Motorola CB radio under your dash and you'll believe, too.



Motorola CB

From the voice of experience in 2-way radio.

To find the dealer nearest you, write: Customer Relations Manager, Motorola, Inc., Automotive Products Division, 333 Northwest Ave., Northlake, Illinois 60164.



voice, even with his back turned. The violins began to coalesce more, and the quality of their attack was more apparent. Brass was still a disappointment, however, sounding woolly and indistinct.

It was here that I measured the hyperactive finale of the Saint-Saens, which got up to 98 dB (96 dB without the bass drum, which didn't sound like much, but which certainly rocked the meter). This is not enough, particularly if the sound is not radiantly alive to begin with. But feeling I was on the track of something, I made my solitary way up to the cheap seats in . . .

The Third Tier. I was really not prepared for what I heard. The orchestra by now was well into the Shostakovich, and the cellos and basses were executing a quiet passage in pizzicato and short, light bowing as I sat down. A fat, rich, glorious "Thrummm" resounded throughout the hall below. When the high strings entered they rushed into focus, bright, full-bodied, precise in attack,

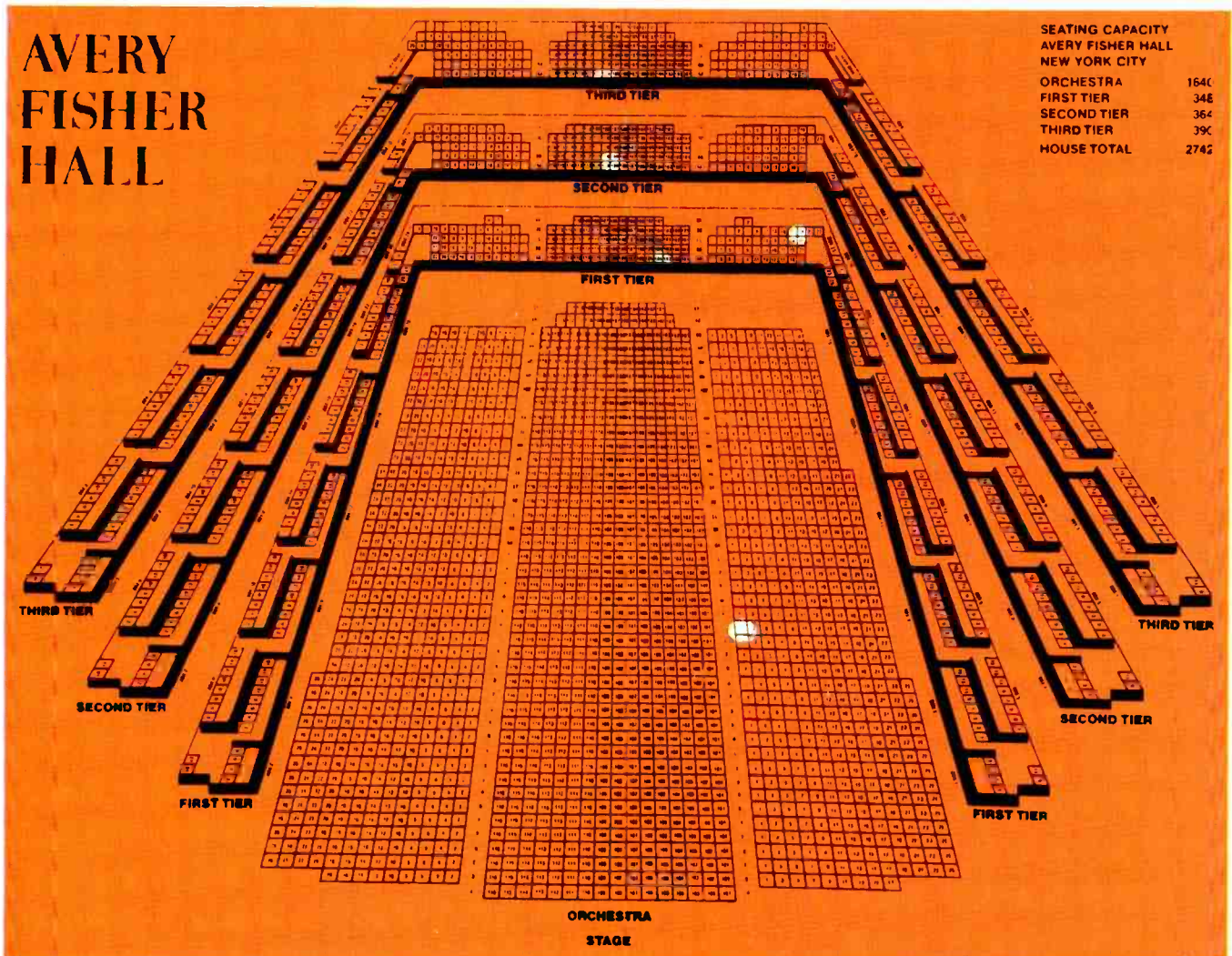
and sometimes even a little steely, although never harsh. The soprano voice, which before had struggled to emerge above the orchestra (incidentally, the soprano and bass were on risers behind the string orchestra, presumably to benefit from the horn-like flare of the stage enclosure), had power that seemed to saturate the stage area and swell irresistibly out. And the important xylophone part had a quality—a stinging, violent snap—that I would have sworn could be captured only by closely spaced microphones, as in the recording I had listened to the night before.

As you can tell, I loved it all. The sound had precisely those characteristics—power, clarity, brilliance, attack—that I look for in a reproducing system and in a recording. Paradoxically, these effects were available (in the seats open to me) only in the part of the hall most remote from the stage. But the explanation, I think, is simple. The third tier also offers the seats closest to the ceiling, which is probably the major sound-

reflecting structure in the hall. This proximity means that a host of reflections arrive almost immediately to reinforce the direct sound reaching you. I only wish the brass had been present (they retired after the Saint-Saens) to cap the whole thing. I made no measurements in the third tier just because the orchestra was so diminished in size and power.

The Performance. The seats we were assigned for the evening performance were to the left of the orchestra section, row U—significantly remote from my listening sites of the morning, which was too bad. Throughout the day I had wondered whether the acoustic absorption of an audience might diminish the prominent mid-range and upper bass, exposing the brilliance I wanted to hear. I have the impression that it helped, but I lacked a standard of comparison and couldn't judge reliably.

In row U-left, it was possible to sense the contributions of both the direct sound from the orchestra and the reflec-



During rehearsal, the author sat in the first tier, row AA, seat 104 (shown by circle in color overlay); then first tier, DD-19; second tier, BB-109; third tier, AA-110. For the performance, orchestra, U-1.

tions from the hall for many instruments. For other instruments (the violins, for example) reflected sound dominated; the string basses, hard by the stage's right reflecting wall, provided almost all direct sound and early reflections, which made them sound very taut, damped, and strangely woody.

Being much closer to the orchestra helped enormously in terms of loudness, and the climaxes were quite satisfying. However, the violins, although clear, were oddly disembodied and somewhat dim, giving a slight cotton-in-the-ears feeling that either they weren't completely there, or you weren't. Woodwind detail was good, with credible timbre, but the brass, quite audible at last, still lacked that characteristic "buzzy" edge of excitement. The brass also seemed late and unsure in its attacks—apparently a result of the time necessary for the sound to build up in the hall. The pedal notes from the organ (extreme stage left, with speakers aiming roughly into the stage enclosure) were not as prominent as they had been in the tiers. And the soprano voice was again struggling to rise above the orchestra.

Having said all this, I'll add that the overall performance, executed as well as I could ever hope to hear for both pieces, was tremendously dramatic, arresting, and satisfying. It did not, however, sound very much like my idea of live music!

Semi-live. At one time or another, I think I have heard—at live performances in real concert halls and elsewhere—virtually all the faults I've ever heard in sub-par high-fidelity systems. The catalogue includes harsh, strident violins, boomy bass, overall fuzziness or raspiness, poor transient response, bad stereo, honkiness, nasality, and even ripping and rattling noises suggestive of cartridge mistracking (usually coming from the bowed strings). When you consider the usual causes for these "distortions" in real and reproduced music, you'll see that they are often somewhat analogous, so I guess it's not too surprising that they sound much the same.

Still, live music does have a definable sound: the sound of the instruments without any interfering acoustic. For lack of a better substitute, this is what I gen-

erally use. The accomplished street violinist who prowls Manhattan's Fifth Avenue is my reference for string sound. Brass I get from several talented quintets who set up at the entrance to New York City's Central Park Zoo in the summers. Woodwinds—flutes, oboes, clarinets, and even bassoons and bass clarinets—abound throughout the city, as do jazz "combos" with abilities and instruments of widely varying quality. There is even a touring bagpipe, for those so inclined.

This is open-air music, without any enveloping acoustic. When you have a good sense of the instrument itself, I believe you're better prepared to make allowances for its sound in different settings, concert halls and listening rooms included. But as for the usual sound of "live" music, it has a variety of sounds; a good reproducing system will reveal this variety, rather than some hypothetical sameness.

P.S. Should the above remarks seem to reflect unfavorably on Fisher Hall, I take them all back. It, too, in its way is an instrument, and a rather sophisticated one. But avoid those rear corners. ◇



(Photos by Susanne Faulkner Stevens.)

View from the stage of the 2742-seat auditorium in the newly reconstructed Avery Fisher Hall at Lincoln Center for the Performing Arts, New York. Seating plan opposite.



Audio Reports

MEASURING AND INTERPRETING TURNTABLE RUMBLE

ONE OF the key specifications of a phonograph turntable is its *rumble* level. Rumble is the audible result of mechanical vibration that causes the pickup cartridge to move relative to the record, or vice versa. This produces an electrical output signal that cannot be distinguished from the recorded program, at a very low audio or sub-audible frequency. As the name suggests, the sound often resembles a low-pitched hum. The vibration comes principally from the motor, although other rotating parts (such as an idler wheel) can also contribute.

In general, rumble covers a broad spectrum of frequencies, with some emphasis on certain discrete frequencies. For example, a conventional four-pole motor, operating from a 60-Hz power line, revolves at about 1800 rpm, or 30 revolutions per second. A slight unbalance or eccentricity in the rotor or its shaft will cause the motor to vibrate at 30 Hz. If the vibration is allowed to reach the platter or the pickup arm, it will generate a 30-Hz signal in the cartridge outputs. Usually this is accompanied by higher frequency components, generally at harmonics of the basic revolution frequency (in this case, 60 Hz, 90 Hz, etc.). The idler wheel turns more slowly than the motor, but is more likely to be eccentric and thus contributes a number of rumble vibration frequencies, beginning at a few hertz and overlapping the range of frequencies contributed by the motor. Finally, the platter itself, turning at $33\frac{1}{3}$ rpm, has a basic rumble frequency of about 0.5 Hz, with harmonics extending into the idler-wheel range.

The result is a broad band of nearly random vibration, covering the frequency range from 0.5 Hz to perhaps 100 Hz or higher, with certain frequencies being emphasized. A major source of this emphasis is the resonance of the tonearm mass with the stylus compliance, which usually lies between 5 and 10 Hz. At this frequency, the rumble output is often boosted by 5 to 10 dB. Belt-drive turntables, of course, do not have the rumble of an idler wheel to contend with, and the flexible belt filters out some of the motor vibration before it can reach the platter. Their rumble content thus tends to be concentrated at the motor frequency and its harmonics, and is often at a lower level than the total rumble of an idler-driven turntable (although there are numerous exceptions).

In recent years, direct-drive turntables have become quite popular. Since only one revolving element is involved (the platter and motor rotor, acting

as a unit), one would expect its rumble to be limited to the basic 0.5-Hz rate, with some harmonics of that frequency. However, direct-drive motors have a number of discrete poles, causing their driving torque to pulsate slightly at a frequency much higher than the basic revolution rate. Depending on their design, they may have low-level rumble components at frequencies of 10, 20, or even 40 Hz.

Rumble is measured by playing a "silent groove" record and measuring the cartridge output voltage, through a preamplifier having standard RIAA equalization. The reference level is usually the cartridge output from a lateral (mono) recording at a velocity of 5 cm/s at 1000 Hz, although some measurement standards are based on 7 or 10 cm/s reference velocities, giving an *apparent* rumble improvement of 3 or 6 dB, respectively (rumble is expressed in decibels below the reference level).

Because of the greatly reduced sensitivity of the human ear at low frequencies, the audibility of rumble is very much a function of its frequency distribution. A -30-dB rumble at 60 or 90 Hz, for example, would be disturbing under almost any listening condition, whereas the same level at 30 Hz might not be audible, and at 10 Hz it certainly could not be heard. To account for this phenomenon, it is usual to *weight* a rumble measurement by placing a high-pass filter between the preamplifier output and the indicating meter.

Several different weighting curves are in use throughout the world. The DIN "B" characteristic is widely used in Europe and Japan, while in this country the CBS Audible Rumble Loudness Level (ARLL) weighting is often employed (we use ARLL weighting in our turntable tests). The same turntable, measured with different weighting curves, will appear to have very different rumble ratings, and it is not possible to convert a reading from one system to another. In general, the DIN "B" curve will give a lower apparent rumble reading than the ARLL curve, and will be 20 to 30 dB lower than an unweighted measurement. Either system, as well as several others that have been proposed and are in use, can be justified empirically by listening tests. Fortunately for the consumer, it is not the absolute numerical value of rumble that is important; so long as the same system is used, comparisons can be made between turntables without serious loss of accuracy.

Unweighted rumble readings (or the DIN "A" mea-

40-CHANNEL MOBILE CB AT RADIO SHACK® RIGHT NOW!



**But that's not the only reason
for buying the Realistic® 452
at the nationwide CB supermarket.**

Count on Radio Shack to be right on top of 40-channel CB, with the kind of full-featured values you've come to expect from our Realistic brand. The new TRC-452 gives you effective mobile communications over all 40 channels — the original 23 and the new 17. No crystals to buy — it has a frequency synthesizer with phase-locked loop circuitry. That means ultra-precise frequency control on receive and transmit and dependable service even under rugged on-the-road conditions. For 16 years

*Price may vary at individual stores and dealers.

Realistic CB's have been designed to meet challenging conditions, and the TRC-452 is no exception. Adjustable RF gain for best reception of strong and weak signals. Switchable automatic noise limiter and adjustable squelch. Illuminated S/RF meter and channel selector. LED modulation indicator. With plug-in dynamic mike, universal mounting bracket, power cable for any 12 VDC positive or negative ground vehicle. Only \$139.95*. So when you go 40-channel — go Realistic!

SOLD ONLY WHERE YOU SEE THIS SIGN:



JUST SAY
"CHARGE IT!"
AT MOST STORES

Radio Shack®

A TANDY CORPORATION COMPANY • FORT WORTH, TEXAS 75107

Radio Shack operates as Tandy International Electronics in Australia, England, Belgium, Holland, Germany, France, and as Tandy Radio Shack in Japan.

surement, which is very similar) also provide useful information. Rumble at sub-audible frequencies may not be heard directly, but can seriously degrade sound quality if it is strong enough. If the amplifier has extended low-bass response (down to a few Hz or to dc) these rumble frequencies can overload the amplifier or move the speaker cones beyond their linear range. The result is a muddying of the sound, caused by intermodulation distortion. This effect can be seen easily by removing the speaker grille cloth and observing the woofer cone while playing a record at a fairly high volume. The sub-sonic "bobbling" of the cone is a clear indication of rumble, even if it cannot be heard. Do not confuse this with the 0.5-Hz in-and-out motion of the cone caused by record eccentricity or warping. Although this can produce the same effect, it is not the fault of the turntable.

It is difficult to state categorically how much rumble is "acceptable." This is a function of room and speaker characteristics, listening volume, and personal opinion. In general, a turntable with an unweighted rumble level of -30 dB or better, and a weighted rumble level below -50 dB, will not contribute significant audible rumble to the program (many records have inherent low-frequency noise that will mask turntable rumble below these levels). If your records are good, and the speakers have a useful response down to 30 or 40 Hz, it might be advisable to look for a turntable with an unweighted rumble of -35 dB or less, and a weighted rumble (ARLL) of -50 to -60 dB, which is typical of some of the better belt-drive players and most direct-drive turntables. Still lower rumble levels can be had, at a price, but do not expect to hear the difference.

About This Month's Reports.

In contrast to recent trends toward technical sophistication in record players, Empire's new Model 698 might be considered as a modern classic. Its only concession to such competitive pressures is an electronically actuated cueing system, which also lifts the arm at the end of a record. Otherwise, it is based on the proven, reliable belt-drive system that has been used in previous Empire players with eminent success. A heavy, finely machined platter, driven by a carefully balanced synchronous motor, results in rumble and flutter levels comparable to, and in some cases lower than, those achieved by much more elaborate means. As always, simplicity is a virtue, and nothing could be more simple and direct than the Empire approach. The major improvement in the 698, compared to previous Empire models, is the drastically reduced arm mass which makes it compatible with today's high compliance cartridges.

Not everyone needs, or can afford, one of the "super power" stereo receivers offered by several manufacturers. The Sherwood S-7910 has most of the operating features, to say nothing of advanced performance, of much more costly products. Its conservative 60 watts per channel is more than sufficient for the majority of home listening requirements. Its FM tuner section is especially noteworthy. Among other assets, it has the greatest stereo channel separation we have yet measured on a tuner or receiver, and a tuning indicator light that glows brightly when the tuner is accurately centered on the station frequency (there are two meters, as well, for those who prefer to use them, but the light is faster and easier to use and at least as effective).



EMPIRE MODEL 698 RECORD PLAYER

Aesthetically pleasing, precisely constructed manual turntable.



Empire Scientific has long been known for its distinctively styled manual record players. The latest version, the Model 698, looks very much like its predecessors, but it has been given a new low-mass tonearm and an electronically con-

trolled cueing lift system. The player's turntable is basically unchanged from earlier models. It employs a heavy-duty hysteresis synchronous motor and belt-drive system that offers the user a choice of 33 $\frac{1}{3}$ and 45 rpm speeds.

All visible metal parts of the record player, including the motorboard, platter, and tonearm, are handsomely finished in satin gold. This is complemented by a wooden walnut base and a walnut and clear-plastic hinged dust cover that remains open at any angle. The record player measures 17 $\frac{1}{2}$ " W \times 15 $\frac{1}{8}$ " D \times 83/16" H (44.5 \times 38.4 \times 20.8 cm) and weighs slightly less than 30 lb (13.5 kg). The market value of the player, less cartridge, is \$400.

General Description. The turntable platter features two-piece construction. Its massive central disc is almost 3" (7.6 cm) thick and is coupled to the motor by a precision-ground belt. A larger-diameter ring-like platter that contains the

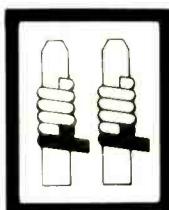
ribbed record mat fits over the central disc. This ring also contains the stroboscope markings. The total weight of the platter system is more than 7 lb (3.2 kg). Although the operating speeds are basically fixed (changed by removing a cover retained by a thumbscrew and manually shifting the belt to a different pulley on the motor shaft), a small change in speed is possible by slight adjustment of a screw that tilts the motor's axis.

The tonearm measures 9" (22.9 cm) from pivot to stylus. It has a newly designed cartridge shell that is easily detached for cartridge installation. The mass of the shell is claimed to be comparable to the mass of fixed shells, accomplished through extensive slotting to remove material. The design of the shell permits adjustment of the cartridge's position for correct overhang. The counterweight, which slides on the rear of the tonearm's tube for balancing, is decoupled by an elastic bushing to damp out the low-frequency resonance.



WIRE WRAPPING TOOL

For AWG 30, .025" (0,63mm) sq. post,
"MODIFIED" wrap, positive indexing,
anti-overwrapping device



OK MACHINE & TOOL CORPORATION

3455 Conner St., Bronx, N.Y. 10475 / (212) 994-6600 / Telex 125091

NEW

**HOBBY-WRAP
Model BW-630**



**Battery
wire
wrapping
tool**

\$34⁹⁵
ONLY (batteries not included)
**COMPLETE WITH BIT
AND SLEEVE**

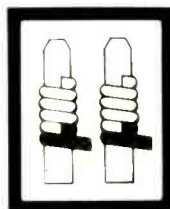
NEW

**HOBBY-WRAP
Model BW-630**



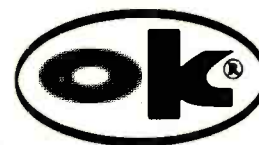
**Battery
wire
wrapping
tool**

\$34⁹⁵
ONLY (batteries not included)
**COMPLETE WITH BIT
AND SLEEVE**



WIRE WRAPPING TOOL

For AWG 30, .025" (0,63mm) sq. post,
"MODIFIED" wrap, positive indexing,
anti-overwrapping device.



OK MACHINE & TOOL CORPORATION

3455 Conner St., Bronx, N.Y. 10475 / (212) 994-6600 / Telex 125091

The vertical tracking force is applied to the balanced tonearm by a calibrated clock spring that is wound around the vertical pivot. It is adjusted by a knurled wheel on the pivot structure. Calibrations are from 0 to 4 grams at 0.5-gram intervals. A dial on top of the pivot housing is for adjusting the antiskating force.

The cueing mechanism is operated by a damped dc solenoid whose motion is initiated by a mere touch of the finger on one of two pairs of closely spaced contacts on the motorboard. No pressure is necessary; the bridging of a pair of contacts by the finger triggers electronic circuits that energize the cueing mechanism. A red light behind each pair of contacts indicates the status of the arm-lifting mechanism, either up or down. At the end of play, a beam of light shining on the photocell under the motorboard is interrupted by a vane that moves with the tonearm. This causes the tonearm to automatically raise from the record's surface. It does not return to its rest post. The arm must be returned and the motor must be shut off manually. A rocker switch controls all power to the record player.

As with earlier Empire record players, the tonearm and turntable of the Model 698 are rigidly mounted to a Y-shaped ribbed casting and the entire system is resiliently floated from the motorboard. This isolates the tonearm and turntable from motor vibration as well as from external shock and vibration. The motor is, in turn, suspended on rubber bushings from the motorboard. A socket under the tonearm receives one of the two plug-in signal cables supplied with the record player. For stereo operation, the longer 5' (1.5-m) cable is used. This cable has a nominal capacitance to ground of 180 pF/channel, which, combined with the input capacitance of a typical preamplifier, will load the phono cartridge with approximately 250 pF of capacitance. If a CD-4 cartridge is used, the 4' (1.2-m) cable, whose nominal capacitance is 70 pF for a recommended 100-pF maximum capacitance for CD-4 cartridges, is used.

Laboratory Measurements. We tested the record player with Empire's top-of-the-line Model 2000Z phono cartridge installed in the tonearm shell. After we balanced the tonearm in the horizontal plane according to instructions, the actual vertical force was about 15% less than the dial indication. We then adjusted the counterweight to correct the error, which yielded exact agreement with the calibrations over the full range

of the dial. We noted, however, that at the zero setting, the pickup stylus rested in the plane of the record, well below the horizontal.

We adjusted the overhang by aligning the stylus with the end of the cartridge shell as detailed in the instructions. This is an uncertain procedure because of the considerable distance between the stylus and the reference line, which almost inevitably leads to parallax error. However, when we made the adjustment carefully, the tracking error was extremely low, measuring zero at 3" and 5" radii and less than 0.4°/in. between 2.5" and 6". The antiskating force had to be set slightly higher than indicated by the tracking force setting, to 2 grams at a 1-gram tracking force, for equal tracking effectiveness on both channels of a 30-cm/s, 1000-Hz test record. Since less compensation will be required at lower velocities, we consider the antiskating calibration to be sufficiently accurate for its purpose.

The lift and descent of the cueing mechanism were both slow and well damped, with little tendency for the pickup to drift outward during descent. About three seconds were required for the tonearm to lift or descend completely once movement began. However, there was an appreciable delay between the time the contacts were touched and the time the tonearm began to move.

The measured capacitance of the two signal cables, including the wiring in the tonearm, was 175 and 85 pF. Because of the action of the elastically mounted counterweight, the resonance of the tonearm with the Model 2000Z cartridge installed exhibited two small peaks. One was at 5.5 Hz and the larger, at 8 Hz, had an amplitude of about 6 dB.

The operating speeds were exact and did not detectably vary with line changes from 95 to 135 volts. The combined unweighted rms wow and flutter was 0.04%. The weighted rms flutter of 0.03% was about as low as we have ever measured and is quite possibly at the residual level of the test records we used. The unweighted lateral rumble was -36 dB, which improved to -57 dB with ARL weighting.

When we vibrated the entire record player through its mounting feet (which are rigidly attached to the wooden base), it displayed average isolation of the pickup system from external vibration.

User Comment. In contrast to the almost "ready-to-play" condition of some record players as they are unpacked,

the Empire Model 698 must be largely assembled by the user. In particular, the tonearm must be mounted and carefully adjusted for height and horizontal orientation (in order for the automatic end-of-play arm lift to operate correctly). This is not difficult, especially since the instructions are complete and clearly written, but it is no job for a neophyte, either. As we have noted, the tonearm should be balanced somewhat below the horizontal with cartridge overhang adjusted with the greatest care to avoid parallax errors.

We found the visibility of the tracking force dial calibrations to be rather poor because of their location on the rear "inside" portion of the pivot support, but this is only a one-time per cartridge adjustment. If you are accustomed to "splitting grams" in setting up a cartridge, the 0.5-gram calibration intervals may seem wide. Fortunately, few cartridges must be set up closer than 0.25 grams from an optimum force, which can be easily interpolated from the dial scale.

When it is properly set up, the Model 698 is one of the most aesthetically pleasing, precisely constructed record players obtainable. Records must be played manually, since the mechanism does nothing automatically except to raise and lower the tonearm (and the long wait for the arm cueing system to go into action tends to discourage its use). As far as "specifications" are concerned, the record player clearly excels in its low flutter. If lower flutter figures are possible, we doubt they could be measured with commercially available test records.

Our measurements show rumble to be about as good as any belt-driven turntable we have seen and nearly equal to the better direct-drive units. The ARL weighted figure of -57 dB represents essentially inaudible rumble, which will be masked by the rumble and low-frequency noise inherent in most records.

A spectrum analysis of the rumble output shows a major component at about 8 Hz (tonearm resonance) and a single, almost discrete component at about 30 Hz (motor revolution frequency). Note that the RIAA equalization which we use, and which is part of the ARL weighting, boosts the 30-Hz level by about 18 dB.

Should the record player be located in an area that causes excessive physical vibration from, say, poor flooring, to reach the system, we recommend installing acoustic isolation mounts. These are available from Audio-Technica

(AT-605 Audio Insulator) and Netronics ("Acoustic-Mount").

In sum, the Empire Model 698 is a beautifully constructed and finished

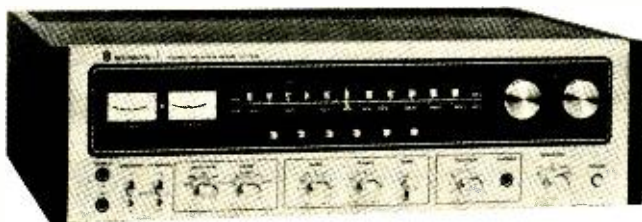
product, one of the few remaining truly manual record players. It should be able to extract the fullest measure of performance from any cartridge and record. It

is certain, too, that no one will wish to hide it from view since it is one audio product that looks as good as it sounds.

CIRCLE NO. 80 ON FREE INFORMATION CARD

SHERWOOD MODEL S-7910 STEREO RECEIVER

Top performer in upper-medium price class.



The full-featured Model S-7910 is just one notch removed from the top of the Sherwood line of stereo receivers. It is rated to deliver at least 60 watts/channel into 8-ohm loads between 20 and 20,000 Hz with less than 0.1% total harmonic distortion (THD).

This receiver has several interesting features. Its 4 CH ADAPTER facility duplicates the functions of a tape-monitoring circuit, which makes it possible to connect a total of three tape decks into the system. This adapter circuit is isolated to prevent interaction with the two main tape circuits. Located before the VOLUME, BALANCE, and tone controls, this facility appears to be an ideal place to connect a Dolby decoder for FM reception, although the user manual makes no mention of this. The FM tuner has linear-phase ceramic i-f filters, PLL (phase-locked-loop) multiplex demodulator, and a Sherwood-developed "digital detector" that never requires alignment and is inherently highly linear and immune to amplitude-modulated signals and noise. The digital detector appears to be a pulse counter detector, judging from the limited information supplied. The three-stage phono preamplifier employs a differential amplifier as its input stage.

The receiver measures 24½"W × 15 5/8"D × 5 7/8"H (54 × 40 × 15 cm) and weighs 34 lb (15.5 kg). Supplied with a walnut-veneered cabinet, it is available in AM/stereo FM and FM-only versions as the Models S-7910 and S-8910 for \$500 and \$475, respectively.

General Description. The receiver is handsomely styled, with the upper half of the front panel devoted to the dial scales, tuning meters, and the large

VOLUME and TUNING knobs. Just below the dial scales are six small pushbutton switches that can be used to change the FM deemphasis from 75 to 25 μs for use with an external Dolby noise-reduction system, engage and disengage the FM muting, allow the receiver to respond to only stereo FM broadcasts, insert an external 4-channel adapter into the signal path, and switch in and out the loudness-compensation circuit.

Illuminated legends appear above the blue dial scales in red to indicate the selected input and when a stereo FM broadcast is being received. Between the signal-strength and FM center-channel meters is a red LED (Sherwood's "Positune" feature) that glows when an FM signal is properly tuned.

The control panel is finished in satin gold, and related groups of controls are enclosed with thin black lines. The SELECTOR switch has positions for PHONO 1, PHONO 2, FM, AM, and AUX inputs. The MODE switch permits selection of either the left or the right channel inputs through both outputs, normal and reversed stereo, and mono (L + R) operation.

The BASS and TREBLE controls are both detented at 11 positions. A lever switch is provided for bypassing the tone controls entirely. To the right of the tone controls are the BALANCE control and a stereo headphone jack. At the far right of the control panel is the SPEAKERS switching arrangement, which activates either, both, or neither of two pairs of speaker outputs. If the second pair of speaker systems is located in the rear of the listening room, the ARS (Ambience Retrieval System) position of the SPEAKERS switch connects them in an ambience-recovery configuration to simulate 4-channel sound from 2-channel sources. The pushbutton POWER switch is located near the SPEAKERS switch.

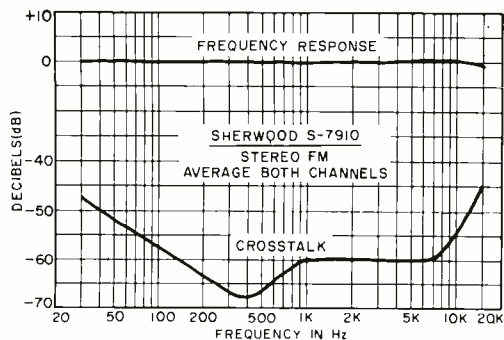
At the lower left of the panel are the tape-monitoring and tape-recording controls. The MONITOR lever switch can be used to connect the receiver's amplifiers to the playback from either of two tape decks or to the selected program source. A similar DUBBING switch interconnects the two tape decks for copying tapes from either one to the other—without interrupting listening to the selected program. Two stereo phone jacks on the front panel parallel the TAPE 2 inputs and outputs on the rear apron for convenience in taping with a recorder that is not permanently connected into the system.

On the rear apron, the various input and output jacks are supplemented by separate PRE OUT and MAIN IN jacks that are connected together in normal operation with a slide switch. Setting the switch to its alternate position opens the signal path for separate access to the outputs of the preamplifier and inputs of the main-amplifier sections so that an active crossover network or other accessory can be inserted into the system. A DIN socket duplicates the functions of the TAPE 2 circuits.

A slide switch near the PHONO 2 jacks provides a choice of three sensitivities to accommodate phono cartridges that have widely differing output signal levels. (The PHONO 1 sensitivity is the same as the highest sensitivity of the PHONO 2 input.) Spring-loaded speaker terminals eliminate the possibility of shorted wires because they require insertion of the stripped wire into small holes in the connector. In addition to the 75- and 300-ohm FM antenna terminals and a terminal for a wire-type AM antenna, there is a hinged and pivoted AM ferrite-rod antenna. There are three accessory ac outlets, two of which are switched.

The output transistors of the amplifier section and the speakers are protected against damage by a fast-acting relay that also provides a turn-on time delay of several seconds. The transistors and their heat sinks are located entirely within the receiver, just inside the rear apron.

Laboratory Measurements. Following the usual one-hour precondition-



Frequency response and crosstalk averaged for both channels in stereo FM.

ing period at one-third rated power, the receiver's rear apron was quite warm, but its top was only mildly warm. The outputs clipped at 74.4 watts/channel into 8 ohms, with both channels driven at 1000 Hz. The 4- and 16-ohm outputs were 97 and 46.6 watts, respectively.

The total harmonic distortion (THD) of the audio amplifiers was very low. It was a barely measurable 0.005% at 0.1 watt and less than 0.01% up to 17 watts output. It was only 0.022% at the rated 60 watts and 0.13% at the clipping output of approximately 75 watts. The intermodulation distortion (IM) was between 0.022% and 0.033% from 0.1 to 20 watts, 0.067% at the rated 60 watts, and 0.1% at 75 watts. At rated output, the THD was between 0.02% and 0.03% from 20 to 7000 Hz. It increased to 0.071% at 20,000 Hz. At lower power outputs, the THD was less at all frequencies, being typically about 0.01% at usable frequencies and power levels.

The amplifier required an AUX input of 66 mV to develop a reference output of 10 watts, with a S/N ratio of 75.5 dB. The PHONO 2 sensitivity was 0.76, 1.5, or 3.3 mV for a 10-watt output, depending on the setting of the sensitivity switch on the rear apron. It was 0.76 mV through PHONO 1. The phono S/N ratio was 72.6 dB, and the phono overload points were unusually high at 190, 380, and 805 mV for the three settings of the sensitivity switch.

The tone controls had a rather moderate range of 8 to 9 dB maximum boost and a cut of 13 dB at the frequency extremes. The Baxandall (feedback) type BASS control had a varying inflection point that shifted from below 100 Hz to about 500 Hz as it was advanced toward its extremes. (The treble curves were hinged at about 2000 Hz.) The high-cut filter had the desirable 12 dB/octave slope, with its -3-dB point at 4700 Hz. It was effective in reducing noise, with surprisingly little effect on the audible program content.

The loudness compensation boosted both lows and highs, the former being in-

creased below 500 Hz to a maximum of +11 dB below 50 Hz at most reduced settings of the volume control. The RIAA phono equalization was accurate to within +1/-0.5 dB from 20 to 20,000 Hz (within ± 0.5 dB from 100 to 20,000 Hz). The cartridge inductance had only a slight effect on the frequency response, with an increase in output (instead of the usual decrease) beginning at about 4000 Hz and reaching a maximum of only 1 dB at 15,000 to 20,000 Hz.

The FM tuner had an IHF usable sensitivity in mono of 12 dBf (2.2 μ V). In stereo, it was 17 dBf (4 μ V), which was also the threshold for automatic stereo operation. The steep limiting curve gave a 50-dB quieting sensitivity of 16.5 dBf (3.7 μ V) with 0.3% THD. In stereo, it was 37 dBf (39 μ V) with 0.4% THD. At a 65 dBf (1,000 μ V) input, the S/N was 68.5 dB in mono and 66 dB in stereo, with respective distortion levels of 0.12% and 0.21%. The stereo distortion with 100% L - R modulation of the signal generator at a 65-dBf level was 0.38% at 100 Hz, 0.14% at 1000 Hz, and 0.1% at 6000 Hz.

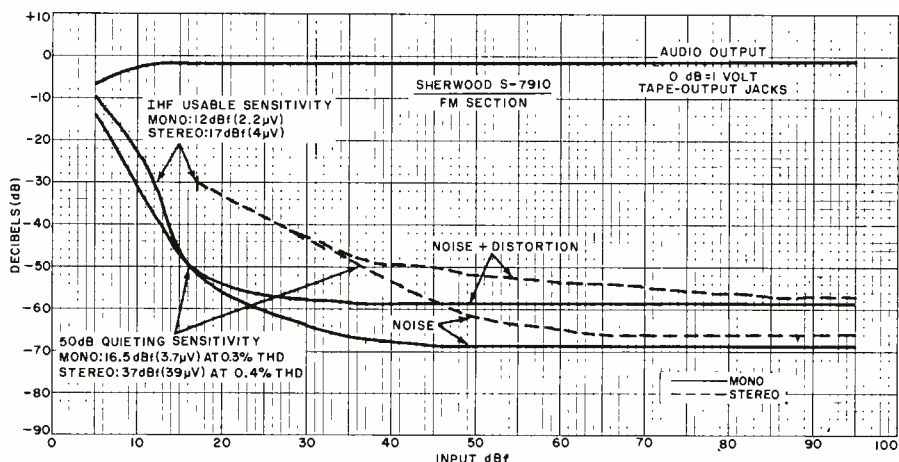
The FM frequency response was very flat over the full range, varying by only +0.5 to -0.3 dB from 30 to 15,000 Hz. The stereo channel separation was extraordinary, by far the best we have yet measured for a tuner. It was 60 dB or

better from 135 to 7000 Hz, reached an unbelievable 68 dB at 400 Hz, and was better than 45 dB over the full 30-to-15,000-Hz range. Doubting our measurements, since even a 50-dB separation is unusual in a tuner, we rechecked this several times, but all the measurements agreed. The AM frequency response, within ± 1.5 dB from 20 to 2800 Hz and down 6 dB at 3700 Hz, was typical of the AM sections of most receivers, although the AM section of this receiver did sound better than many we have heard.

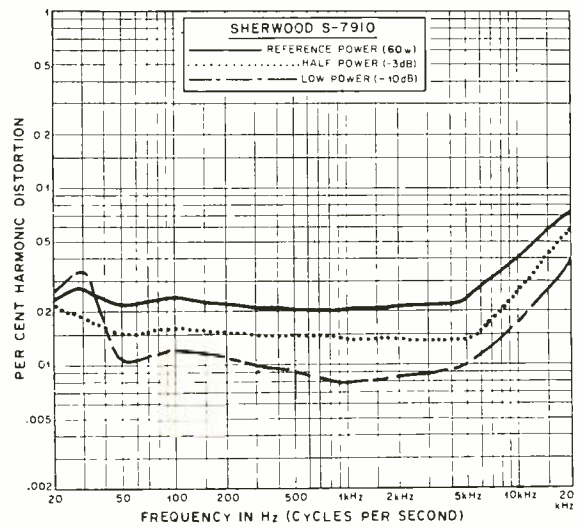
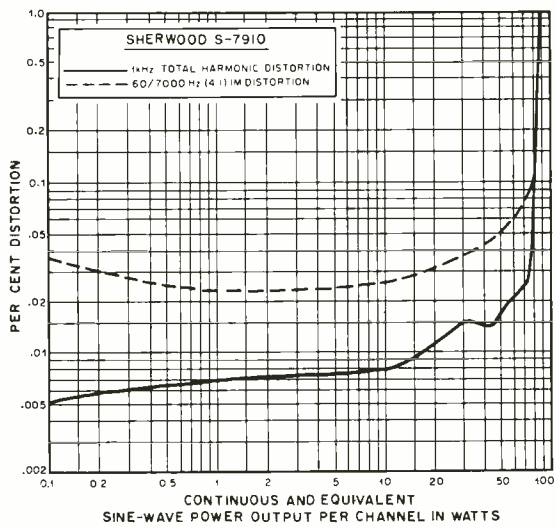
Other FM-tuner performance parameters included: capture ratio of 1.2 dB at 65 dBf, with a very good 73-dB AM rejection; image rejection of 80 dB; alternate channel selectivity of 60 dB (with perfectly symmetrical response about the center frequency, a rather unusual occurrence in FM tuners); and adjacent channel selectivity of 5.8 dB. The muting and stereo thresholds were identical at about 17 dBf (4 μ V). In spite of the almost perfect response flatness up to 15,000 Hz, the 19-kHz pilot carrier leakage into the outputs was a very low -68 dB and the tuner hum was -66 dB.

User Comment. From its features and general performance, it is obvious that the Model S-7910 receiver will be a formidable competitor in the upper-medium price class. Although more power is available (from Sherwood as well as other manufacturers) at considerably higher prices, it is doubtful if most people would ever notice the difference. Certainly a conservative 60 watts of essentially distortionless audio across the full frequency range is more than enough even for most low efficiency speakers in typical home environment.

All the controls operated very smoothly. The FM muting was positive and transient-free. The dial calibration was accu-



Noise and sensitivity curves for FM section.



Total harmonic distortion and 60/70,000-Hz IM distortion.

Harmonic distortion at three power levels.

rate, with a maximum error of about 100 kHz (less than the width of the pointer). The "Positune" FM tuning indicator appeared to duplicate the function of the center channel tuning meter. The LED came on only when the meter pointer was centered on the meter's scale, signifying correct FM tuning. However, the LED is much easier to see, especially at a distance.

The sound was all one could expect from a receiver having this order of per-

formance. Since the actual channel separation of FM broadcasts is far less than the capability of the receiver, it is unlikely that one would ever notice the 60-dB isolation between channels, but you can always be assured that you will never hear crosstalk. With almost any cartridge one might use, the most sensitive setting of the phono switch will be more than adequate in avoiding input overload. In most cases, this switch will be used to balance the levels of the phono

and tuner sections. It is nice to know that no combination of cartridge and record can come close to the overload limits of the preamplifier.

At a time when receivers in the \$750 to \$1000 price range are almost common, it is reassuring to find one priced less than \$500 that will match just about any of them in performance and control features, to say nothing of sound quality though with lower power output.

CIRCLE NO. 81 ON FREE INFORMATION CARD

THERE'S A BETTER WAY TO GO.

Energy shortages tell us we have to change our driving style.

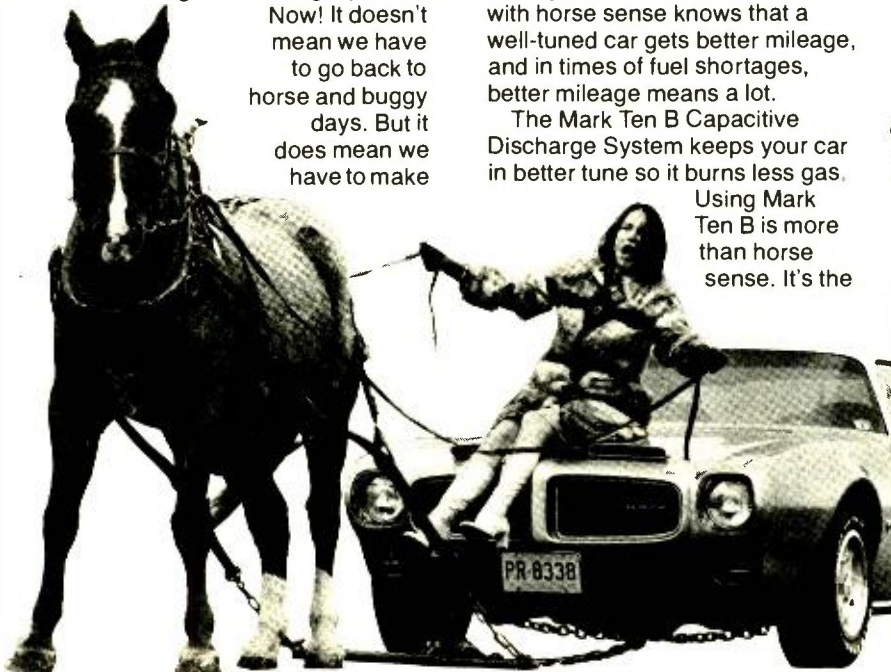
Now! It doesn't mean we have to go back to horse and buggy days. But it does mean we have to make

every drop of gas give us the most go for our money. Anyone with horse sense knows that a well-tuned car gets better mileage, and in times of fuel shortages, better mileage means a lot.

The Mark Ten B Capacitive Discharge System keeps your car in better tune so it burns less gas.

Using Mark Ten B is more than horse sense. It's the

smart move under the hood, helping a nation survive an energy crisis and keeping you on the road. Delta Mark Ten. The best way to go.



DELTA PRODUCTS, INC.
One Delta Way, Dept. PE
Grand Junction, Colo. 81501
(303) 242-9000

I want to know more about Mark Ten CDI's. Send me complete no-nonsense information on how they can improve the performance of my car.

Name _____

Address _____

City _____ State _____ Zip _____

NEWS HIGHLIGHTS

Film Stars Robot

A computer-controlled robot is the star of a new film entitled, "Hierarchical Control." The film, which runs for 20 minutes, demonstrates computer control techniques developed by the U.S. Commerce Department's National Bureau of Standards and how they can best be used in the automation of factories. Using simple performance tasks including stacking blocks and inserting a pin in a hole, the movie analyzes the improvements on programming speed as higher levels of control are added. The film will be made available on free loan. Write: National Bureau of Standards, Office of Developmental & Control Technology, A130, Technology Building, Washington, D.C. 20234.

FCC to Test Warehoused CB Models

Under a precedent-setting program set up by CEDA (Communications Equipment Distributors Association), representatives from FCC Field Engineering Offices will be able to select a CB radio from a participating CEDA member's warehouse and test it to see if it meets current type-acceptance standards. Although the FCC has long wanted to test the radios that consumers actually buy, rather than testing only those submitted by manufacturers, they lacked the budget to carry out such a program. The FCC said late last year that they plan to take full advantage of CEDA's program "after the first of the year, when 40-channel radios are offered for sale and the new transmitter and receiver specifications take effect."

EIA Reports Imports "Up"

For the first nine months of 1976, U.S. imports of consumer electronics equipment have increased, according to the Electronic Industries Association (EIA). Total TV receiver imports are up 95.3%, with total color up 156.2% and monochrome up 67.4%. Home radios are up 21.7%, and automobile radios are up 37.4%. Phonographs increased 123.9%; record players, changers, and turntables are up 45.9%; total tape equipment (play/record), 67.1%; and play-only tape equipment, 79.2%.

Marine Radiotelephone Misuse

The widening use of full-channel vhf/FM radiotelephones has increased the incidents of boatmen selecting improper radio channels, according to the Radio Technical Commission for Marine Services. Channel 13 has been set aside for communications directly between the masters and pilots of approaching vessels. But the reserved radio channel is in jeopardy as pleasure boatmen increasingly attempt conversations on channel 13. The Commission encourages recreational boatmen to listen to channel 13 when in the vicinity of large ships that are maneuvering, but notes that they should limit any radio contact to that necessary for safe passage of the commercial vessels.

More Computer Stores

In December 1975, Paul Terrell opened his first Byte Shop in Mountain View, Cal. Thanks to the tremendous growth of the hobby computer market, Terrell anticipated, at the end of last year, a total of 34 Byte Shops to be in operation by Christmas of 1976. . . . The success of existing computer stores has also prompted Semiconductor Specialists, Inc., an industrial distributor, to announce entry into the computer hobbyist market. The company plans to establish MPU Shops at all 12 of its U.S. locations, the first in the Chicago area. The MPU Shops will have working models of five μ P kits, three unassembled kits, and four additional μ P chips not in kit form. Two complete developmental systems will be available, and books, power supplies, tape readers, and accessories in kit form will be carried. . . . Close behind is the Computer Shack, a retail store devoted to only personal μ C's and peripherals and interfaces. President Ed Faber of Computer Shack, Inc., projects a nationwide chain of 100 franchised Computer Shack retail stores by the end of 1977. Plans are to provide complete sales and service for the computer hobbyist, educational, and business user and feature a broad line of μ C's and modules, books, tools, and comprehensive line of accessories. In addition, each Computer Shack will have its own game room where customers can operate μ C's and peripherals in various games of skill, according to a company spokesman.

TV Process Converts B&W to Color

Imagine Shirley Temple, the Marx Brothers, and the original King Kong in full-color TV motion pictures. B.J.A. Systems Inc. has devised a process that is said to transform monotone scenes into clear, bright, realistic color images. The coloring process is accomplished through a combination of electronic color generation, video animation, and artistic skill. Basically, B.J.A.'s artists assign color based on grey level information in the B&W TV or video signal. Using a combination of analog and digital techniques, the operator can color an entire scene. The result is a full-color version of previous monochrome footage on broadcast-quality tape or video cassette.

WWV & WWVH Broadcast Changes

The National Bureau of Standards (NBS) plans to discontinue broadcasting on 2.5, 20, and 25 MHz from WWV and 20 MHz from WWVH. All broadcasts from these standard time and frequency shortwave stations on other frequencies will continue unchanged in power and format. The reduction in the number of frequencies is expected to commence February 1, 1977. The frequencies are being dropped in a cost-saving move.

Shakespeare's White Knight. The best antenna going. And coming.

Shakespeare comes on strong for the new 40 channel era. With high performance CB antennas that turn on the power on all 23 or 40 channel CB transceivers.

Shakespeare's new White Knight Antenna combines the rugged, mechanical strength of gleaming white fiberglass with precision engineered electronic components. Components like the high quality loading coil permanently fused in a solid polycarbonate thermoplastic base. Totally impervious to the environment. And pre-tuned to an SWR of 1.9 to 1 or less over the 40 channel band (1.3 to 1 or less at the center). To assure maximum range and peak performance everytime you key the mike. That's what sets the White Knight antenna apart from all the others.

Ride full tilt into the 40 channel era with the new White Knight CB Antenna. And take the Shakespeare performance route home.

The White Knight Antenna, Style 4125/available in a variety of pre-assembled mounting styles. Complete with cables and connectors. Under \$25.

CB ANTENNA

Shakespeare

Shakespeare

Coming on strong for the Knights of the Road.

Shakespeare Company/Antenna Group, P.O. Box 245, Columbia, S.C. 29202
In Canada: Len Finkler Ltd., Ontario.

NRI BRINGS "POWER-ON"
 TRAINING TO YOUR HOME...
 FOR QUICKER, EASIER
 LEARNING AND
 FASTER EARNING

NRI FIRSTS

First and only school with designed-for-learning Quadraphonic Audio Center with four SP14 speaker systems. This solid state SQ™ system is designed so that you perform meaningful experiments at every stage of assembly . . . for thorough training in audio technology.



™Trademark of CBS, Inc.

You get trouble-shooting experience from the chassis up . . . with NRI's unique training equipment.

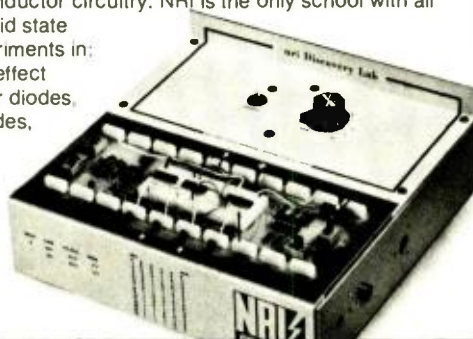
The "firsts" described here are typical of NRI's over 63 years of leadership in electronics home training. When you enroll as an NRI student, you get the technical knowledge and the priceless confidence of "hands-on" experience sought by employers in communications, TV-audio servicing, computers, and industrial and military electronics. NRI training is designed for your education . . . from the educator-acclaimed Achievement Kit sent the day you enroll, to bite-size, well illustrated, easy-to-read lessons programmed with designed-for-learning training equipment.

NRI Firsts make learning at home fast and fascinating. More than a million have come to NRI for home training. Professional TV/Audio technicians who learned their profession through home training rate NRI as first choice by far, over any other school.

SEND FOR THE FREE FULL-COLOR CATALOG . . . for full details on NRI home training. There is no obligation . . . *no salesman will call.*

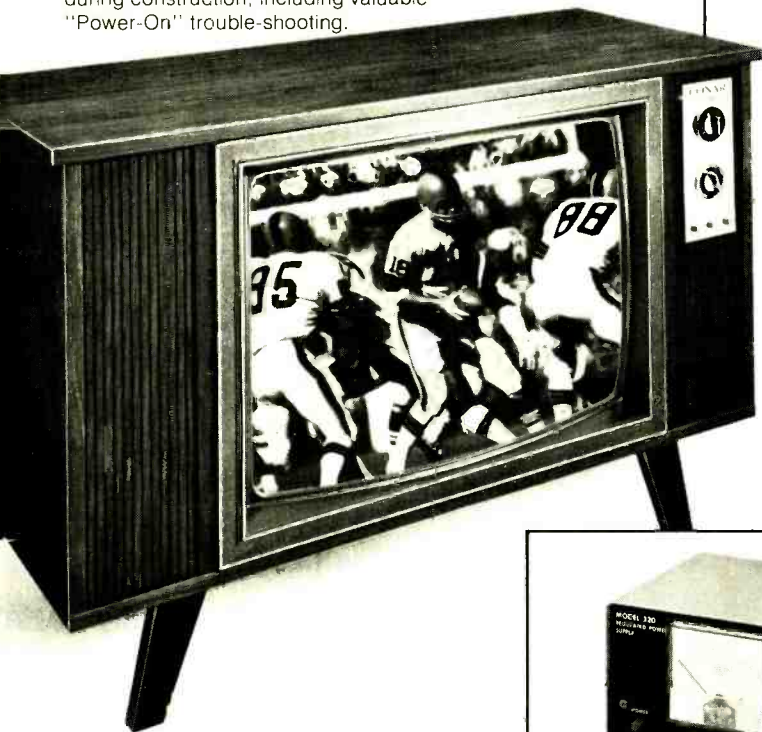
First with an electronics Discovery Lab™. This self-contained advanced solid-state lab gives you fast, hands-on access to fully-powered semiconductor circuitry. NRI is the only school with all these modern solid state component experiments in: bipolar and field effect transistors, Zener diodes, light-emitting diodes, SCR's and phototransistors.

™McGraw Hill CEC.

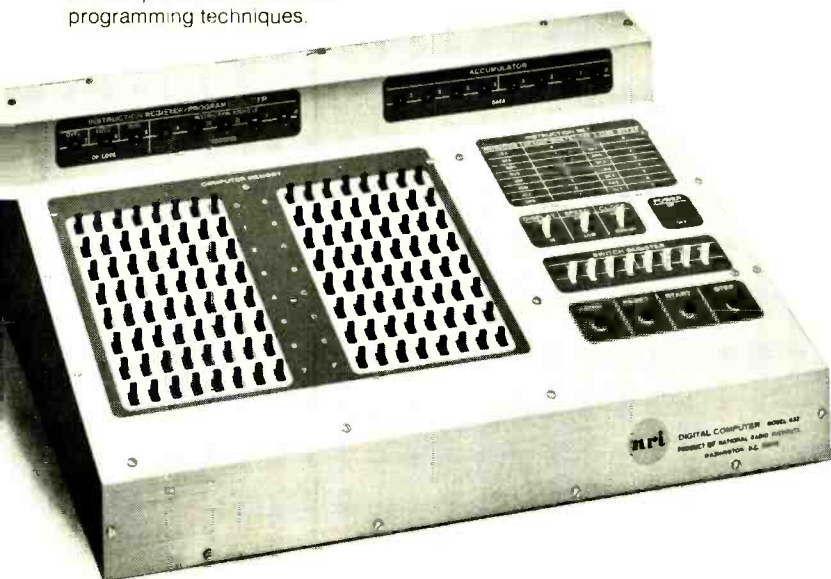


First and only school with new Optical Transmission System engineered to allow you to analyze digital and analog signal transmission via light beam. Systems you build use LED and phototransistor technology, simulating basic principles of laser communications as used in video disc home entertainment systems.

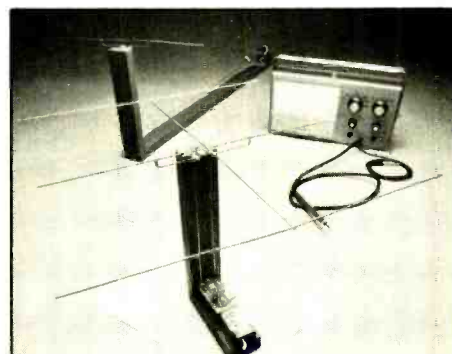
First and only school with designed-for-learning 25" diagonal solid state Color TV complete with cabinet. This solid state set was designed by NRI's own engineers from the chassis up so that students can perform over 25 in-set experiments during construction, including valuable "Power-On" trouble-shooting.



First and only training with an actual programmable digital computer to give you the only home training in machine-language programming . . . essential to trouble shooting digital computers. Extra Memory Expansion Kit doubles memory size for practice in advanced programming techniques.



First and only school with a portable CMOS digital frequency counter engineered by NRI to give you experience in the newest types of digital systems coming into expanded use in consumer electronics.



First and only school with an Antenna Applications Lab engineered to give you a thorough understanding of practical communications antenna requirements. You assemble and test several different types of antennas and matching sections, measuring gain and radiation patterns.



First and only school with a solid state regulated power supply engineered by NRI to give you experience with modern power supply designs; to give you a premium power supply for your NRI Transceiver, or to use in trouble-shooting mobile equipment.



First and only school with designed-for-learning, 400-channel, digitally-synthesized VHF Transceiver to give you the only fully-up-to-date 2-meter equipment for complete training in commercial, amateur, and CB communications. The design incorporates circuitry and components representative of the latest state of the art. Circuitry is on five plug-in circuit cards to take full advantage of NRI "Power-On" training.

If card is missing, write to:

NRI Schools
 McGraw Hill Continuing
 Education Center
 3939 Wisconsin Ave.
 Washington, D.C. 20016

WHY SETTLE FOR LESS— THAN A 6800 SYSTEM

MEMORY—

All static memory with selected 2102 IC's allows processor to run at its maximum speed at all times. No refresh system is needed and no time is lost in memory refresh cycles. Each board holds 4,096 words of this proven reliable and trouble-free memory. Cost—only \$125.00 for each full 4K memory.

INTERFACE—

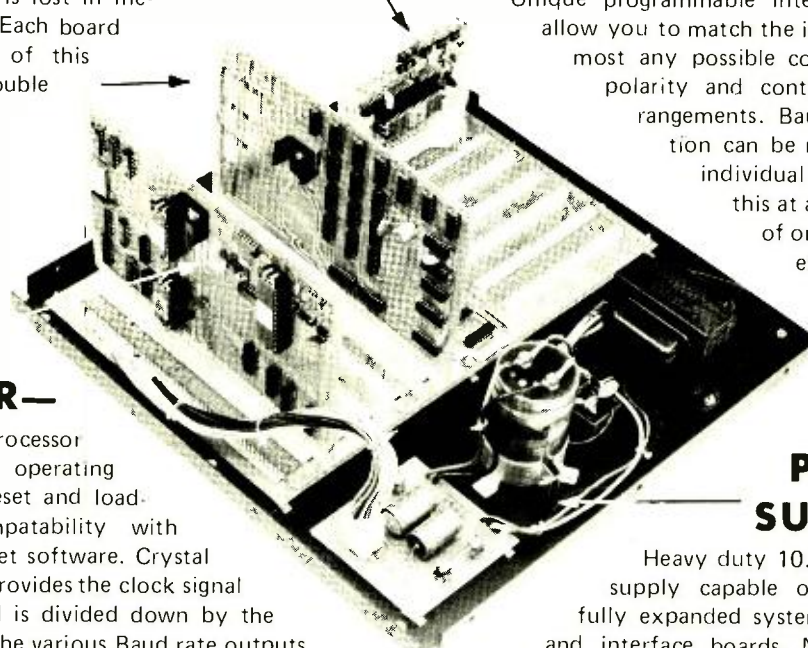
Serial control interface connects to any RS-232, or 20 Ma. TTY control terminal. Connectors provided for expansion of up to eight interfaces. Unique programmable interface circuits allow you to match the interface to almost any possible combination of polarity and control signal arrangements. Baud rate selection can be made on each individual interface. All this at a sensible cost of only \$35.00 for either serial, or parallel type

PROCESSOR—

"Motorola" M6800 processor with Mikbug[®] ROM operating system. Automatic reset and loading, plus full compatibility with Motorola evaluation set software. Crystal controlled oscillator provides the clock signal for the processor and is divided down by the MC14411 to provide the various Baud rate outputs for the interface circuits. Full buffering on all data and address busses insures "glitch" free operation with full expansion of memory and interfaces.

POWER SUPPLY—

Heavy duty 10.0 Amp power supply capable of powering a fully expanded system of memory and interface boards. Note 25 Amp rectifier bridge and 91,000 mfd computer grade filter capacitor.



DOCUMENTATION—

Probably the most extensive and complete set of data available for any microprocessor system is supplied with our 6800 computer. This includes the Motorola programming manual, our own very complete assembly instructions, plus a notebook full of information that we have compiled on the system hardware and programming. This includes diagnostic programs, sample programs and even a Tic Tac Toe listing.

Mikbug[®] is a registered trademark of Motorola Inc.

SWTPC 6800
Computer System

with serial interface and 4,096 words of memory. \$395.00



- Enclosed is \$395 for my SwTPC Computer Kit Send Data
- or BAC _____ # _____
- or MC _____ Ex Date _____

NAME _____

ADDRESS _____

CITY _____ STATE _____ ZIP _____

Southwest Technical Products Corp., Box 32040, San Antonio, Texas 78284

BY GEORGE W. RANDIG

BUILD A DIGITAL BICYCLE-SPEEDOMETER

*Seven-segment LED readouts indicate speed
from 1 to 99 miles per hour.*

AMONG the popular bicycle accessories is the bike speedometer. This is usually a friction-producing device with an analog readout. Consequently, the cyclist has to pedal somewhat harder to overcome the friction, and the speed indicator's calibration markings are difficult to read. The digital speedometer described here overcomes these objections.

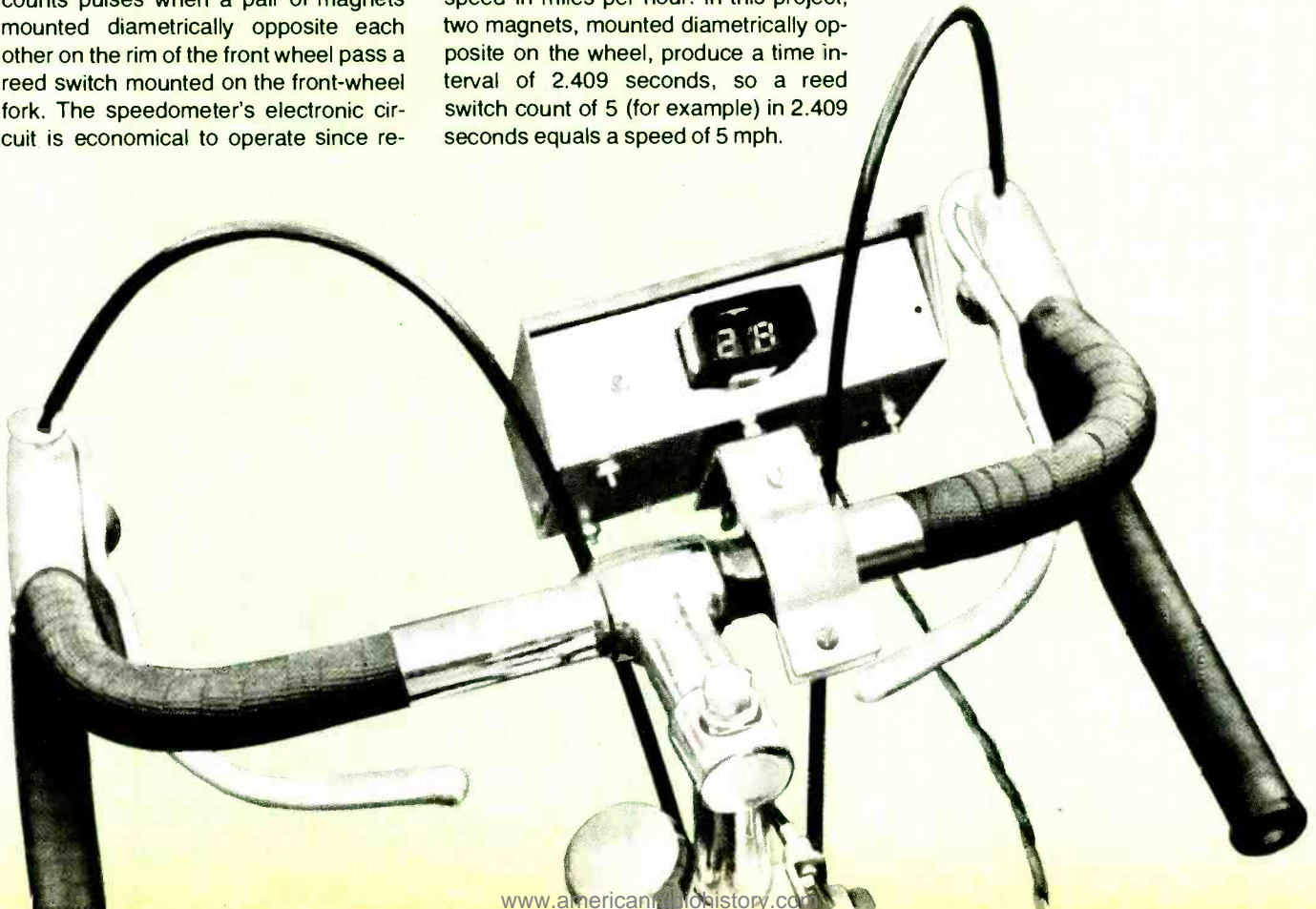
This low-cost digital LED-display speedometer incorporates a frictionless method of counting wheel revolutions and converting them to bike speed. It counts pulses when a pair of magnets mounted diametrically opposite each other on the rim of the front wheel pass a reed switch mounted on the front-wheel fork. The speedometer's electronic circuit is economical to operate since re-

chargeable nickel-cadmium cells supply the power.

The speedometer is capable of accurately indicating speeds from 1 to 99 mph. This is determined by the number of times the wheel rotates in a particular time interval. For example, a 27-inch diameter wheel will go through 745.96 revolutions in one mile. If the wheel is rotating at one mile per hour, it makes one revolution in 4.819 seconds. If the digital counter that is driven by the reed switch is allowed to accumulate the pulses for 4.819 seconds, the count represents the speed in miles per hour. In this project, two magnets, mounted diametrically opposite on the wheel, produce a time interval of 2.409 seconds, so a reed switch count of 5 (for example) in 2.409 seconds equals a speed of 5 mph.

The reed switch is used to drive a pair of conventional digital decade counters, each having a 7-segment LED readout, with the carry of the first (units) counter driving the second (tens) counter.

The speedometer uses two seven-segment LED displays for numeric presentation. Its magnetic pickup is a simple open-close scheme for operating the reed switch to "pulse" the input counter in the circuit. A timing circuit sets up the correct latching and reset intervals, and a novel calibration scheme lets you use



the speedometer with almost any bicycle wheel diameter. In addition, details are given on how to build a battery recharging circuit.

About the Circuit. The speedometer, shown schematically in Fig. 1, employs two decades of digital counting. Each decade contains a single IC that has a binary counter, latch, BCD-to-seven-segment decoder, and LED display driver all in one package. The carry output of IC1 (pin 22) is used to drive IC2. The values of current-limiting resistors R8 through R21 are selected as a compromise between minimum current and acceptable brightness of the LED displays under high ambient light conditions. Resistor R22 serves as a protective device in the event of accidental segment-to-ground shorting.

System timing is provided by half of dual timer IC3. The timing period is determined by the setting of calibration potentiometer R2. The output pulse from the timer half of IC3 serves as the latch signal for the two decade counters. The trailing edge of this pulse is differentiated by C2 and R4, inverted by Q1, and then used as the reset pulse for the counting system.

The remaining half of IC3 is used as a free-running oscillator. The output from this oscillator is coupled through C9 to calibration switch S3. When the speedometer is operating, and before the bicycle wheel is placed in motion, depressing S3 substitutes the known frequency of the oscillator signal for the wheel-rotation signal and allows adjustment of timing potentiometer R2 until the display indicates the diameter of the bicycle wheel. This is the only calibration required by the speedometer. The values of C3, R6, and R7 have been selected for an 11.2-pulse/second (pps) rate, which puts a 27 on the display (for 27" wheel diameter).

The input to the speedometer, via J1, comes from the reed switch mounted on the front fork of the bicycle. The reed switch closes each time a magnet mounted on the rim of the wheel is in close proximity with it. When the input to IC1 (pin 2) is open, a high (logic 1) is assumed. When the reed switch closes, the input drops to zero (logic 0), and enters one count into IC1 for each closure.

Capacitor C7 at the input of IC1 debounces the reed switch, while capacitor C6 at the output of the first decade counter prevents the second counter from being incremented by more than one count for each carry pulse.

Power for the speedometer is provided

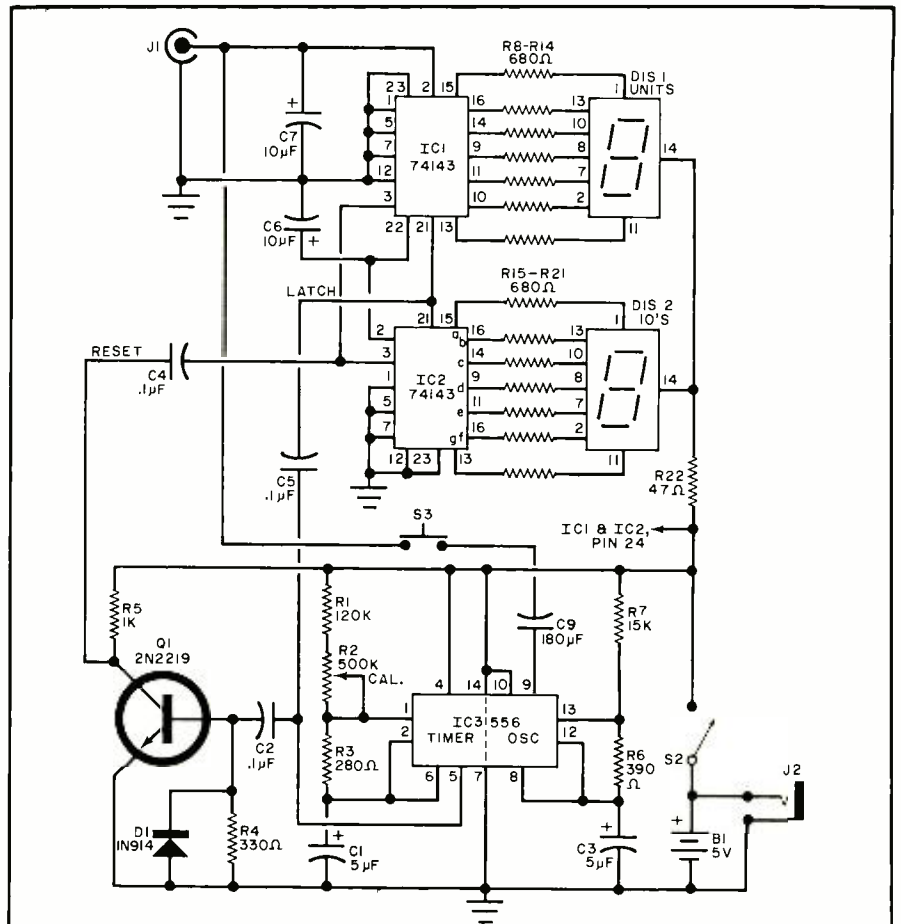


Fig. 1. Each decade counter uses one IC that includes LED driver. IC3 provides latch and reset and is also calibration oscillator.

PARTS LIST

- | | |
|--|---|
| B1—Four 1.25-volt AA-size nickel-cadmium cells in series | R1—120,000 ohms |
| C1, C3—5- μ F, 35-V electrolytic capacitor | R3—280 ohms |
| C2, C4, C5—0.1- μ F disc capacitor | R4—330 ohms |
| C6, C7—10- μ F, 35-volt electrolytic capacitor | R5—1000 ohms |
| C8—180- μ F, 35-volt electrolytic capacitor* | R6—390 ohms |
| C9—180- μ F, 35-volt electrolytic capacitor | R7—15,000 ohms |
| D1—1N914 diode | R8 through R21—680 ohms |
| D2 through D5—50-PIV, 1-A rectifier assembly or separate 1N4001 rectifier diode* | R22—47 ohms |
| D6—6-volt, 1/2-watt zener diode* | R2—500,000-ohm miniature potentiometer |
| DIS1, DIS2—Common-anode LED-type 7-segment display | S1—Reed switch (Radio Shack No. 275-1550 or similar) |
| F1—1/4-ampere fuse* | S2—Spst switch |
| I1, I2—6-to-9-volt, 150-mA indicator lamp (#TS-47 or similar)* | S3—Normally open, momentary-action spst switch |
| IC1, IC2—SN74143 | S4—Spst switch* |
| IC3—556 dual timer | T1—12.6-volt, 300-mA transformer* |
| J1—Phono jack | Misc.—Two magnets (see text); enclosures for main circuit and recharger; 2-meter length of two-conductor cable; line cord*; perforated board; IC sockets (3); transistor sockets; solder clips; fuse holder*; metal U bracket; electrical tape; machine hardware; hookup wire; solder; etc. |
| J2—Miniature phone jack | |
| P1—Phono plug | |
| P2—Miniature phone plug* | |
| Q1—2N2219 transistor | |
| The following resistors are 1/2-watt, 10%: | |

*For recharger.

by four 1.25-volt rechargeable nickel-cadmium cells in series. The cells can be recharged, without having to remove them from the project, with the circuit shown in Fig. 2. You simply plug P2 on the recharger's output cable into J2 on the speedometer, plug the recharger's

line cord into an ac outlet, and turn on the power.

Indicator lamps I1 and I2 in the recharger lamps are used to limit the charging current to a safe level. Zener diode D6 maintains a constant 6-volt charging potential.

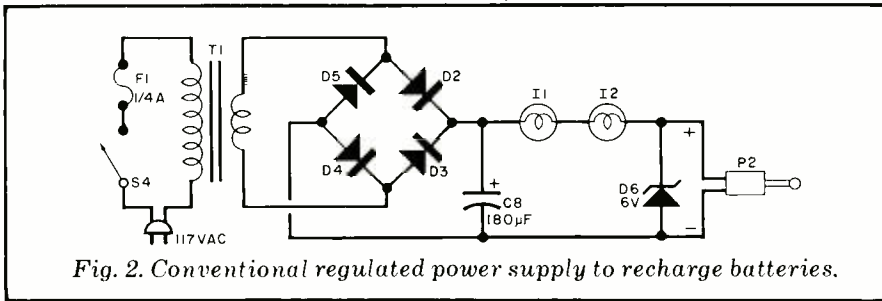


Fig. 2. Conventional regulated power supply to recharge batteries.

Construction. There is nothing critical or difficult about assembling the speedometer and its battery charger. To simplify construction, the speedometer is best assembled on two perforated boards, one for the displays and the other for the remainder of the circuit. Use sockets for the transistor and IC's and solder clips for the passive components. Hookups between the two boards and the off-the-board components can be made with lengths of insulated stranded hookup wire.

Machine the enclosure that will house the speedometer by cutting out a display window and drilling holes for R2 and S3 in the front panel and drilling holes for J1, J2, and S3 in the rear panel. Then, secure the battery holder for B1 to the floor of the case and mount a handlebar clamp on the bottom of the enclosure. Cement a red filter over the display window and mount the circuit board assemblies into place. Finally, connect the circuit board to the other components.

The simple recharger circuit shown in Fig. 2 can be assembled by any method you find convenient. House it in a suitable enclosure, making certain that no point on the primary side of T1 touches the case or the circuit on the secondary side of the transformer. Mount I1 and I2 inside the case. (There is no need for these lamps to be mounted in holders.) The holes for the line cord and power-output cable should be lined with rubber grommets.

When both the speedometer and the recharger have been assembled and checked for proper wiring and soldering, charge the cells while you put together and mount the input assembly.

The reed switch should be cemented to a 1" long by 3/8" square (25.4 × 9.53 mm) wood block. This block is then held in place on the bicycle's front fork by a metal U bracket. (See Fig. 3 for fabrication details.) Two magnets, such as those used for cabinet doors, should be cemented with epoxy to the rim of the

wheel 180° apart. Note: Do not mount the magnets on the wheel in locations where they will interfere with the caliper brake pads.

Wrap a few turns of electrical tape around the U bracket and mount the reed switch block in place as shown in photo. Once it is mounted, the reed switch block should be anchored rigidly to the front fork of the bicycle, and the reed switch should be oriented so that the magnets pass directly along its axis and within 1/4" (6.35 mm) of it.

To test the input system, turn the bicycle upside down and connect an ohmmeter across the contacts of the reed switch. Slowly rotate the front wheel of the bicycle until one of the magnets passes the reed switch. As the magnet approaches the reed switch, the latter

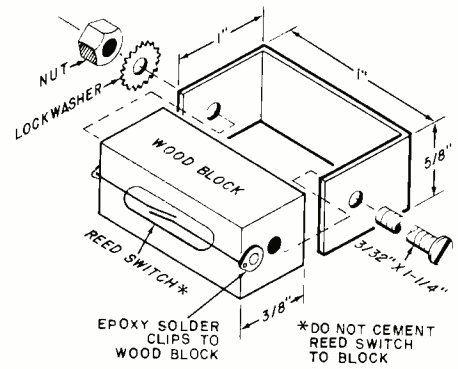


Fig. 3. Details of mounting bracket for reed relay.

should close and produce a zero reading on the meter. As the magnet moves away from the reed switch, the contacts should open, and the meter's pointer should register infinity. Perform this test with both magnets. Then set the wheel to rotating slowly so that the magnets pass by the reed switch several times. With each pass of the magnets, the meter's pointer should momentarily deflect toward the low end of the scale.

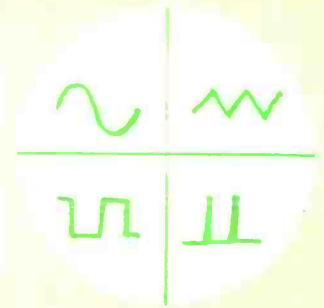
With the battery pack inside the speedometer, mount the project to the handlebars of your bicycle and connect the reed-switch input to it via its cable. Now, to calibrate the speedometer, set the front wheel of your bicycle so that the reed switch is midway between the magnets. Depress calibration switch S2 and adjust timing control R2 until the display indicates the wheel's diameter. Release S2, and you are ready to pedal away—but watch your speed. ◇



Photo shows how reed relay is clamped to fork holding front wheel of bicycle with magnets (one shown) on inner rim.

BUILD THE

FOR ELECTRONIC MUSIC



**A low-cost voltage-controlled oscillator
with sine, triangle, square-wave and pulse outputs.**

BY JAMES BARBARELLO

IF YOU'RE an electronic music buff and are looking for an inexpensive but flexible VCO, this project is for you. Dubbed the V-4, it has four outputs—sine, triangle, and square waves and variable width pulses. It also boasts provisions for pulse-width modulation and front panel controls for sine-wave symmetry, triangle shifting, square-wave amplitude and pulse-train amplitude.

Furthermore, two V-4 voltage controlled oscillators can be used simultaneously to produce harmony effects when teamed up to an "input multiplier." The multiplier, which is also a part of this project, amplifies the input control voltage by a constant adjustable from one to two. This allows you to produce a fundamental tone from the first V-4 and a tone one octave above it or any fraction in between from the second.

About the Circuit. The schematic diagram of the V-4 is shown in Fig. 1. It is a standard design using readily available components. Integrated circuit IC2, an Intersil 8038 VCO, is the heart of the project. Input stage IC1, a 741 op amp summer, processes the control voltage inputs (V_C) to produce a 0-Hz output when V_C is zero. (Multiple inputs facilitate the use of special effects such as frequency modulation, etc.) Transistors Q1 and Q2 form a Schmitt trigger which converts the triangle output of IC2 into a pulse train with variable duty cycle.

The duty cycle of the pulses is determined by the setting of R16. Potentiometer R17 "trims" the input to the Schmitt

trigger so that minimum pulse width is obtained when R16 is set fully counterclockwise. The amplitude of the pulse train is governed by R22. This control also determines the amount of hysteresis in the trigger, and therefore the minimum pulse width obtainable. For the specified component values, the duty factor is adjustable from approximately 0 to 50 percent.

Diodes D1 and D2 drop the supply voltage so that the potential difference from point B to ground (V_B) can be matched at the output of IC1 (V_A). This is done because the two voltages must be equal for an output frequency of zero Hertz. Resistor R12 insures that sufficient current will flow through the diodes to keep V_B constant as the current drain of IC2 varies.

The input multiplier shown in Fig. 2 is a noninverting amplifier whose gain is adjustable from unity to two. You will recall that, in the musical scale we most commonly use, the frequency of any note is the twelfth root of two or 1.059463094 times that of the previous note. So, if a note a perfect fourth above the fundamental is desired, the control voltage must be multiplied by 1.25992105 (the twelfth root of two raised to the fourth power). The input multiplier will do this when its gain is adjusted by means of potentiometer R26 in the feedback circuit of IC1B.

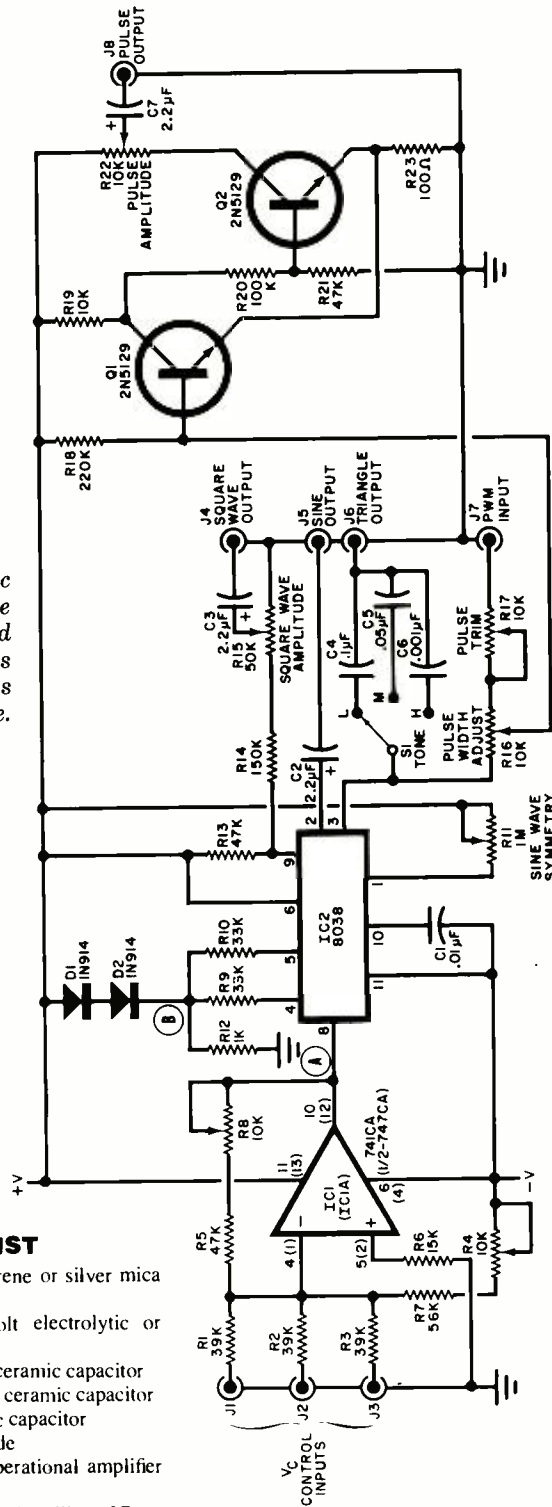
Once this aural adjustment is made, all other tones produced will be a perfect fourth above that which would be produced at unity gain. A multiplier control input (V_C) of more than 3 volts is not

useful (assuming an adjusted multiplier gain of two) because IC2 will not respond linearly with a control input of more than 6 volts. Resistors R6 and R24 are used to load the unused inputs of multiplier and input stages, respectively, while generating minimum output offset voltages. If the optional input multiplier is included in the project, a 747 dual op amp should be used: As indicated in Fig. 1 and 2, IC1 becomes IC1A, and the multiplier is IC1B.

Design Equations. You might have to vary some of the component values to suit your existing power supply and/or controller. Therefore, we will discuss the important design equations of the V-4. The output frequency of the 8038 is proportional to the quantity ($V_B - V_A$). For a standard controller (nominally 0 to 5 volts), we want a 0-volt input to cause V_A to equal V_B . We also want a 6-volt input (20% overrange) to cause V_A to equal the quantity $(2/3)(V_{CC} - V_{EE})$, where V_{CC} and V_{EE} are the positive and negative supply voltages, respectively. Any voltage greater than $(2/3)(V_{CC} - V_{EE})$ will cause the IC to act nonlinearly. For the circuit in Fig. 1, V_A equals $-K1(V_C) - K2(V_{EE})$. For the above constraints, $K1 = (V_B/6) - (V_{CC}/18) = R5/R1$, and $K2 = (V_B/V_{EE}) = R5/R7$. For minimum offset voltage, $R6 = R1 || R5 || R7$. Furthermore, $V_B = V_{CC} - 1.4 V$ and

$$\begin{aligned} f_{OUT} &= 1.5 (V_B - V_A) / R9C1 (V_{CC} - V_{EE}) \\ &= 1.5 (R5/R1) V_C / (2V_{CC}R9C1) \\ &\text{when } |V_{CC}| = |V_{EE}| \\ &= K3 V_C \end{aligned}$$

Fig. 1. Schematic of the voltage controlled oscillator shows where the various outputs are available.



PARTS LIST

- C1—0.01- μ F, 5% polystyrene or silver mica capacitor
- C2,C3,C7—2.2- μ F, 25-volt electrolytic or tantalum capacitor
- C4—0.1- μ F Mylar or disc ceramic capacitor
- C5—0.05- μ F Mylar or disc ceramic capacitor
- C6—0.001- μ F disc ceramic capacitor
- D1,D2—1N914 silicon diode
- IC1—741CA or 747CA operational amplifier IC (see text).
- IC2—8038 voltage-controlled oscillator IC
- J1—J8—Phono or other suitable jack
- Q1,Q2—2N5129 npn silicon transistor
- The following fixed resistors are 1/4-watt, 10% tolerance unless otherwise specified.
- R1,R2,R3—39,000 ohms
- R5,R13,R21,R24—47,000 ohms
- R6—15,000 ohms
- R7—56,000 ohms
- R9,R10—33,000 ohms, 5% max.
- R12—1000 ohms
- R14—150,000 ohms
- R18—220,000 ohms
- R19—10,000 ohms
- R20,R25—100,000 ohms

- R23—100 ohms
- R4,R8,R17—10,000-ohm printed circuit trimmer potentiometer
- R11—1-megohm linear taper potentiometer
- R15—50,000-ohm linear taper potentiometer
- R16,R22—10,000-ohm linear taper potentiometer
- R26—100,000-ohm linear taper potentiometer
- S1—1-pole, 3-position rotary switch
- Misc.—Printed circuit or perforated board, suitable enclosure, hookup wire, IC and transistor sockets, knobs, machine hardware, solder, etc.

The constant K3 was chosen to be 208 to conform with the author's controller. Thus, the product $R9C1 = 0.00361 R5/(R1 V_{CC})$. Intersil recommends a value of R9 (and R10, as the two are identical) between 10,000 and 100,000 ohms for best linearity. Because the capacitance of C1 is on the order of 0.01 μ F, a small deviation from the nominal value will affect K3 considerably. Therefore, a capacitor with as close a tolerance as possible (no more than 5%) should be used.

Given these factors, the following design steps are suggested:

1. Select a single value for R1, R2, and R3 between 33,000 and 47,000 ohms;
2. Determine the value of R5 using the equation $R5 = R1 ((V_B/6) - (V_{CC}/18))$;
3. Find the resistance of R7 as given by the formula $R7 = R5 (V_{EE}/V_B)$;
4. Calculate the value of R6

$$R6 = \frac{1}{(1/R1) + (1/R5) + (1/R7)}$$

5. Then, the product $R9C1$ is determined by the equation $R9C1 = 0.00361 R5/(R1 V_{CC})$ where R9 will be between 10,000 and 100,000 ohms.

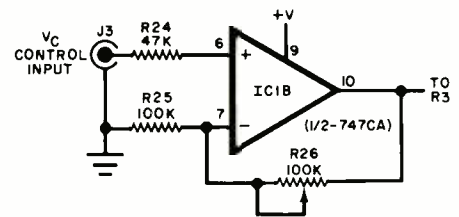


Fig. 2. Input multiplier circuit adjusts the control voltage.

Construction. The V-4 VCO can be assembled using printed circuit or perforated board. Suitable etching and drilling and parts placement guides are shown in Fig. 3. The use of sockets for the semiconductors is recommended. Using standard components, a K3 of 217.17 was obtained. This was deemed sufficiently close to the ideal value of 208. However, trimmer potentiometers can be used in place of R9 and R10 to allow precise adjustment of K3. If a second V-4 with an input multiplier is to be used with the first, trimmer potentiometers *must* be used so that its K3 can be matched to that of the first V-4. For best symmetry, the resistance of R9 and R10 should be as closely matched as possible.

Figure 4 shows modifications to the etching and drilling and parts placement

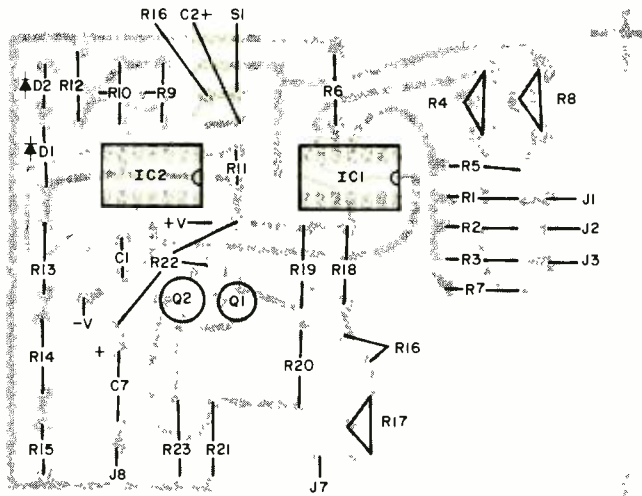
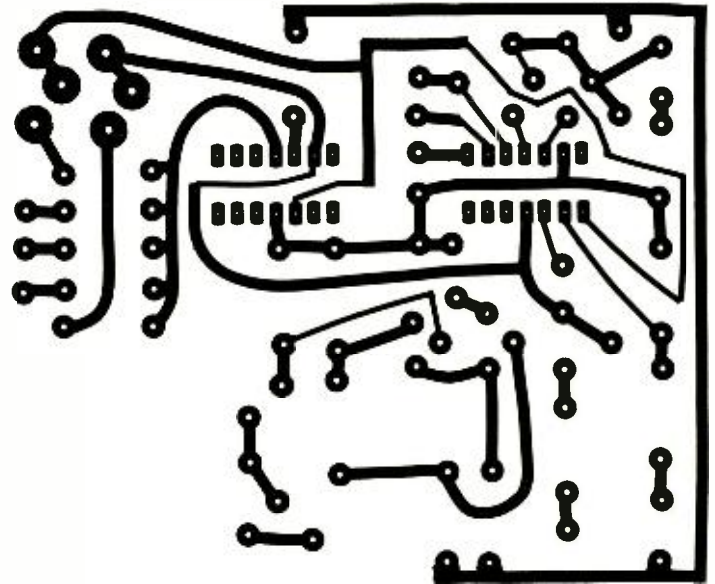


Fig. 3. Component layout diagram is shown above. Etching and drilling guide at right.



guides that must be made if an input multiplier is included. A 747 dual op amp replaces the 741 at the IC1 location.

A suggested panel layout for the V-4 (less input multiplier) is shown in Fig. 5. If solid wire is used for interconnection between the switches and controls on the panel and the pads on the pc board, no mounting brackets are necessary. You can use phono jacks, miniature phone jacks, banana jacks, or any other suitable type of connector for input and output signals.

Calibration. Connect the V-4 to a well-regulated bipolar (\pm) 15-volt supply. Regulation is very important because the output frequency is proportional to the quantity $2/(V_{CC} - V_{EE})$. Then make sure your controller is providing correct control voltages. If 5 volts produces the fifth octave, 2.5 volts should produce the fourth, 1.25 volts the

third, 0.625 volt the second, and 0.3125 volt the first. Before calibrating the V-4, check the values of V_{CC} and V_B . Determine K_4 from the equation $K_4 = (V_B/6) - (V_{CC}/18)$. Set trimmer potentiometers R_4 and R_8 approximately to their midpositions. Connect the positive probe of a high-impedance voltmeter to point B and the negative probe to point A.

Apply a control voltage to one of the inputs and adjust R_4 for a meter reading of $(K_4 V_C)$ volts. Next, remove the control voltage and adjust R_8 for a zero-volt reading. Then, reapply the control voltage and again adjust R_4 for a reading of $(K_4 V_C)$ volts. Remove the control voltage and adjust R_8 for a zero-volt reading. Repeat this procedure until no further adjustment is necessary. Then apply a control voltage and adjust R_{17} for minimum pulse width with R_{16} set fully counterclockwise. This completes the calibration procedure.

Using the VCO. The V-4 can be used just like any other VCO. Keep the following guidelines in mind:

- When using the triangle output, turn R_{16} (PULSE WIDTH ADJUST) fully clockwise. The HIGH and MEDIUM positions of S_1 will result in a triangle output with less low-frequency content than the LOW position. Accordingly, the output waveforms will have steeper slopes and "brighter" tones.
- The grounds of the controller and the V-4 must be tied together.

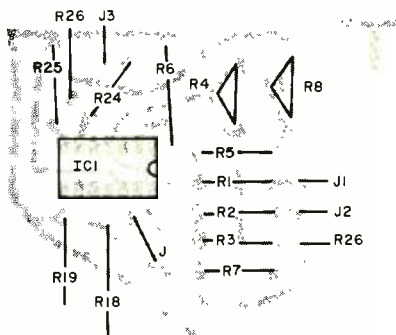


Fig. 4. Adjustments that must be made to the basic board if an input multiplier is used.

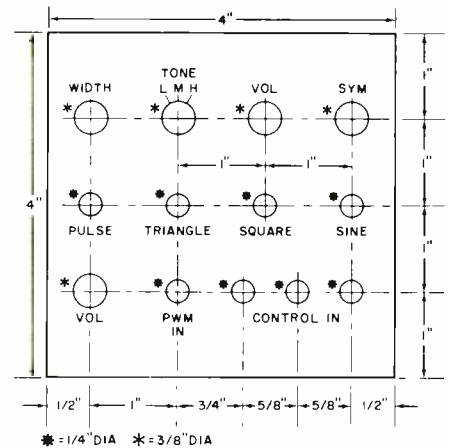
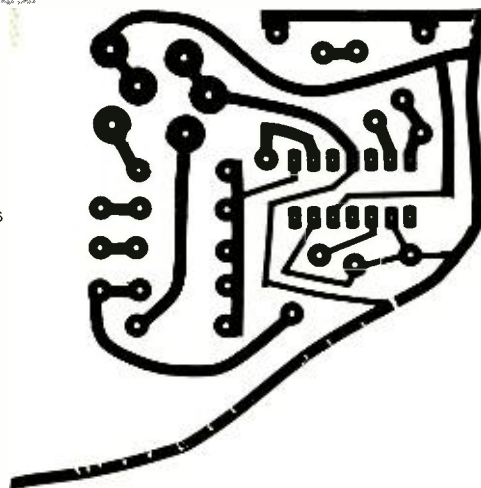
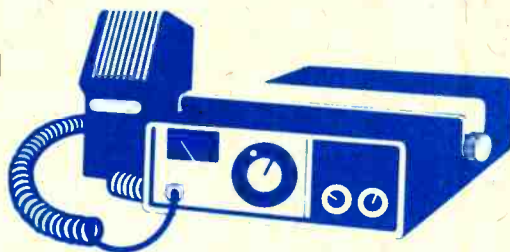


Fig. 5. Suggested layout diagram for the front panel of the V-4 without the input multiplier.

- When using the pulse width output, connect the PWM input to a control oscillator and adjust the control oscillator output for zero volt if no modulation is desired. Alternatively, the PWM input can be grounded. If this input is left floating with respect to ground, R_{16} will have little or no effect on the width of the output pulses.

1977 Special Focus on CB RADIO

- CB RULES CHANGES FOR 1977
- PROS AND CONS OF CB FREQUENCY-GENERATION METHODS
- WILL SUNSPOTS AFFECT CB COMMUNICATIONS?
- HOW EXTERNAL SPEAKERS CAN IMPROVE CB PERFORMANCE
- BUILD A SILENCER



CB RULES CHANGES FOR 1977

THE Federal Communications Commission (FCC) dropped its big bombshell in July 1976, when it released new rules that expanded the Class D Citizens Band from 23 to 40 shared AM and SSB frequencies. The channel-expansion date was effective January 1, 1977, accompanied by a host of other revisions and new rulings.

Among the new rules are name changes, effective January 27. The Citizens Radio Service is now called the Personal Radio Services, with Class D now named the Citizens Band Radio Service. Also, Part 95 of the Rules now consists of four subparts. Only the applicable subparts need be in the possession of a licensee. Thus, CB'ers will no longer have to fight through deep technical standards, the Remote Control Service, etc.

The new band extends from 26.965 MHz to 27.405 MHz. All channels are spaced 10 kHz apart except those adjacent to one of the five Class C channels. (The sixth Class C channel is 27.255 MHz, which is the same as Class D's channel 23.) Had the FCC added more channels above 27.405 MHz, it is believed that serious intermodulation interference would have resulted.

The new channels are not numbered by the FCC. The original 23 channels were. However, the industry quickly numbered the channels 1 through 40. Can you imagine a channel selector that indicates the frequency (such as 27.395) instead of a channel number?

Until the band was expanded, 27.235, 27.245, 27.265, and 27.275 MHz were not available for CB use. The frequency 27.225 MHz is CB channel 22 and 27.255 MHz is CB channel 23. To avoid

confusion, channel 23 remains at 27.255 MHz, with channel 24 (27.235 MHz) and channel 25 (27.245 MHz) interspersed between channels 22 and 23. Channels 25 through 40 extend from 27.265 MHz to 27.405 MHz in 10-kHz steps. As far as the user is concerned, the frequencies actually used do not matter; only the consecutive channel numbers need be considered.

Channel 9 (27.065 MHz) is still reserved as an *emergency* channel. Since channel 11 (27.0 5 MHz) has been restored as a general-use channel, there are now 39 AM and 78 SSB channels available for standard communication, plus channel 9.

All CB transmitters must be type-accepted by the FCC, of course. Now, however, new CB *receivers* must be certified by the FCC as well.

Most 23-channel CB sets have a heterodyne-type frequency synthesizer that employs an oscillator operable on six different frequencies in the 27-MHz region. These signals, if radiated, can interfere with land-mobile radio systems operating in the 37-MHz region of the 30-59 MHz (low vhf) land-mobile band.

Because the second harmonic of a CB signal can cause TVI (television interference) to television channel 2, and the third harmonic can interfere with the reception of TV channel 5, the new rules require that the harmonic attenuation of newly type-accepted CB transceivers be at least 60 dB, as compared to the earlier 50 dB requirement. The strength of any harmonic of a 4-watt transmitter may not exceed 4 microwatts (μ W). (In the future, the FCC might increase the harmonic attenuation requirement to 100 dB, limiting the power of any har-

monic of a 4-W transmitter to 0.0004 microwatt.)

The FCC now requires that, at any frequency, a signal at the antenna terminals of a CB receiver not exceed a level of 2 nanowatts and will probably tighten this standard to 0.2 nanowatt in the future. Direct radiation from the chassis may not exceed 5 μ V per meter, when measured at a distance of 3 meters. Also, interference arising from the power line (base station or mobile transceiver used with an ac adapter) may not exceed 100 microvolts.

In earlier days, type-acceptance of CB transceivers appears to have been granted largely on the basis of test measurements presented to the FCC. Now, however, the FCC examines a sample transceiver. Moreover, it is expected that the Commission will sample production models, too.

Samples of 40-channel CB transceivers were not accepted for testing by the FCC until September 10, 1976, with a cutoff date of November 1 for those new rigs that would receive type-acceptance by January 1, 1977 (assuming they passed the tests). During early tests, it was found that many manufacturers had trouble limiting the *receiver's* signal radiation to the newly established 5- μ V standard. Consequently, the FCC has been stretching the figure to 8 μ V for actual units examined by the Commission. Furthermore, production models can get away with 15 μ V on a sampling basis.

Clearly, the FCC is enabling CB radio manufacturers to phase-in the new standards, which, frankly, makes sense. Otherwise, production would be seriously curtailed and customers would be faced by higher price tags.

The new rules prohibit the use of internal or outboard adapters to permit 23-channel transceivers to be operated on the new channels (24 through 40). However, the FCC voted to authorize manufacturers to convert 23-channel transceivers, in stock as of November 1, into 40-channel units. Although new 40-channel equipment must meet the 5 μV /meter (stretched to 8 μV) specification for receiver chassis radiation, converted sets may radiate up to 50 μV /meter, measured at a distance of 3 meters.

Converted CB rigs (only those 23-channel units with "digital" circuitry are likely, for economic reasons, to be "convertible" by manufacturers) must carry a special label stating that they have been converted under a special FCC waiver dated November 10, 1976.

There's nothing in the new rules that prohibits the manufacture of new 23-channel units, but they promise to be supplanted by newer models with the 17 new channels added. Manufacturers of 23-channel units that do not meet the new standards must cease production by August 1, 1977, and sales must be discontinued by January 1, 1978. (Owners of these units may continue to use them, however.)

Other Changes. Other CB radio rules changes have occurred. For example, instead of having to wait weeks for a CB license before going on the air legally, you can now issue your own "temporary permit," make up your own temporary call sign, and start transmitting immediately after buying and installing a CB transceiver! When you unpack your CB transceiver, there should be a copy of FCC Form 505, a copy of FCC Form 555-B, and a copy of Part 95, FCC Rules and Regulations (the CB rules), in the carton.

You must complete FCC Form 505, the application for a CB station license and mail it to the Federal Communica-

tions Commission, P.O. Box 1010, Gettysburg, Pa. 17326. But don't send along the \$4.00 requested! Effective January 1, 1977, *CB Licenses are free!* (Rebates are expected to be sent out at a future time.) Most existing official call signs consist of three letters and four numerals (such as KDQ-1212). New ones now consist of four letters and four numerals.

Because of the high theft rate of CB mobiles, the revised FCC rules require that manufacturers engrave the unit's serial number on the chassis, making eradication difficult.

Looking Ahead. In mid-1976, the FCC formed PURAC (Personal Use Radio Advisory Committee) whose members include CB users, equipment suppliers, engineers, and others who serve the FCC in an advisory capacity. Anyone can join and attend meetings.

Standards had to be tightened so that TVI could be reduced and so that CB users would suffer less from adjacent channel interference ("bleedover" and "splatter"). With more than 7 million CB licensees operating an estimated 16 million transmitters, the problems could get worse as the CB transceiver "population" grows. Note that FCC holds the CB'er responsible for maintaining interference-free communications.

Nearly all CB transceivers are rated as being capable of nearly 100 percent modulation. Few are capable of 100 percent positive (upward) modulation, but many can achieve greater than 100 percent negative (downward) modulation on peaks. It is the negative overmodulation that causes problems. Distortion is produced and the signal can splatter onto adjacent channels or over the entire band. For this reason, the FCC is taking a hard look at modulation limiter functioning. As a result, many CB radios are no longer playing loose and fast with their AML circuitry. Therefore, expect

somewhat lower modulation capability with some 40-channel rigs.

Interference from low-power (no more than 100-mW input) "walkie-talkies" used by children can be expected to abate as the FCC no longer permits such units to be manufactured for use on the CB 11-meter band. The frequency range of these two-way radio portables has been moved to 49.82-49.90 MHz—a far cry from CB's 27-MHz band. The older walkie-talkies can be used until 1983, but most will be out of service by then.

The FCC is studying the possibility of expanding the Citizens Band in the 220-225 MHz spectrum and the 890-947 MHz band. New frequencies would also serve to accommodate the hordes of new CB users that will join the throng in future years.

What about the new 40-channel rigs? There will probably be a shortage during the first quarter of this year, but production will likely catch up to demand later in the year. The 40-channel units offer 17 new, virtually unoccupied channels which will permit clearer and longer-range reception for awhile. Moreover, the widespread use of digital circuitry makes possible electronic numerical channel displays that are easier to read, can be built into a microphone, and add a certain "class" to the rig. There are many 23-channel rigs that have this feature, too. Some of the added 17 CB channels will be subject to the possibility of interference from Industrial, Land Transportation, and Public Services licensees which will share four new channels (24, 25, 26, and 27) for another three years.

In brief, there's safety in numbers with CB radios today, with close to 20-million CB radios in use throughout the country. Emergency calls, motorist assist, and just plain talk fun can be yours at modest cost—whether you are operating with 23 or 40 channels! \diamond

BY WILFRED M. SCHERER

PROS AND CONS OF CB FREQUENCY-GENERATION METHODS

You'll be making a buying decision among crystal, frequency synthesizer, and phase-locked-loop digital when you pick a CB transceiver. Here's how each works and its attributes.

ALL RADIO transmitters (and most receivers) contain stages that generate r-f energy. These *oscillator* circuits vary in design and application. For ex-

ample, in CB transceivers, r-f signals at two or more frequencies are required to determine the transmit and receive channels.

Responding to this challenge, manufacturers employ one of three methods of frequency generation: crystal oscillators, crystal synthesizers, and phase-

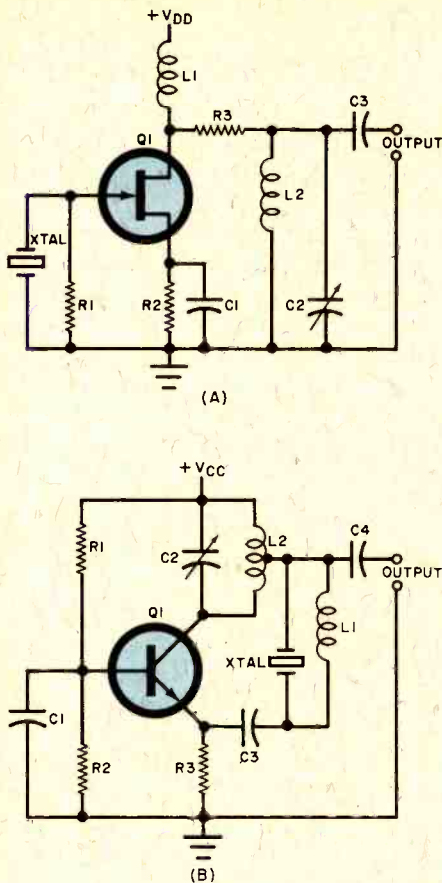


Fig. 1. Typical crystal oscillators employing field-effect (A) and bipolar (B) transistors.

locked-loop synthesizers. With the advent of 40-channel units, the latter method has been widely adopted for full-channel transceivers. Equipment with fewer channels (hand-held types, for example), however, still utilize individual crystal and crystal synthesizer systems. In this article we'll examine the strengths and weaknesses of all three approaches.

Some Basics. The receiver section of a typical transceiver is a *superheterodyne*. "Superhets" have been around for a long time, and the basic principle remains unchanged. Prior to detection, the received r-f signal is frequency shifted or converted to an intermediate frequency (i-f). This conversion is performed by the mixer stage, which heterodynes two r-f signals. That is, one signal is "beat" against another, resulting in four output signals—the two originals plus one at the sum of the two beat frequencies and one at the difference.

For example, if we heterodyne a 2-megahertz (MHz) signal with a 4-MHz one, we will obtain a signal at 6 MHz (6

MHz = 4 MHz + 2 MHz), and another one at 2 MHz (2 MHz = 4 MHz - 2 MHz). The frequencies involved in CB communications are around 27 MHz, and the i-f most commonly used is 0.455 MHz or 455 kHz.

This low i-f enables us to have receivers that exhibit high gain (to pick up weak signals) and good selectivity (to reject signals on frequencies other than that of the desired channel). To receive a Channel 13 signal at 27.115 MHz on a transceiver with a 0.455-MHz i-f, the mixer stage will beat the Channel 13 signal with one at 27.570 or 26.660 MHz supplied by a *local oscillator*. In the first case, the difference frequency (27.570-27.115) will be 0.455 MHz, and in the second, it will be 27.115-26.660, or 0.455 MHz. Note that the subtraction is made so that a positive remainder is obtained. No matter which local oscillator frequency is used, the sum frequency will be around 54 MHz. This signal will not be passed by the tuned circuits in the i-f section.

However, this receiver will suffer from poor *image rejection*, because the i-f is low compared to the original frequency, which has been mixed or converted only once. (Such a receiver is called a single-conversion unit.) It will not be able to tell the difference between the desired CB signal and one 0.91 MHz (twice the i-f)

removed. For example, a 26.205-MHz signal, if it reaches the mixer, will beat with the 26.660-MHz signal and produce a 0.455-MHz output. Similarly, if a 27.570-MHz local oscillator signal is used, a signal in the 10-meter amateur band at 28.025 MHz could be picked up simultaneously (28.025 - 27.570 = 0.455).

The image signal generally can not be attenuated by more than 10 dB or so, because the r-f circuits of the receiver must pass a band of frequencies for total coverage of the CB band. These circuits are not selective enough at 27 MHz to adequately discriminate between signals 0.91 MHz apart. However, a significant improvement in image rejection can be realized by going to a higher i-f (typically 7-10 MHz). This will place the image signal much farther away from the frequencies of interest, to a point where the r-f circuits can attenuate any image that does reach them by as much as 50 to 80 dB.

Unfortunately, at higher i-f's it's not very easy to obtain high selectivity without using expensive filters, such as those used in single-sideband (SSB) equipment. Also, the gain of i-f stages at these frequencies is usually lower than those at 0.455 MHz. Therefore, *double conversion* is often used. This system employs two mixers, two local oscilla-

TABLE I

Channels	Crystal Oscillator Frequencies in MHz			Channels
	f_1	f_2	f_3	
1-4	32.7	6.19	5.735	1, 5, 9, 13, 17, 21
5-8	32.75	6.18	5.725	2, 6, 10, 14, 18, 22
9-12	32.8	6.17	5.715	3, 7, 11, 15, 19
13-16	32.85	6.15	5.695	4, 8, 12, 16, 20, 23
17-20	32.9			
21-23	32.95			

Receive: $f_1 - f_2 - f_{sig} = 0.455$ MHz (i-f)
 Transmit: $f_1 - f_3 = f_{transmit}$
 Example for Channel 13
 Receive: $32.850 - 6.190 - 27.115 = 0.455$ MHz
 Transmit: $32.850 - 5.735 = 27.115$ MHz (transmitting frequency)

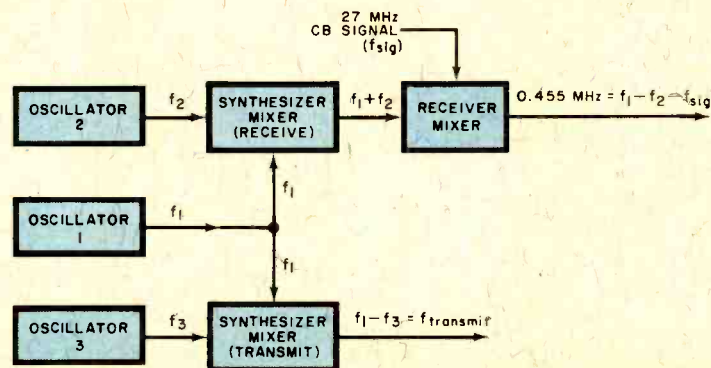


Fig. 2. Block diagram of 14-crystal, 23-channel synthesizer. Various crystal combinations are given in Table I.

tors, and thus two i-f's. The first, high i-f yields good image rejection and the second, low i-f provides high gain and selectivity.

A simple transmitter, on the other hand, does not employ heterodyning. It consists simply of an oscillator whose output is at the transmitting frequency, one or more driver stages, a modulator, and a final amplifier. However, heterodyning is used in more complex transmitters. Both types of transmitters will be examined.

Crystals and Crystal Control. Oscillators employing quartz crystals are often employed in applications (such as CB radios) demanding a high degree of frequency stability. This stability is the crystal oscillator's greatest asset, usually many times greater than that obtained from an oscillator using coil/capacitor tuned circuits as the frequency-determining elements.

The crystal oscillator's stability is derived mainly from the properties of the crystal itself, which exhibits the piezoelectric effect. That is, when physically compressed, a voltage develops across the crystal. Conversely, when a voltage is impressed across the crystal, it physically deforms. Placing the crystal in a suitable circuit (see Fig. 1.) will cause it to vibrate at a frequency determined mainly by its physical dimensions (principally its thickness).

The major disadvantage of quartz crystal frequency control is that the crystal has to be ground for *one* specific frequency, whereupon it is mounted in a sealed case. So a receiver with 40-channel capability and one intermediate frequency would require 40 individual crystals, each one ground to produce a specific output signal frequency equal to the sum of (or difference between) a particular channel frequency and the i-f. (This requirement has spurred designers to develop sophisticated circuits to reduce the crystal count, as we shall later review.)

The channel selector on the transceiver's front panel connects the appropriate crystal to the local oscillator for generation of the required frequency. More recent designs employ diode switching. That is, one side of each crystal is connected to the oscillator circuit, and the other side is connected to a switching diode, which is in turn grounded. The selector switch forward biases the appropriate diode, effectively grounding the crystal to which it is connected. All other diodes are turned off, thus keeping their crystals inactive.

It is interesting to note that the crystals in the circuits of Fig. 1 are not ground to oscillate directly at 27 MHz. Crystals capable of oscillations at such high frequencies are generally very thin and fragile, ruling out their use in high-frequency applications such as CB. Rather, *overtone* crystals are used. Here, a quartz crystal, like a violin string, can be made to physically resonate (and therefore electrically resonate) at overtones of its fundamental frequency, which does not carry the same meaning as "harmonic." The overtone is a *physical* phenomenon whose frequency differs from the harmonic due to the mechanical loading of the crystal, whereas the harmonic is an electrical phenomenon that's an integral multiple of the fundamental frequency.

Most CB crystals are specifically ground for overtone operation, and the overtone or working frequency of the crystal is stamped on its metal case.

Until a few years ago, most transceivers with 23-channel coverage used clusters of crystals. For a single-conversion receiver, 23 channels were needed. The transmitter section also required 23 crystals, but these were ground to produce outputs at the channel frequencies—not at frequencies offset from the

channels by the receiver i-f—bringing the total up to 46 crystals for 23-channel transceiver coverage. If a dual-conversion receiver were used, another crystal was added for the second i-f stage. Although the operating frequencies would be tightly controlled, crystal cost for this was too high.

Crystal Synthesizers. To produce CB transceivers at the lowest possible cost, manufacturers developed circuits to minimize the number of crystals needed for full CB coverage. The most common approach is called the *crystal synthesizer*. It uses the heterodyning principle to generate needed frequencies, and reduces the crystal tally down to 12 or 14 for 23-channel coverage.

In one synthesizer, one of six high-frequency crystals is mixed with one of four low-frequency crystals to produce a difference-frequency output which is the required frequency of heterodyning on receive. Similarly, one of four other low-frequency crystals is used in conjunction with one of the six high-frequency crystals to produce the transmit frequency. The various combinations required for each channel are given in Table I. The block diagram of the system is shown in Fig. 2.

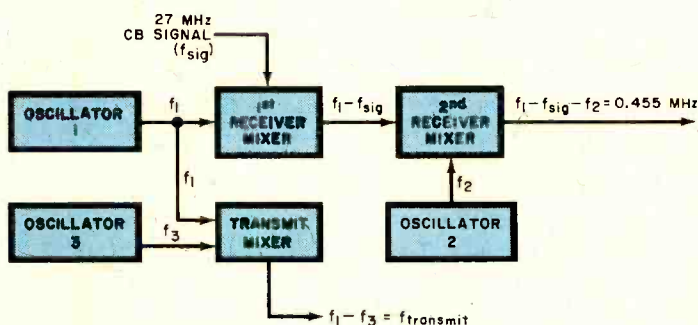


Fig. 3. This 23-channel crystal synthesizer has dual conversion on receive. Crystal combinations in Table II.

TABLE II

Channels	Crystal Oscillator Frequencies in MHz			Channels
	f_1	f_2	f_3	
1-4	37.6	10.18	10.635	1, 5, 9, 13, 17, 21
5-8	37.65	10.17	10.625	2, 6, 10, 14, 18, 22
9-12	37.7	10.16	10.615	3, 7, 11, 15, 19
13-16	37.75	10.14	10.595	4, 8, 12, 16, 20, 23
17-20	37.8			
21-23	37.85			

Receive: $f_1 - f_{sig} =$ approximately 10.6 MHz (first i-f)

$f_1 - f_{sig} - f_2 = 0.455$ MHz (second i-f)

Transmit: $f_1 - f_3 = f_{transmit}$

Example for Channel 13

Receive: $37.75 - 27.115 = 10.635$ MHz (first i-f)

$37.75 - 27.115 - 10.18 = 0.455$ MHz (second i-f)

Transmit: $37.75 - 10.635 = 27.115$ MHz (transmitting frequency)

TABLE III

AM/SSB Crystal Synthesizer

f_1 —one of six crystal frequencies near 22 MHz
 f_2 —one of four crystal frequencies near 12.8 MHz
 f_3 —b.f.o. at 7.8 MHz
 f_4 —7.345 MHz
 Receive:
 $f_1 + f_2 - f_{sig} = 7.8$ MHz (first i-f)
 $f_1 + f_2 - f_{sig} - f_4 = 0.455$ MHz (second AM i-f)
 $f_1 + f_2 - f_{sig} - f_3 =$ voice frequencies
 Transmit: $f_1 + f_2 - f_3 = f_{transmit}$
 Example:
 SSB— $22 + 12.8 - 27 = 7.8$ MHz (first i-f)
 $7.8 - 7.8 =$ voice frequencies
 AM— $22 + 12.8 - 27 = 7.8$ MHz (first i-f)
 $22 + 12.8 - 27 - 7.345 = 0.455$ MHz (second i-f)
 Transmit: $22 + 12.8 - 7.8 = 27$ MHz (transmitting frequency)

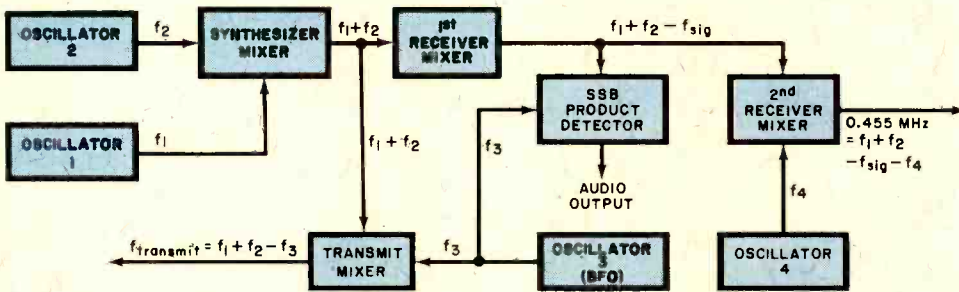


Fig. 4. Crystal synthesizer for a 23-channel AM/SSB transceiver. Crystal combinations are given in Table III.

Another standard 23-channel configuration using 14 crystals is shown in Fig. 3, but this one provides dual-conversion on receive. In this case, the first i-f is at approximately 10.6 MHz, produced by heterodyning one out of six high-frequency crystals with the received CB signal, and extracting the difference frequency. This i-f is, in turn, mixed with one of four lower-frequency crystals to produce the second 0.455-MHz i-f. Transmit frequencies are generated by single-conversion using one of the six high crystals and one of the four low crystals. The necessary combinations are listed in Table II.

The total number of crystals can be reduced to 12, but, unfortunately, reduction in crystal count is offset by the need for an extra oscillator and another mixer.

Other crystal frequencies can be used in these synthesizer systems as long as the sum or difference signals provide the required i-f or i-f's as well as the corresponding transmit channel frequency.

Single Sideband. So far, we've considered crystal control and synthesis for AM rigs. Now, let's examine what happens in SSB gear.

Single sideband is a more efficient

method to transmit information. Instead of sending two mirror image sidebands and a carrier, as is done in AM systems, SSB signals contain only one sideband and no carrier. Eliminating one sideband has no effect on the information contained in the total signal because both contain exactly the same components. The carrier, on the other hand, contains no information *in itself*, but it must be present in one way or another at the receiver for the extraction of the information in the sidebands.

If the carrier is not transmitted, the receiver must re-insert an equivalent carrier

before the signal is detected. This job is handled by the *beat frequency oscillator*, whose output is mixed with the signal (usually after one or more stages of conversion) in the *product detector*. The output of the product detector, if the b.f.o. is exactly on the proper frequency (set by the *clarifier*), is a fair rendition of the other operator's voice.

SSB transceivers require sharp filters because the transceiver must ignore the other sideband, which is very close to the desired one. But since we need a narrow filter anyway, it's usually not worth going to dual conversion. The image frequencies are well removed from the operating *passband* of the filter. When single conversion is used, the basic 12-crystal synthesizer can be used with some modifications. However, this works for SSB only.

Almost all rigs that have SSB provisions also include AM, and a common arrangement used in these dual-mode transceivers is shown in Fig. 4. On SSB, single conversion to a 7.8-MHz i-f is used. Dual conversion is used for AM signals, and the first i-f is mixed down to 0.455 MHz. (See Table III.)

The 23-channel crystal synthesizers discussed are being neglected now in favor of phase-locked-loop (PLL) or digital circuitry that uses far fewer crystals. The principle is even more important in considering the new 40-channel rigs where, using crystal synthesizers, additional crystals and more complex switching would be needed.

Digital Synthesizers. Using the so-called digital or PLL synthesizer, a full-coverage transceiver requires only two or three crystals and the synthesizer itself only needs one. (The other one or two are used in heterodyning stages.)

A basic synthesizer (Fig. 5) is composed of a *reference oscillator*, a *phase-locked loop*, a Schmitt trigger, a *phase comparator*, a *low-pass filter*, a *phase comparator*, a *low-pass filter*, and an *error amp*.

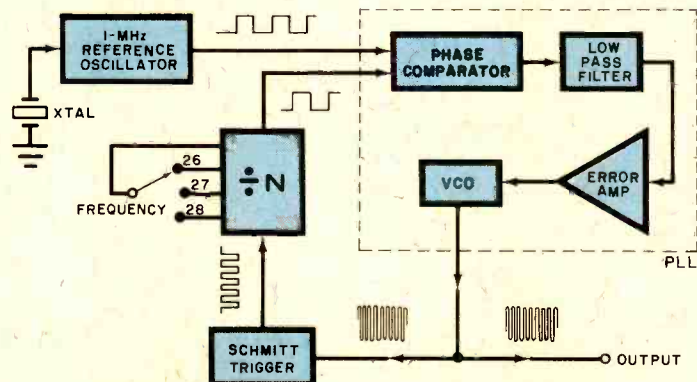


Fig. 5. A basic digital frequency synthesizer. Many frequencies can be generated using one reference crystal.

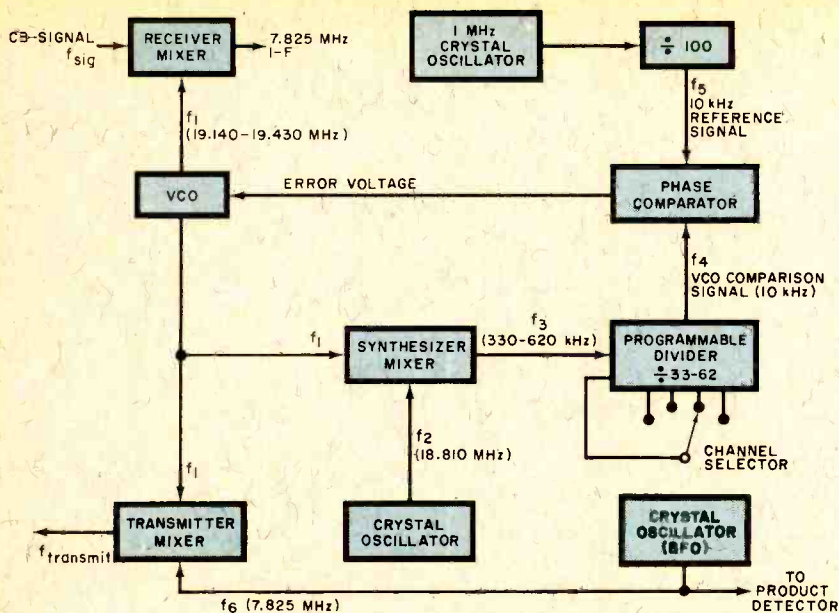


Fig. 6. A digital (PLL) synthesizer for AM/SSB use.

ror amplifier. The reference oscillator is a crystal-controlled circuit that produces a stable, known frequency which will be used as a reference. This phase comparator samples the frequencies of two input signals and produces an output voltage that is directly proportional to the frequency difference of the inputs. The low-pass filter smooths this error signal into a dc level. The voltage-controlled oscillator or VCO is an oscillator whose output frequency varies directly with the level of a control voltage applied to it. The Schmitt trigger converts sine waves into square waves, and the $\div N$ circuit divides the frequency of an applied square wave by a whole number, N .

Now that we've defined some essential terms, let's consider (for simplicity's sake) the operation of a synthesizer that will generate one of three separate frequencies—26, 27, and 28 MHz.

The reference oscillator produces a steady square wave (sketched at its output in Fig. 5), whose frequency is governed by a 1-MHz crystal. At the same time, the VCO is oscillating at a frequency which we'll assume to be 26.52 MHz. We'll further assume that the FREQUENCY switch in the $\div N$ circuit is set at 26. The output of the VCO is "squared up" by the Schmitt trigger, as shown in Fig. 5, and is divided down to 1/26th of its original frequency by the $\div N$ circuit. Thus, two signals are applied to the phase comparator—one at exactly 1 MHz and the other at 1.02 MHz.

The output of the phase comparator will be an error voltage because the reference frequency is lower than that of the VCO (after it has been divided down). The lowpass filter will smooth out

this voltage, which is amplified by the error amplifier. The amplified error voltage is applied to the VCO, and will cause the frequency of the VCO output to decrease. As the VCO frequency approaches 26 MHz, the output of the $\div N$ circuit approaches 1 MHz. In turn, the error signal gets smaller and smaller, and eventually disappears when the VCO is running at exactly 26 MHz. At that point, the frequency at the $\div N$ output is exactly 1 MHz, and is exactly in step with the output of the reference oscillator.

If we then turn the FREQUENCY switch to 27, the VCO momentarily keeps running at 26 MHz. Its output is now divided by 27, and the frequency applied to the phase comparator is about 0.98 MHz. The resulting error voltage is smoothed, amplified, and applied to the VCO, whose frequency moves upward. As it approaches 27 MHz, the error signal gets smaller and smaller, until the VCO is running at exactly 27 MHz. A similar

chain of events now occurs if the FREQUENCY switch is set at 28.

The enormous advantage of the digital or PLL synthesizer is that we can obtain any number of frequencies from the circuit merely by changing the frequency divider ($\div N$) circuit. All synthesized frequencies are as stable and as accurate as the one reference oscillator. Moreover, being digital, it's easy to create lighted electronic-generated numerals to identify channel numbers.

Practical Circuits. A complete PLL-synthesis system used in a 23-channel, single-conversion AM/SSB transceiver is shown in Fig. 6. The VCO operates in the 19.140-to-19.430-MHz range to provide a local oscillator signal. This signal is heterodyned on receive with the incoming CB signal, resulting in a 7.825-MHz i-f. The VCO comparison signal is obtained by first mixing the VCO output with the 18.810-MHz output of a crystal oscillator. Difference frequencies ranging from 330 to 620 kHz appear at the output of the synthesizer mixer. This, in effect, functions as an automatic pre-dividing system.

The difference frequency for a given VCO output frequency is then divided by the programmable divider. In this stage, the amount of frequency division, ranging from $\div 33$ to $\div 62$, is determined by the setting of the channel selector. The resulting VCO comparison signal, at approximately 10 kHz, is then applied to a phase comparator, as is a 10-kHz reference signal. This reference is obtained by dividing the output of a 1-MHz, crystal-controlled oscillator by a factor of 100. The output of the phase comparator is an error voltage that shifts the VCO output until it is "on channel."

When the channel selector is set to Channel 13 and the transceiver is in the receive mode, an incoming signal at 27.115 MHz is heterodyned with the

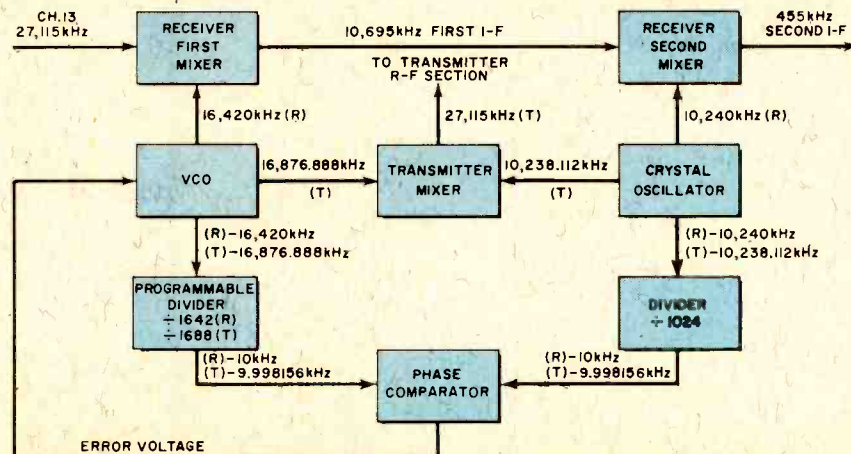


Fig. 7. Digital synthesizer for AM with dual conversion on receive.

VCO's 19.290-MHz output to produce the 7.825-MHz i-f. Simultaneously, the VCO output is beated with the 18.810-MHz crystal oscillator output, and a difference signal at 480 kHz is extracted. This is divided by a factor of 48 in the programmable divider to produce a VCO comparison signal at 10 kHz. If the VCO drifts slightly, an error voltage is produced to correct the frequency shift. On transmit, the VCO output at 19.290-MHz is heterodyned with a 7.825-MHz crystal oscillator output to produce a sum frequency of 27.115 MHz. This 7.825-MHz crystal oscillator is also used as the bfo on receive.

A PLL synthesizer for a 23-channel AM transceiver with a dual-conversion receive section (to improve image response) is shown in Fig. 7. On receive, an incoming Channel 13 signal at 27.115 MHz is heterodyned with the 16.420-MHz VCO output to generate a 10.695-MHz first i-f. (The full range of the VCO is 16.270 to 16.560 MHz.) The first i-f is then heterodyned with the output of the reference oscillator. In the receive mode, this reference signal has a

frequency of 10.240 MHz. Extracting the difference signal results in a 455-kHz second i-f. The reference oscillator output is divided by a factor of 1024 and applied to the phase comparator at a frequency of 10 kHz on receive. At the same time, the VCO output is divided by a factor of 1642, and the resulting 10-kHz signal is applied to the phase comparator. For 23-channel receive coverage, the dividing factor is varied from 1627 to 1656.

On transmit, the VCO and reference oscillator outputs are heterodyned by the transmitter mixer, and the sum frequency is extracted. For this sum signal to be at the center frequency of Channel 13, the VCO output frequency must be increased 455 kHz, the i-f frequency. However, there is no integer that, when divided into the new VCO frequency, will result in a quotient of exactly 10 kHz.

The foregoing problem is solved by shifting the reference oscillator output downward by 1.888 kHz to 10.238112 MHz. Dividing this new reference by 1024 results in an output at 9.998156 kHz. Then, by increasing the new VCO

frequency slightly (from 1.861 to 1.914 kHz, depending on the setting of the channel selector), and by programming the divider for a factor in the 1646-1702 range, the VCO comparison signal will also be 9.998156 kHz. The feedback arrangement of the PLL will keep the VCO and the sum of the VCO and the reference close to their ideal values.

The basic 23-channel PLL system is the obvious system used in the new 40-channel rigs. The only real modifications required are expansion of the programmable divider and the use of a VCO with wider range. Fortunately, these are readily accomplished, and some manufacturers are even offering to modify their existing 23-channel "digital" rigs for full 40-channel coverage.

The most exciting development in PLL synthesis is the development of LSI systems. That is, the production of complete PLL synthesizer circuitry in one or two large scale integrated circuits, requiring few additional external components. This methodology is clearly the wave of the future for generating frequencies for CB. ◇

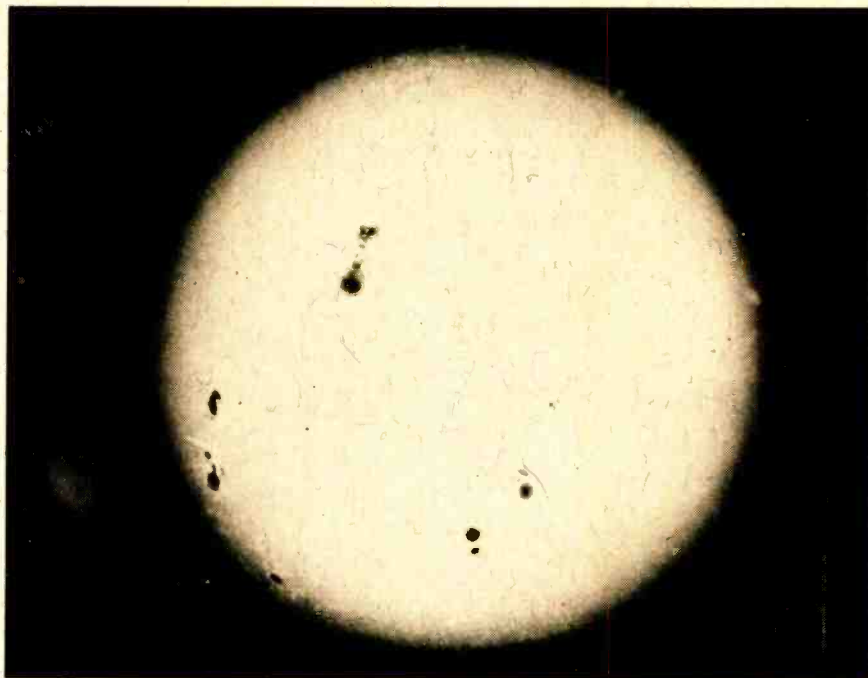
WILL SUNSPOTS AFFECT CB COMMUNICATIONS?

Sunspots, the ionosphere, and CB propagation prospects.

BY STANLEY LEINWOLL

Last summer, many CB newcomers were startled when, without warning, they heard signals coming in from great distances, in some cases, from as far as 1000 miles. Then, late in August, the phenomenon stopped as abruptly as it had begun.

The phenomenon observed was, of course, skip. It occurs when conditions are such that signals are propagated over distances far greater than their normal range. To those CB'ers who use the band for short-range two-way communications in accordance with FCC rules (150-mile maximum), skip can be a nuisance if it increases channel crowding. For some, skip is exciting and fascinating (but illegal). Although the rash of summer skip was short-lived, a new factor is coming into play that will likely increase its frequency—sunspots. Some people knowledgeable in the field of radio propagation are predicting that, in a few years, coast-to-coast skip will occur regularly. This, they assert, will cause a



The sun exhibits high sunspot activity on June 24, 1957 (U.S. Navy photo).

"traffic jam" on the Citizens Band. Others, however, including Eugene Parker, Chairman of the University of Chicago's Department of Astronomy and Astrophysics, and originator of the concept of the "solar wind," feel that no serious disruption of the Citizens Radio Service will take place.

To fully understand the propagation events that took place last summer, why the same conditions will recur this summer, and what the outlook for the 11-meter band might be for coming years, let's discuss the fundamentals of radio propagation at CB frequencies.

How a Radio Signal Travels.

When a radio wave leaves a transmitting antenna, it travels outward in all directions and moves simultaneously along the ground and through space. The component that travels along the ground remains in contact with the earth until it dies out. The effect of the earth on this ground wave signal is much like that of friction on a rolling ball. The loss of energy to friction slows the ball down and finally brings it to a complete halt.

Although radio waves do not slow down (they travel at the speed of light in a given medium), their amplitudes or field strengths rapidly diminish as they move along the ground. How great the attenuation is for a specified distance depends on the type of ground over which the signal passes. In general, flat or smooth earth extracts less energy than rough or hilly terrain, and moist or rich soil attenuates less than dry, sandy, or rocky earth. In general, 11-meter ground wave signals do not travel more than five or ten miles before they are "exhausted."

The Space Wave. There is another path that signals take upon leaving the antenna. It is a straight line through the lower atmosphere. This direct or space wave propagates directly from the transmitting antenna to the receiving antenna if the two are within sight of each other.

This mode of transmission is also called line of sight. Obviously, the higher above ground the antennas are, the greater the distance covered. For example, the television antennas atop the Empire State Building in New York City are mounted at heights exceeding 1,000 feet and provide line-of-sight coverage for more than 50 miles in all directions from the city. In contrast, the line-of-sight distance for antenna heights of ten feet is about three miles. If both antennas are raised to 50 feet above the ground, coverage is extended to 18 miles.

In addition to height above ground, atmospheric effects sometimes influence line-of-sight range, but these are not as significant as antenna elevation. The space wave always travels relatively short distances—rarely more than 25 to 30 miles. Its most desirable characteristic is that its range does not change radically from night to day, from one season to the next, or from year to year.

The Sky Wave and the Ionosphere. Figure 1 reveals a third component of the radiated signal, one which travels upward toward outer space. The signal is shown striking a region in the upper atmosphere and being returned to earth some distance from the transmitter. If it were not for this atmospheric region, called the ionosphere, most long-distance, high-frequency communication would be impossible, and there would be no such thing as Citizens Band DX.

The ionosphere is an electrified region which begins at an altitude of about 60 miles (97 km) and extends several hundred miles up. It has the ability to reflect radio signals in the frequency range be-

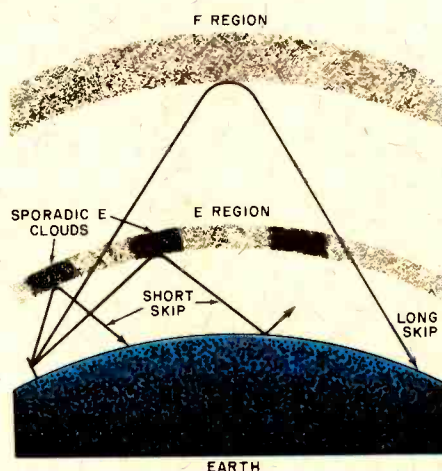


Fig. 1. Sky waves can be reflected by the E (short skip) or F (long skip) regions of ionosphere.

tween about 2 and 30 MHz and return them to earth. The radio signal that travels to the ionosphere and returns to earth is called the sky wave. From here on, our discussion will deal solely with sky-wave signals and how they depend on the ionosphere for propagation over long distances.

The ionosphere is formed primarily by ultraviolet and X-radiation from the sun, which interacts with the gases in the upper atmosphere. In the process, some of the gas atoms lose one or more electrons. A gas atom that has lost an elec-

tron is called an ion. Actually, the free electrons in the ionosphere are responsible for the propagation of radio waves over long distances. A radio wave entering the ionosphere causes the free electrons to vibrate. Each oscillating electron acts like a tiny antenna, and radiates energy.

Ionization, and hence, free electrons, concentrate at different altitudes because ultraviolet radiation occurs over a relatively wide range of frequencies, and these penetrate to different levels. Because the gases in the upper atmosphere respond to various wavelengths in the ultraviolet range, there is a tendency for free electrons to concentrate into stratified layers, or regions. The most important layers of the ionosphere in terms of propagation of radio waves are the E and the F layers.

The E layer exists primarily during the day at an altitude of about 60 miles (96.6 km). During the daylight hours of the summer months, the E layer can reflect 11-meter signals up to distances of about 1000 miles (1610 km). This effect, which is sporadic in nature, is one of the most important means of propagating signals on the Citizens Band.

Sporadic-E Propagation. Sometimes, at the lower limits of the E layer dense clouds or patches of electrons are created. They are able to reflect frequencies much higher than normal. These clouds are random in nature and relatively short lived, lasting no more than several hours. Accordingly, they are called sporadic-E or E_s clouds. Because of the high electron density in E_s patches, they are often capable of propagating 11 meter signals.

Since the height of E_s is about 60 miles (96.6 km), the distance to which an E_s propagated signal can travel is limited to approximately 1000 miles (1610 km). For this reason, E_s openings are usually referred to as *short-skip* propagation, as opposed to *long skip*, in which propagation takes place via the higher F layers.

E_s activity varies with the time of the day and season of the year. It is most common from late spring to mid-August. There is a secondary peak during the winter months, but it is not as intense as summer activity. E_s occurs most frequently during the daylight hours, peaking in the early afternoon. This past summer E_s was also common during the evening hours.

E_s activity also varies with latitude. The further south we go, the more intense and frequent sporadic-E openings

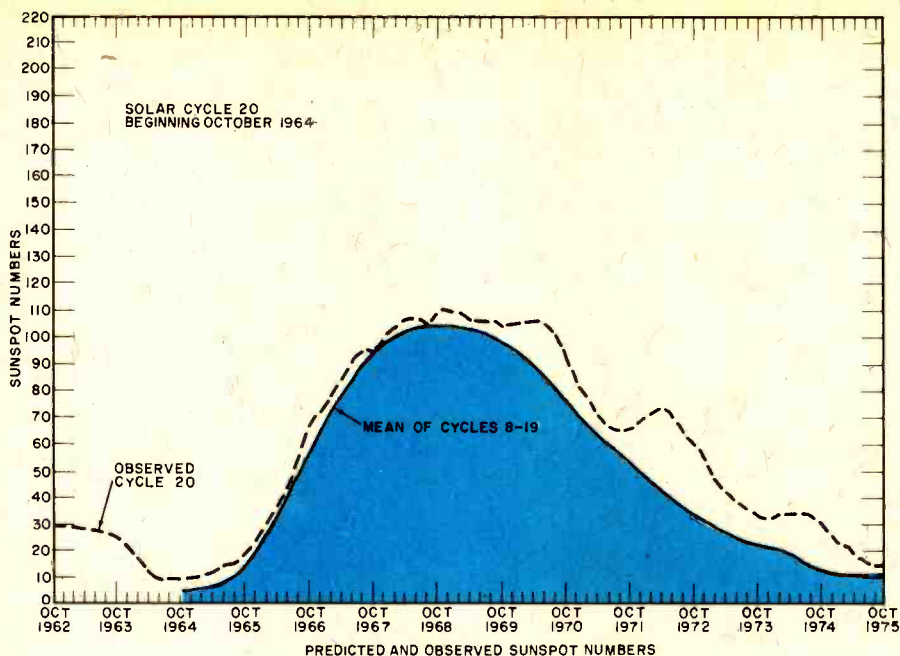


Fig. 2. Predicted and observed sunspot counts for the mean of cycles 8-19 and for the one now ending (20).

become. Consequently, circuits across the southern United States observe this effect more frequently than those in more northerly latitudes.

The mechanism that produces E_s is not clearly understood. However, a relatively recent theory of an Australian scientist, Dr. J. D. Whitehead, appears to have gained wide acceptance. Dr. Whitehead explains E_s as due to wind shears—a transient upper atmosphere condition in which the wind velocity at E -layer altitudes is zero, while wind velocities immediately above and below approach 200 miles per hour and are in opposite directions. When this happens, free electrons are pulled from above and below into the zero-velocity region, resulting in E_s clouds. Dr. Whitehead's theory, which also involves the action of the Earth's magnetic field, explains the seasonal nature of E_s , as well as its variation with latitude.

Long-Term Outlook—The F Layer.

The action of E_s explains the occurrence of CB DX during the summer months. What happens during the rest of the year is dependent on events that take place in another part of the ionosphere, collectively referred to as the F layer.

The F layer is more important than the E layer because it is always present, day and night, season after season. It makes long-distance, shortwave communication possible. Because the 11-meter band is at the upper end of the short wave or high-frequency part of the spectrum, it has a strong influence over CB

DX propagation. To understand the role of the F layer in CB propagation, let's briefly discuss how it changes on a daily and a seasonal basis.

The intensity of ultra-violet radiation reaching the F region of the ionosphere is subject to considerable variation. It changes from day to night, from season to season, and between one point on the surface of the earth to another. In addition, there are year-to-year changes which occur over an eleven-year cycle. These latter changes depend on sunspots, which emit ultraviolet radiation. Some years, there are many more sunspots than in others. Consequently, radiation from the sun is greater during those years. The ionosphere can then reflect higher frequencies than when radiation is at relatively low levels. Let's go into these variations in greater detail:

●**Diurnal Variations.** During the day radiation from the sun is most intense. As a result, ionization is at a maximum, and the frequencies that the F region can reflect are higher during the day than at night. At night, in the absence of direct radiation from the sun, ions and free electrons begin to recombine, and the region becomes less electrified and less dense. Consequently, it loses its ability to reflect frequencies at the high end of the shortwave spectrum. As a result, CB DX is almost *never* possible via the F region during nighttime hours.

●**Seasonal Variations.** It is obvious that the more hours of daylight there are in a day, the longer high frequencies will be propagated by the ionosphere. During the daylight hours, therefore, higher

frequencies are reflected by the ionosphere in wintertime than those reflected in the summer.

●**Geographical Variations.** As we move towards the equator, the sun is more directly overhead for longer periods. Because the effect of radiation on the ionosphere also depends on the angle of incidence of this radiation, it is evident that the closer to the equator we are, the higher the frequencies we can expect to use.

The Sunspot Cycle. If diurnal, seasonal, and geographical variations were the only factors affecting ionization levels, then the same conditions would prevail from one year to the next at the same geographical location, and the pattern of usable frequencies over a particular circuit would be a simple matter to predict. Unfortunately, that is not the case.

One of the most important factors influencing the behavior of the ionosphere is sunspot activity. Sunspots are enormous craters of hot, whirling gases on the surface of the sun. Although the nature and origin of sunspots are not fully understood, it is known that they are one of the principal sources of ultraviolet radiation from the sun. Because ultraviolet radiation affects the ionosphere, the importance of sunspots is clear. Sunspots, which are imbedded in the sun, move across its face in an east to west direction as the sun rotates. It takes a spot approximately 13 days to move across the visible face of the sun. That's about half of the solar period of rotation.

In the middle of the 18th Century, accurate records of sunspots were initiated. It was observed that sunspot changes occurred in a regular manner. In Fig. 2, the solid line also shows the average of all cycles observed since the middle of the 19th Century. It can be seen that a sunspot cycle goes from minimum to maximum and back to minimum in approximately eleven years. But the cycle is not symmetrical. It takes 3 to 4 years to go from minimum to maximum, and about 7 years to go from maximum to minimum. It should be noted, however, that some cycles have been as short as nine years while others have been 13 years long.

Figures 3 and 4 illustrate the importance of sunspot activity on CB propagation. These figures show the predicted range of frequencies useful for communications between the East and West Coasts of the U.S. for the present and several years hence, when sunspot activity will have increased to the point

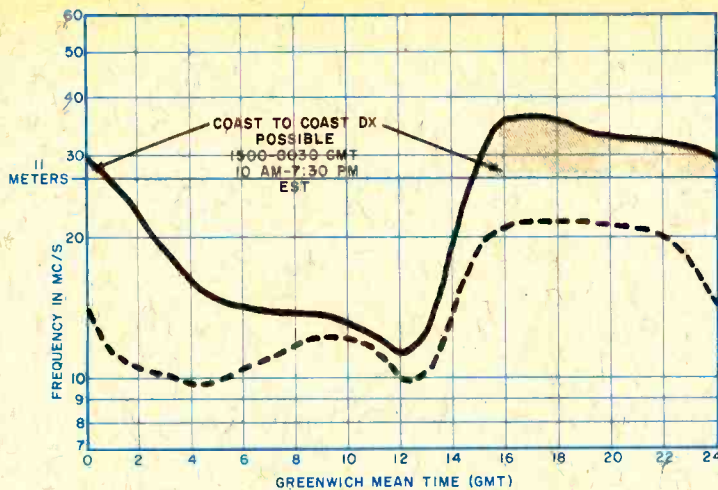


Fig. 3. Solid line is propagation curve showing highest usable frequencies during sunspot minimum and maximum in winter months.

where CB signals will propagate more regularly via the ionosphere. For the winter of 1979-80 (Figure 3) we can see that coast-to-coast reception will be a

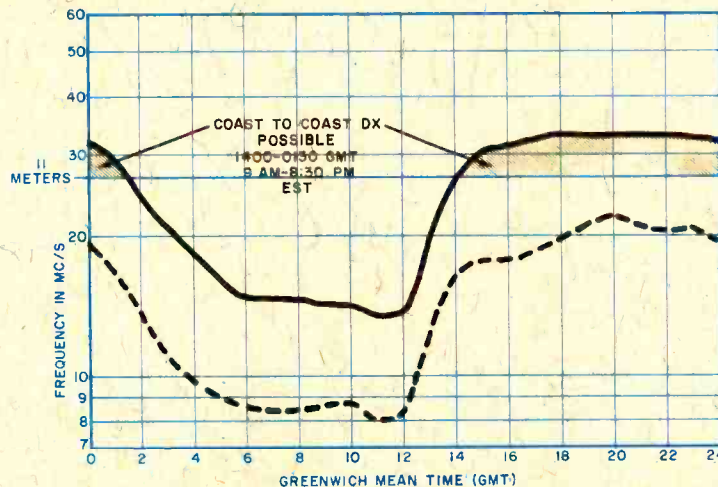


Fig. 4. Same as Fig. 3 for spring and fall. In both cases, dashed lines indicate currently useful frequencies.

possibility between the hours of 1500 and 0030 GMT or 10 a.m. to 7:30 p.m. EST. For the spring and autumn months (Figure 4), coast-to-coast reception of CB signals will at least be possible from 1400 to 0130 GMT, or 9 a.m. to 8:30 p.m. EST. In contrast, the currently useful frequencies (shown by the dashed line) indicate that no CB DX reception will be generally achievable at any time of day.

The upper limit of frequencies the ionosphere will reflect even during maximum sunspot activity also depends on the distance between the transmitter and the receiver. At periods of high sunspot activity, some DX might occur around midday for distances of about 1000 miles and beyond. The further the separation, the longer the opening.

Once the openings start occurring, how long will they last? Well, a look back at Figure 2 indicates that about half the cycle registers numbers of 90 or more. It is at that cutoff point that ionization is high enough to give more regular CB openings. We can therefore predict at this time that 1979 and a few later years should see more CB DX openings than at present, although intensity is speculative since the sunspots are not on a true regular cycle. When the foregoing sunspot peak occurs, it may be a temporary nuisance to some CB'ers and a listening bonanza for others. The difference depends on when the peak really occurs and the extent of the sunspot buildup. In any event, don't worry about it because it cannot be controlled and it will pass soon enough. ◇

HOW EXTERNAL SPEAKERS CAN IMPROVE MOBILE CB PERFORMANCE

BY STEPHEN R. DAVIS

OF ALL the accessories currently available for use with mobile CB transceivers, the external speaker is perhaps the one most often overlooked. However, the addition of such a speaker can often dramatically increase the reception by improving voice intelligibility.

A speaker, whether it is inside the transceiver cabinet or outside, converts the received and detected r-f signals into an intelligible replica of the other operator's voice. It must do so without introducing an appreciable amount of distortion, and should respond only to those frequencies which convey useful information. Let's consider the practicalities of CB speaker performance by evaluating a number of influential factors—starting with the human voice itself.

Speech Characteristics. Four basic qualities denote human speech: am-

plitude or intensity, frequency, harmonic content and time functions. The corresponding aural characteristics are loudness, pitch, tonal quality, and time perception or speed of sound production.

Speech is by no means constant in intensity. Some sounds are accented and loud, others are soft. The wide dynamic range of speech places special demands on the hardware in a voice communications link. Soft sounds, such as consonants, are much more likely to be washed out by ambient noise than vowels. But voice articulation, and hence intelligibility, is greatly dependent on the clear reproduction of consonants.

Male voices generally occupy the bandwidth shown in Fig. 1. The range of generated frequencies is about 300 to 6000 Hz. Vowel sounds are found from about 300 to 1000 Hz, and average about 20 dB above consonants, which are found from 1000 to 6000 Hz. This makes consonants much more vulnerable to noise than vowels, and that's why radio operators are often forced to resort to phonetics such as *Bravo, Delta*, and *Tango* to distinguish *b, d*, and *t*. Also, some communications gear includes special signal-processing circuitry to reduce the consonant-masking effects of high-frequency noise.

Another factor influencing intelligibility is the rate of speech. Many listeners tend to miss key words in radio broadcasts when the announcer is averaging a snappy 200 words per minute. However, the 100-word-per-minute delivery by Franklin D. Roosevelt allowed an entire nation to absorb and reflect upon his famous "fireside chats." Among the time elements at work here are the lengths of individual sounds, the ratio of speech elements to pauses, and the rate at which complete words are spoken.

The Human Ear. For true communication, there must be a speaker and a listener, whether they are standing face to face or separated geographically but linked by a telecommunications network. In the latter case, the link hardware must be designed to work not only with the human voice, but also with the human ear.

The ear will accept a wider range of both sound amplitudes and frequencies than the voice is capable of producing. From the threshold of hearing—0 dB, or 0.0002 dynes/cm²—it can tolerate inputs up to three trillion times greater. The average range of frequencies the ear can detect is from 20 to 15,000 Hz. However, its response depends on amplitude, as demonstrated by the famous

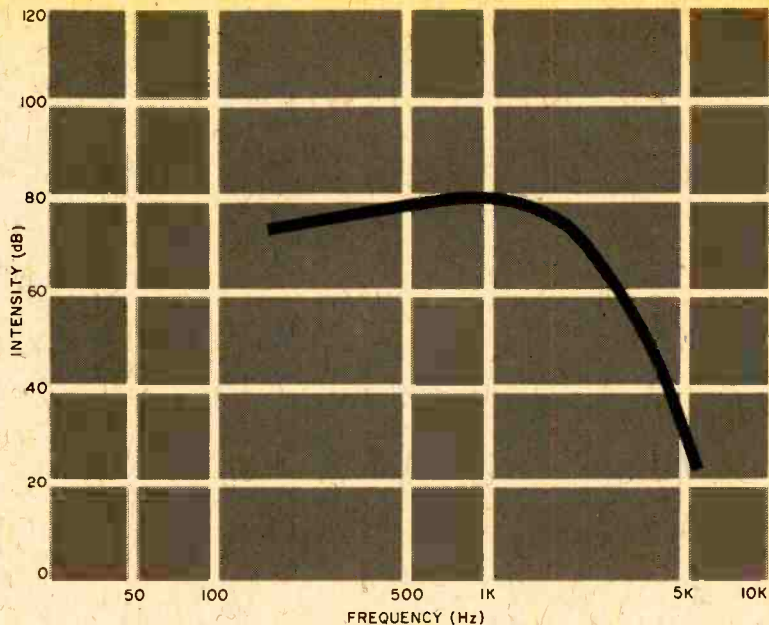


Fig. 1. Bandwidth of the average male voice.

Fletcher-Munson curves. Hearing is keenest over the 1000-to-5000-Hz segment. That's where the consonants are.

There are, however, some practical difficulties which result from the ear's response. Under certain circumstances, the ear will fail to distinguish one sound from another. This is called the masking effect, and is expressed as the increase (in dB) in the threshold of audibility of one sound when "masking" noise is introduced. It is shown graphically in Fig. 2, which indicates that it is harder to hear bass and treble sounds in a noisy environment than those in the midrange. Also, the graph shows that consonant

sounds are more readily masked than vowels.

Environment. In addition to the masking effect, a host of other environmental factors influence intelligibility. Absorption of high-frequency sounds can further diminish consonant strength. Such absorption often occurs in a mobile environment when the sound does not travel directly from transducer to listener, but rather is reflected by soft surfaces. Carpeting and upholstery are the prime offenders. However, if a reflecting boundary is hard, annoying reverberations can result. In the absence of reflections and

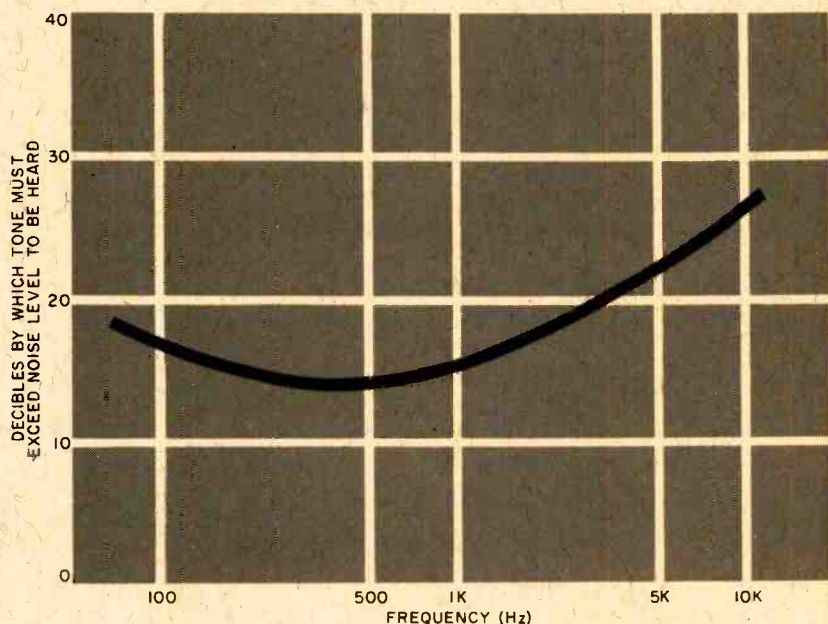


Fig. 2. When noise is present, desired sound must be increased in volume to preserve intelligibility.



Photo shows external speaker in typical under-dash position.

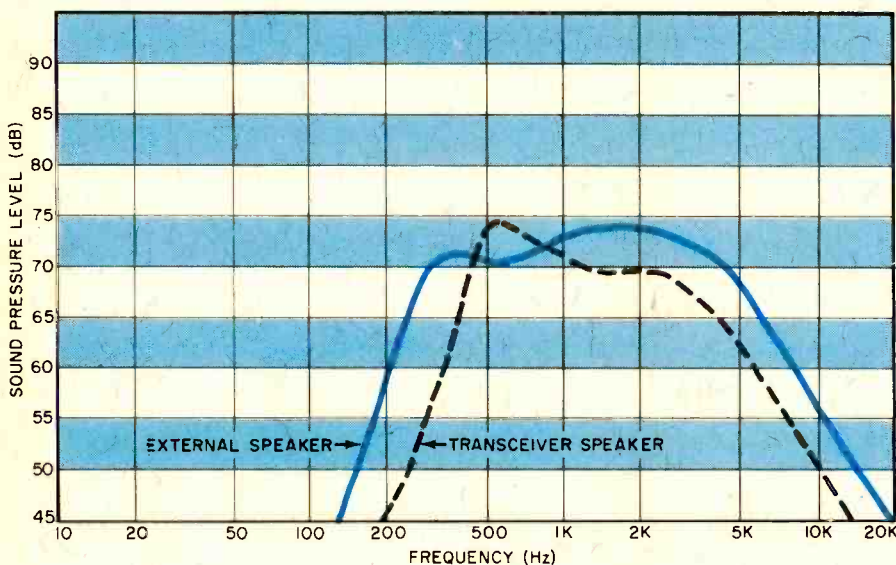


Fig. 3. On-axis response of transceiver's internal speaker (dashed) vs. Acoustic Fiber Sound Systems' "Kriket" KCS-35 external communications speaker (solid) in anechoic chamber.

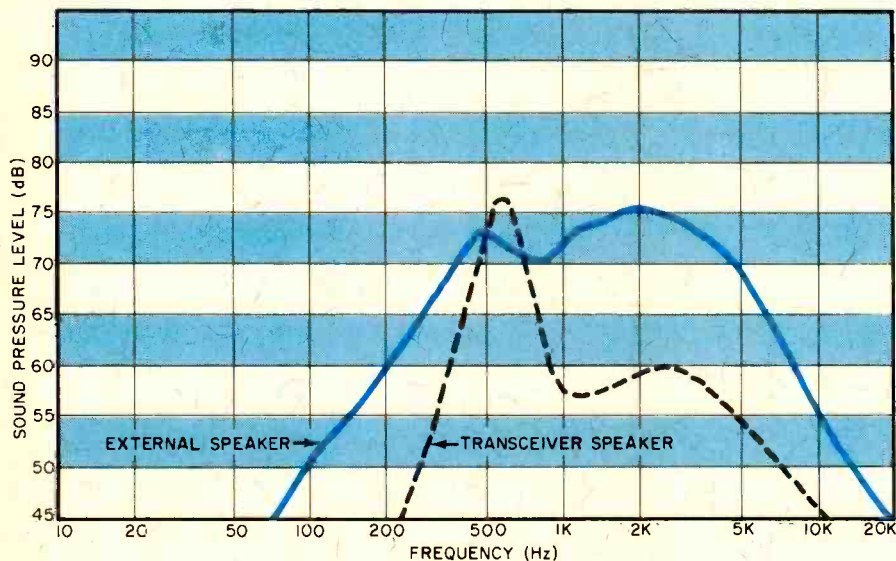


Fig. 4. Frequency response of internal (dashed) and external speaker (solid), both as mounted in typical mobile installation.

reverberation, sound levels diminish in direct proportion to the distance between the sound source and the listener. Of course, there may be sound sources present whose outputs are either above or below the bandwidth of the voice. If their levels are appreciable, intelligibility is adversely affected.

Hardware Considerations. Thus far we have considered the roles played by the human ear, voice, and the intervening environment. Now let's see how the communications gear itself affects the situation.

Properly designed voice communications systems should have an audio frequency response—both at the transmitter and receiver—which is best for those frequencies carrying the desired information. Conversely, they should ignore all sounds outside the useful bandwidth. In the course of modulation, transmission, reception, and demodulation, a minimum of electrical noise should be introduced.

To best illustrate the effects discussed, let's consider a communications system with which we are all familiar—the mobile CB installation. The mobile environment of a car, van or truck generates ambient noise in the 200-to-500-Hz range. High frequencies are attenuated by padding, carpeting, etc. Wideband (wind) noise can be considerable at highway speeds. Electrical noise can be suppressed if care is taken in grounding all parts of the vehicle body and chassis, and by shielding the ignition system if necessary. Given the sophisticated circuitry of today's CB transceivers, unwanted noise generated by the rigs themselves can be neglected.

The major weak point in most rigs is the internal speaker. For one, its frequency response is usually far from ideal. For example, the dashed curve in Fig. 3 shows the frequency response of a typical transceiver with an internal speaker, as measured in an anechoic chamber using a microphone placed one meter in front of the speaker.

This transceiver was then mounted under the dash of a standard size American automobile and its frequency response measured with the microphone positioned to coincide with the average listener's ear. The resulting response is shown as the dashed curve in Fig. 4.

Obviously, the automotive environment had a marked influence on the overall response. Because the transceiver's speaker is mounted on the underside of the enclosure, it was pointing directly towards the floor. Also, the mi-

crophone was about 120 degrees off the front axis of the speaker, and most of the sound reaching it was reflected by the carpeting and upholstery. Predictably, poor high-frequency performance was observed.

A dramatically different result was obtained with an external speaker designed for voice communications. First, a frequency response test was performed in an anechoic chamber. The solid curve in Fig. 3 is the result of this test. Then the speaker was mounted in the automobile so that its front axis of radiation was facing the listener (microphone). Again, its frequency response

was measured, and appears as the solid curve in Fig. 4. The frequency response of the external speaker was broader and more uniform over those frequencies essential to voice intelligibility.

This can be explained by considering three factors. First, the external speaker has an inherently better frequency response, as indicated by the anechoic chamber tests. Second, the microphone—positioned at the location of the typical listener's ear—was on axis with the front of the external speaker. Therefore, it received the maximum portion of the high-frequency energies radiated by the speaker. Finally, because most of

the sound incident upon the microphone was directly radiated by the speaker, there was minimal alteration of the audio output signal by environmental characteristics of the car's interior.

In other words, the external speaker performed comparably in both the artificial and natural environments, but the transceiver's internal speaker showed a marked degradation in performance in the car as compared to its anechoic performance. Of course, the optimum position for an external speaker would be atop the dashboard of an automobile. But this is not always advisable since it could obstruct the driver's vision. ◇

BUILD A

SILENCER

*Squelches operating radio
or tape player
when CB signal begins.*

BY RONALD MILES

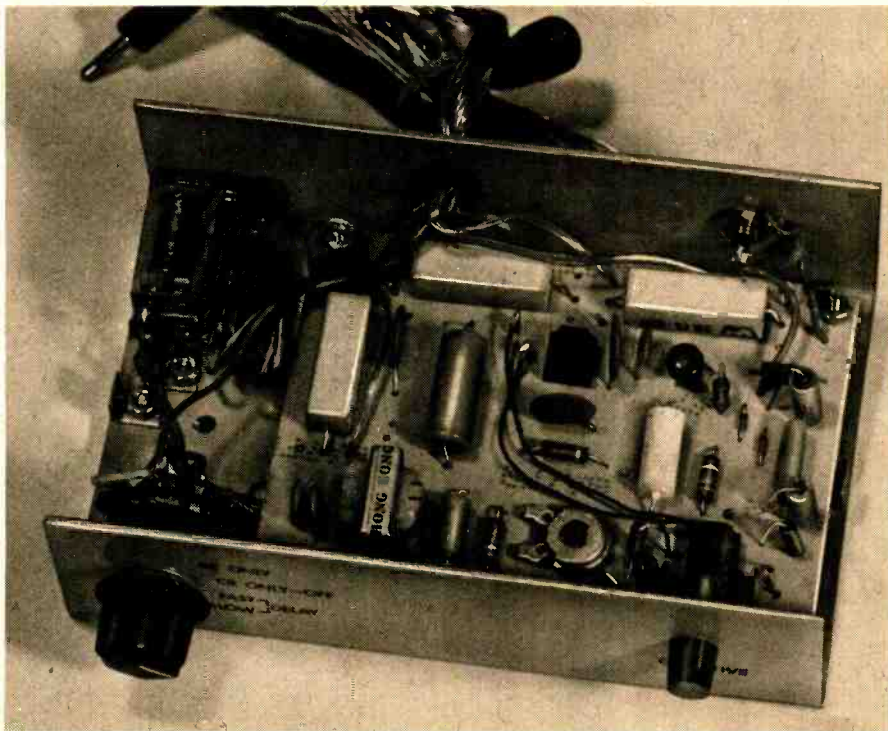


Photo of prototype shows main circuit board mounted in chassis with relay in back corner, controls on front.

MANY CB'ers are torn between listening to an auto AM/FM radio or tape player and monitoring CB calls. With both active, the sound is cacophonous when the CB receiver unsquelches. The user can manually turn down the volume of the broadcast radio or tape player every time the CB becomes active, of course, undermining driving safety.

A CB'er can have his cake and eat it too, however, by using the "Silencer" described in this article. It will automatically quiet the radio or tape player when the CB receiver is unsquelched or the CB transmitter is used. The entertainment system will remain silent until either the CB receiver returns to the squelched state or the CB transmitter is no longer in use. At this point, the entertainment system returns to its normal volume. No major changes to either the CB transceiver, AM/FM radio, or tape player are required.

Although designed for mobile applications, the Silencer can also be used with any receiver that has a squelch. For example, one can have a scanning monitor operating in the same room as a stereo music system; and each time the scanner stops at a station (becomes unsquelched), the audio system will be silenced until the vhf conversation is ended and the scanner resumes its normal scanning mode.

The only conditions required are that both radios should have speaker impedances of about 8 ohms; the audio power output should not exceed about 5 watts; the r-f power from the CB rig must not exceed FCC specs; and the vehicle (where used) must have a negative-ground electrical system.

How It Works. The complete schematic is shown in Fig. 1. Audio voltage

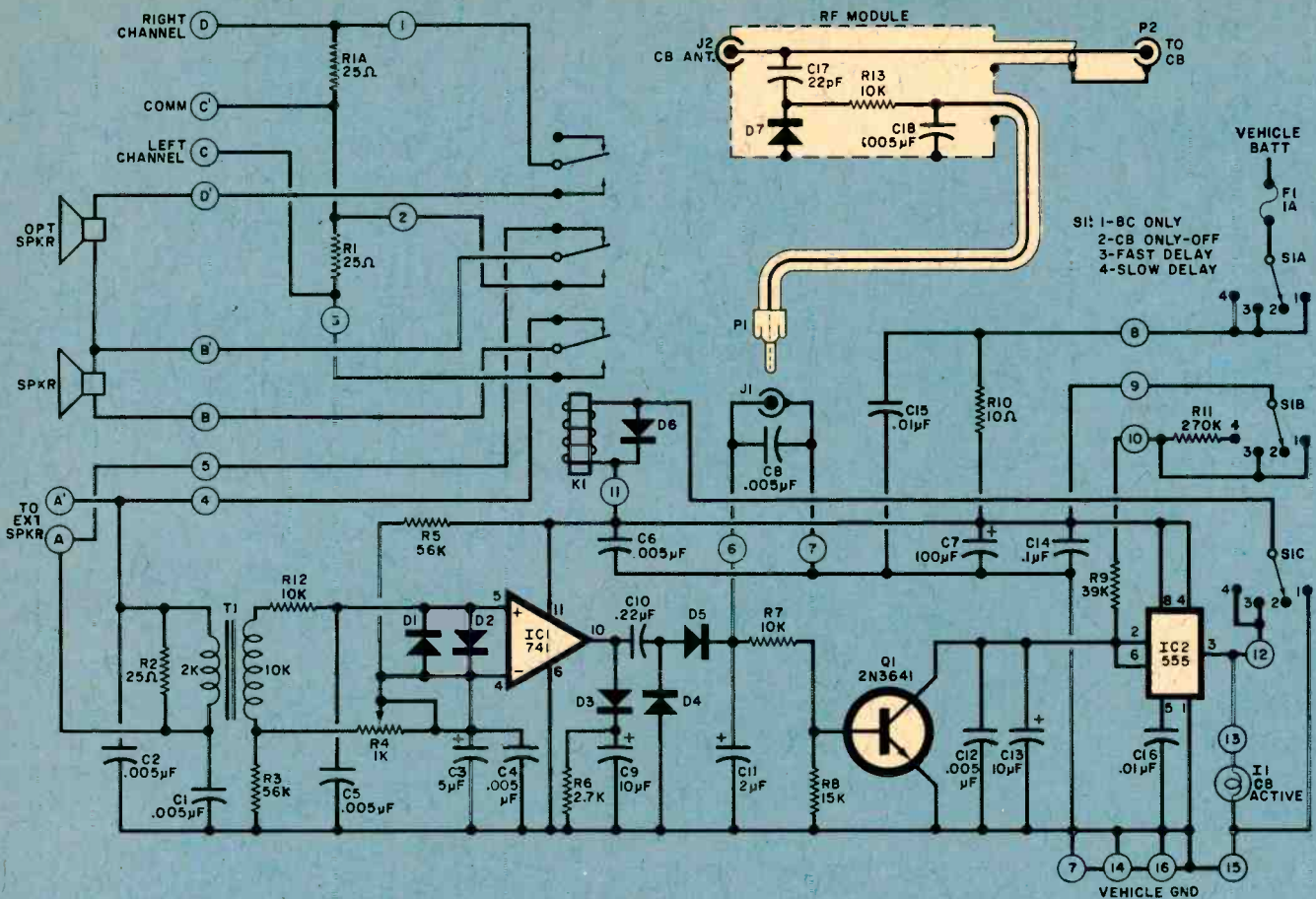


Fig. 1. Schematic of the Silencer. Circuit of the r-f module is at upper right.

PARTS LIST—R-F MODULE

C17—22-pF, 100-V mica capacitor
 C18—0.005- μ F, 100-V ceramic capacitor
 D7—high-speed silicon diode 100 mA at 100 V (ECG 177)
 J2—SO-239 coaxial cable connector
 P1—phono connector to mate with J1 and suitable length of shielded audio cable
 P2—PL-239 coaxial connector with suitable length of RG-58/U coaxial cable
 R13—10,000-ohm, 1/2-watt resistor
 Misc.—Suitable chassis for Silencer (Lafayette 12R03017V or similar), r-f module (Calectro H4-736 or similar), knob, L-brackets (2), press-on type, relay mounting bracket, terminal strip (three-lug), mounting hardware, spacers, grommets, etc.

PARTS LIST—BASIC SILENCER

C1, C2, C4, C5, C6, C8, C12—0.005- μ F, 100-V ceramic capacitor
 C3—5- μ F, 25-V electrolytic capacitor (axial lead)
 C7—100- μ F, 25-V electrolytic capacitor (axial lead)
 C9, C13—10- μ F, 25-V electrolytic capacitor (axial lead)
 C10—0.22- μ F, 100-V capacitor
 C11—2- μ F, 35-V electrolytic capacitor (axial lead)
 C14—0.1- μ F, 50-V ceramic capacitor
 C15, C16—0.01- μ F, 100-V ceramic capacitor
 D1 through D5—high-speed silicon diode, 100 mA at 100 V
 D6—silicon rectifier diode 100 V at 1 A
 F1—1-A fuse with in-line holder (Radio Shack 270-1281 or similar)
 I1—12-V, 50-mA panel lamp (Radio Shack 272-322 or similar)
 IC1—741 op amp
 IC2—555 timer

J1—chassis mounted phono connector
 K1—12-volt, 100-mA coil, 1-A contact rating. Monaural: dpdt (Radio Shack 275-206 or similar); stereo: 3pdt (Allied 88601053 or similar)
 Q1—2N3641 npn silicon transistor
 R1, R2—25-ohm, 5-watt resistor
 R1A—same as R1, used in stereo version only
 R3, R5—56,000-ohm, 1/2-watt resistor
 R4—1000-ohm miniature potentiometer
 R6—2700-ohm, 1/2-watt resistor
 R7—10,000-ohm, 1/2-watt resistor
 R8—15,000-ohm, 1/2-watt resistor
 R9—39,000-ohm, 1/2-watt resistor
 R10—10-ohm, 1/2-watt resistor
 R11—270,000-ohm, 1/2-watt resistor
 R12—10,000-ohm, 1/2-watt resistor
 S1—miniature rotary switch, 4-position, 3-pole (Calectro E2-166 or similar)
 T1—10k:2k miniature driver transformer (Radio Shack 273-1378, Calectro D1-722, or similar)

from the CB remote speaker output is connected to pads A and A' so that R2 becomes the load for the output transformer. The audio voltage generated across R2 is applied to the primary of transformer T1, whose turns ratio provides a voltage step-up of five times, besides providing dc isolation.

The audio voltage on the secondary of T1 is applied to IC1 used as a comparator. The voltage divider combination of

R5, potentiometer R4, and resistor R3 produces a dc voltage (variable with the setting of R4) between the inverting and noninverting inputs of IC1 and this voltage is adjusted so that low-level ac signals will not cause the comparator to change states.

When audio of sufficient amplitude is generated across the secondary of T1, parts of its cycle will cancel out the dc voltage developed across the potenti-

ometer and the comparator will switch state with each cycle, thus acting as a very-high-gain ac amplifier whenever high-level audio comes in. Thus, IC1 will produce an output only when the CB receiver is unquieted.

The pulsed output from IC1 is coupled through capacitor C10 to a rectifier consisting of D4, D5, C11, and voltage divider R7 and R8. When the positive voltage across R8 exceeds one diode drop,

transistor *Q1* is turned on and essentially forms a short circuit across the *IC2* timing capacitor *C13*.

Integrated circuit *IC2* is set up as a timer whose RC circuit consists of *C13*, *R9*, and, when function switch *S1* is in the SLOW DELAY position, *R11*. In the normal mode, *IC2* pin 3 is low, and no power is supplied to the CB ACTIVE lamp *I1*. When transistor *Q1* saturates, *IC2* starts its timing cycle, and if *S1* is in either the FAST DELAY or SLOW DELAY positions, relay *K1* is energized to switch the CB audio output to the speaker, and at the same time, disconnect the broadcast radio or tape player speaker. When the CB audio ceases, *IC1* no longer delivers voltage to the rectifier, and transistor *Q1* cuts off. Then *IC2* starts its timing cycle to cause *K1* to change states. The delay keeps the relay from "chattering" during any pause between words, and also keeps the broadcast radio from becoming active for a short period of time after a transmission is received, and the transmitter is activated in reply. Function switch *S1* provides a selection of fast or slow delays.

We have described how the broadcast radio or tape player is de-activated and the CB speaker comes alive when the CB receiver is un-squelched. Now we will discuss the r-f module that detects the operation of the CB transmitter and does the same switching.

As shown in Fig. 1, the separate r-f module is connected in series with the CB antenna and is "transparent" during CB reception. When the transmitter is activated, some of the r-f is rectified by *D7* and filtered by *R13* and *C18*, and the resulting dc voltage is passed via a length of shielded audio cable to the base of transistor *Q1*, in parallel with the audio signal path from *IC1*. The presence of the rectified r-f voltage starts the timer up in the same way as for the au-

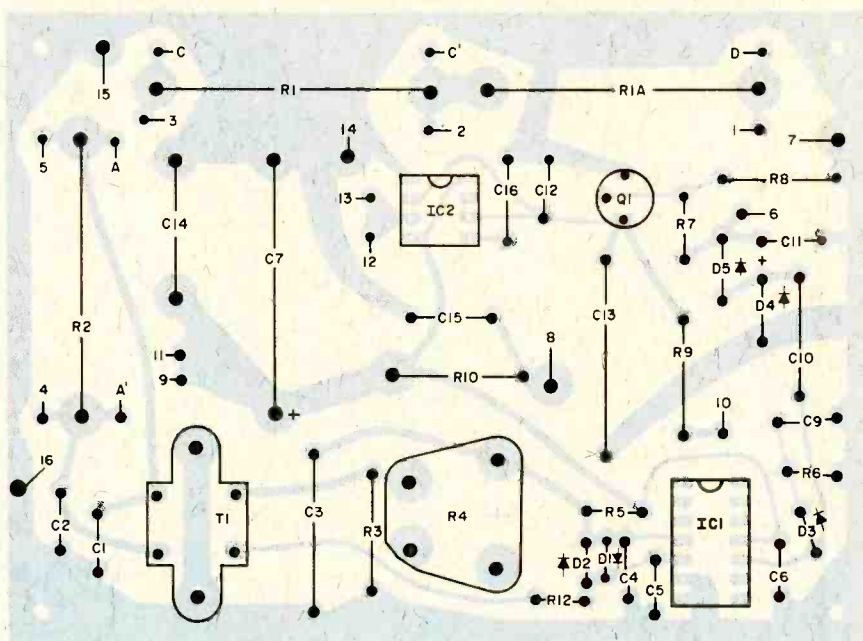
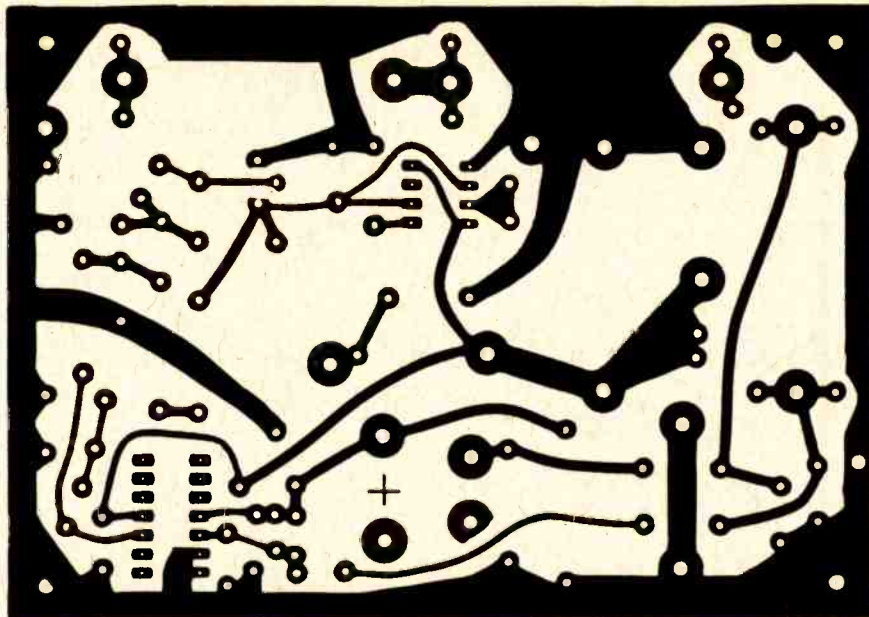
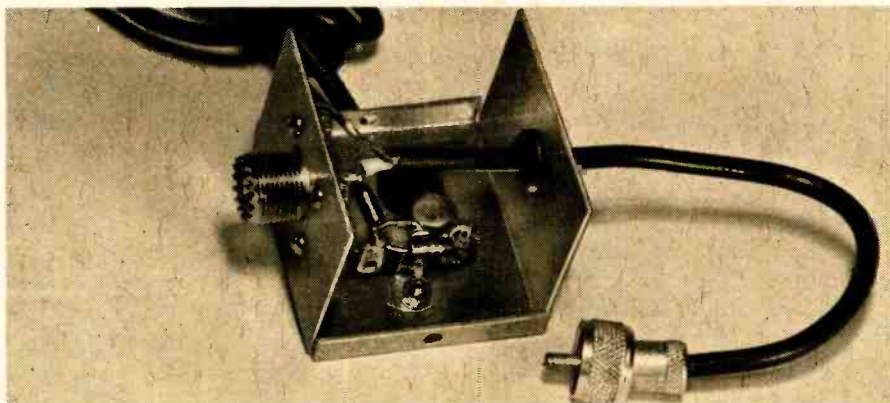


Fig. 2. Etching and drilling guide (top) and component layout for Silencer does not include r-f module components.



Components for the r-f module are assembled in their own metal enclosure and suitably connected to the rest of the circuit.

dio signal. If you do not use a CB transmitter, the r-f module may be omitted.

Construction. The Silencer consists of two assemblies—the basic electronics and the optional r-f module.

The basic electronics circuit has two variations. If the radio to be silenced is monaural, then resistor *R1A* can be eliminated and for relay *K1* use a double-pole, double-throw type. If you wish to silence a stereo system, then install *R1A* and use a 3-pole, double-throw relay for *K1*.

The basic electronics is assembled on a pc board such as that shown in Fig. 2,

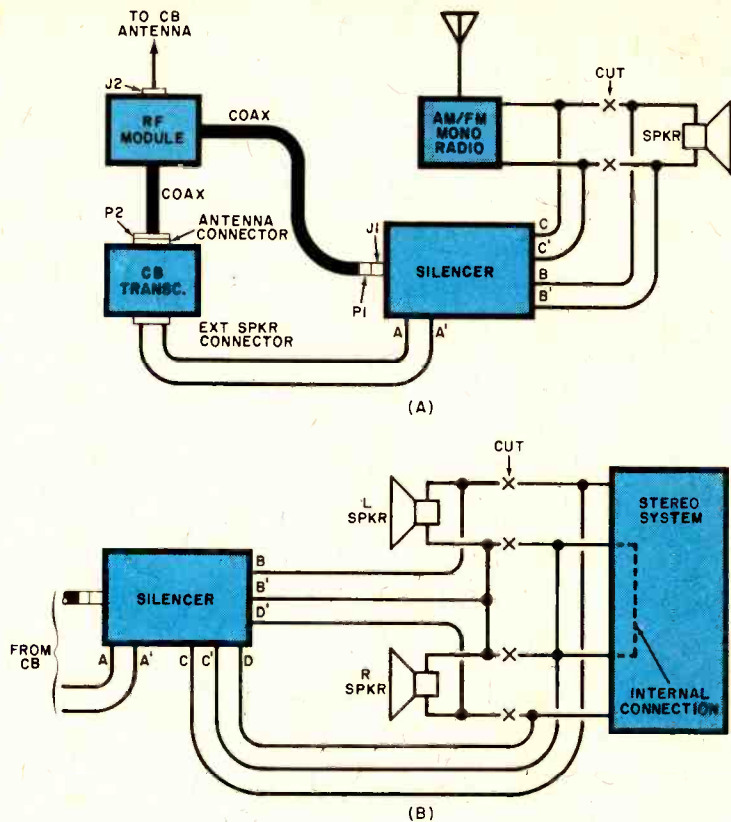


Fig. 3. To use the Silencer with a CB rig and monaural radio or tape deck, use set up at (A). For a stereo system, use (B).

which also illustrates component installation. Note that some resistors and capacitors are mounted vertically because of the narrow pad spacing, and that (optional) sockets are used for the two IC's. There must be a hole directly under the center of potentiometer *R4* so that this control can be adjusted through a mating hole in the bottom of the chassis. If you elect to use perforated board and either a wiring pencil or wire-wrap, try to keep the component installation similar to that shown in Fig. 2 to minimize stray r-f pickup by *IC1*.

The prototype basic electronics was mounted in a standard 1 7/8" by 6 1/4" by 4 1/8" metal two-piece chassis having suitable holes drilled in the front panel to mount function switch *S1*, and lamp *I1*. Jack *J1* is mounted on the rear panel, and a suitable rubber grommetted hole should be provided for the various cables. Don't forget the hole for *R4* on the underside of the chassis. Interconnections to the board are made via the small circled pads as shown in Fig. 1.

The finished circuit board is mounted on the bottom of the chassis via four small spacers, while the relay is mounted in one corner of the chassis using an L-bracket as shown in the photograph.

The r-f module is mounted in its own

2 1/8" by 2" by 1 3/4" metal enclosure. A three-lug terminal strip is used to support the components, while connector *J2* is mounted on one wall. A length of RG-58/U coaxial cable terminated in a suitable connector for the antenna output of the CB transceiver, is passed through a grommetted hole opposite *J2*, with the coax braid connected to the grounding lug of *J2*, and to the metal chassis. The dc output of the r-f module is passed out of the metal chassis through its own coaxial audio cable that is terminated with a connector to match *J1* on the main chassis.

Installation. If you are going to use the Silencer with a CB rig in conjunction with a conventional monaural radio or tape player, use the circuit shown in Fig. 3A. Use the external speaker output of the CB transceiver for the audio output. Note that a few radio speakers may have one of their terminals grounded to the speaker frame and thus to vehicle ground. If this is the case, remove this connection from the frame, connect the Silencer as shown, and ground the corresponding lead between the Silencer and the radio.

Locate the speaker leads on the radio to be silenced and cut them. Connect

the radio audio output and speaker leads as shown in Fig. 3A. If you are going to silence a stereo system (radio or tape player), then use the circuit shown in Fig. 3B. (In the case of stereo, don't forget *R1A* and the relay.)

The stereo system usually has four wires that connect to the two speakers. Use an ohmmeter to determine which pair is connected together within the stereo system (share a common, usually ground, connection), then follow the wiring of Fig. 3B.

Initial Adjustment. With the Silencer connected to the CB system as shown in Fig. 3, turn off the AM/FM radio, set the Silencer function switch (*S1*) to the CB ONLY-OFF position, and sensitivity control *R4* to its maximum resistance (minimum sensitivity) position.

Turn on the CB and set the squelch completely off. Temporarily disconnect the CB antenna from the r-f module, and adjust the CB volume so that a faint "hiss" is heard a couple of feet from the speaker. Without touching the CB, place the Silencer function switch to the FAST DELAY position, and note that after several seconds the speaker is silent.

Using an insulated screwdriver, rotate *R4* very slowly from its maximum resistance until the front-panel CB ACTIVE lamp comes on and the hiss is again heard. Reconnect CB antenna, locate an unused CB channel, and normally squelch the receiver. Key the transmitter and note that the CB ACTIVE lamp comes on and stays on as long as the transmitter is keyed. Release the transmitter switch, and after a few seconds the CB ACTIVE lamp should extinguish.

Turn on the AM/FM radio and note that its output is heard in the speaker whenever the CB is squelched, providing the transmitter is not in use. You may note that sometimes the AM/FM radio is suddenly silenced when no CB call is heard. This occurs when some CB'er touches his transmitter key momentarily without making an actual transmission. The Silencer will operate as if an actual CB signal has been received. If this occurs too often, the CB may be inadequately squelched or the Silencer too sensitive. If the relay chatters when receiving a CB call, the Silencer should be set for less sensitivity (*R4*). When the Silencer has been set for the desired CB receiver volume, lowering the volume will reduce the Silencer sensitivity.

Lastly, note that, when power is first applied to the system, the Silencer will come on in the CB mode until the delay runs out. This is normal. ◇

IN TWO previous articles (POPULAR ELECTRONICS, August 1976 and September 1976), we discussed the construction of the low-cost Elf microcomputer, gave some programming examples, and described some low-cost optional input/output circuits. Here we will examine some software operating systems and discuss adding 1024 bytes of memory for as little as \$20.

Operating Systems. An operating system is a program that makes it easier to program and use your computer. For example, if you want to change M(43) in the basic Elf memory, you would have to start at M(00) and step through memory to location 43 before you could change it. Program 1 is a simple operating system for the Elf microcomputer. It lets you directly examine or modify any memory location. It also allows you to start program execution at any memory location. We call Program 1 ETOPS-256 (Elf Toggle Operating System for 256-byte memory). After loading ETOPS in RAM, it can be used to help you load and run other programs.

To examine a memory location using ETOPS, set 01 into the toggles. Flip the RUN switch up and 01 will be displayed. Now set the address of the memory byte you want to examine into the toggles and push the INPUT switch. The next time you push the INPUT switch, you'll see the selected memory byte displayed. Keep pushing the INPUT switch to see the sequence of bytes stored in memory.

To modify any memory location, set 02 into the toggles and turn the RUN switch up. 02 will appear. Set the address of the memory byte you want to modify (via the toggles).

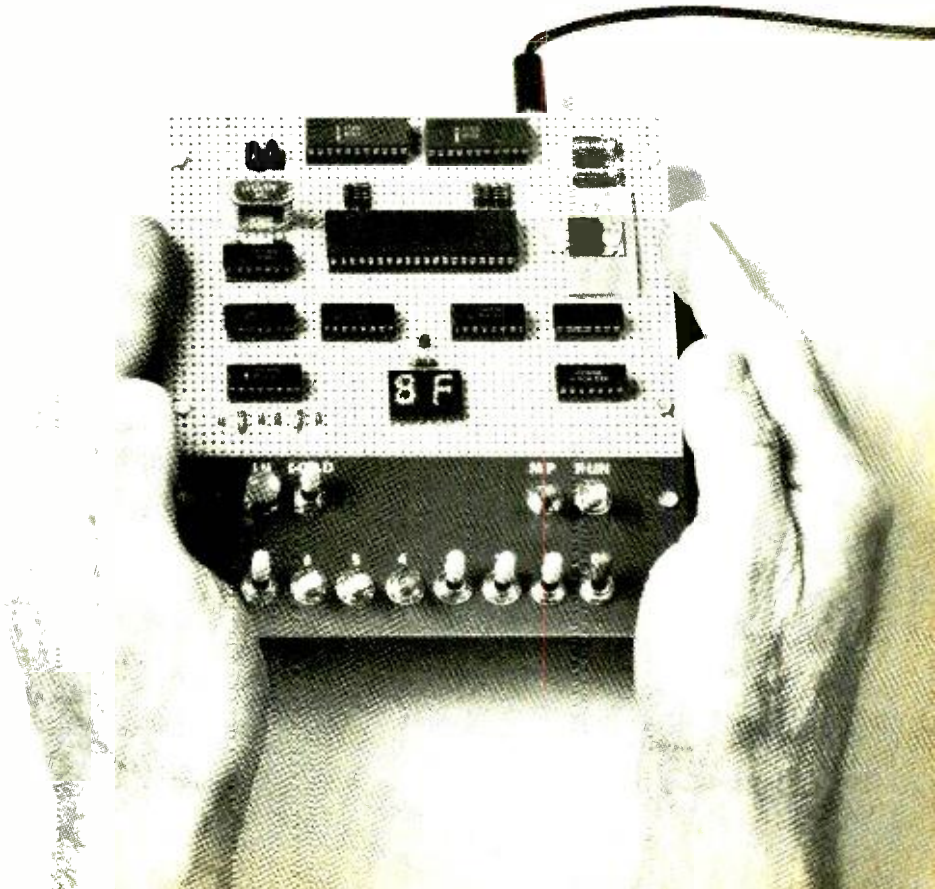
Push the INPUT switch and the Q light comes on. Now set the toggles to the value of the byte you want to place in the selected memory location and push the INPUT switch to store it in RAM. You can store a sequence of new bytes by setting each byte into the toggles and pushing the INPUT switch. The Q light warns that you are modifying memory.

If you have the toggles set to 00 when you flip the RUN switch up, you can then set the toggles to the beginning address of a program you want to execute. Just push the INPUT switch to start executing your program at the selected address. Your program will begin execution with R3 as the program counter.

If you've added the battery RAM option to your system, ETOPS will be ready to use as soon as you turn on power. Since ETOPS uses only 32

Build the COSMAC "ELF" Microcomputer

PART 3: How to expand memory, plus more programs



PROGRAM 1--ETOPS-256

```

0000 F8 20 A1 R1.0 = work
03 E1 X=1
04 6C 64 21 D = toggles
07 3F 07 Wait for IN on
09 37 09 Wait for IN off
0B 32 1D M(1D) if D=00
0D F6 33 11 M(11) if D=01
10 7B Q=1
11 6C A1 R1.0 = toggles
13 3F 13 Wait for IN on
15 37 15 Wait for IN off
17 39 1A M(1A) if Q=0
19 6C M1 = toggles
1A 64 Show M1, R1+1
1B 30 13 Repeat M(13)
1D 6C A3 R3.0 = toggles
1F D3 P=3
20 00 Work area
21 User programs from
M(21) to M(FF)

```

PROGRAM 3

```

0050 F8 FF A1 R1.0 = work
53 F8 00 51 M1=00
56 E1 64 21 Show M1
59 F0 FC 01 51 M1+1
5D F8 10 B2 R2.1 = delay
60 22 R2-1
61 92 3A 60 M(60) if R2.1≠00
64 30 56 Repeat M(56)

```

PROGRAM 2--EHOPS-256

```

0000 F8 FF A2 R2.0 = work
03 F8 23 A5 R5.0 = BSUB
06 F8 33 A6 R6.0 = HSUB
09 F8 0D A3 R3.0 = M(0D)
0C D3 P=3
0D D5 A1 BSUB, R1.0=D
0F 6C D, M2 = toggles
10 3A 14 M(14) if D≠00
12 81 A3 R3.0 = R1.0
14 F6 3B 1C M(1C) if D=02
17 D5 E1 BSUB, X=1
19 64 Show M1, R1+1
1A 30 17 Repeat M(17)
1C D5 E1 BSUB, X=1
1E 51 64 M1=D, show M1, R1+1
20 30 1C Repeat M(1C)
22 D3 P=3 (return)
BSUB
23 D6 HSUB
24 FE FE D left x 2
26 FE FE D left x 2
28 A0 D6 R1=D, HSUB
2A 80 F1 52 M2=R1 or M2
2D 64 22 Show M2
2F 30 22 Go to M(22)
31 F0 D5 D=M2, P=5
HSUB
33 E2 FC 01 X=2, D+1
36 FA OF 52 M2=D and OF
39 62 22 Select key M2
3B 3D 33 M(33) if key off
3D 7B F8 09 Q=1, D=09
40 B4 R4.1=09
41 24 94 R4-1
43 3A 41 M(41) if R4.1≠00
45 7A Q=0
46 35 46 Wait for key off
48 30 31 Go to M(31)

```

bytes, you still have 224 bytes available for your own programs.

Keyboard System. Adding a hex keyboard would make your Elf microcomputer even easier to use. With 16 keys labelled 0 through F, you would have to press only two keys for each byte you want to store in memory. In the second article, we described a circuit for monitoring the states of 16 switches or keys. (See POPULAR ELECTRONICS, Sept. 1976, page 38, Fig. 3). If you add this circuit and a 16-key hex keyboard, you can use Program 2—EHOPS-256 (Elf Hex OPERating System for 256-byte memory). This program requires 74 bytes of RAM so you still have 182 bytes left for your own programs. You can also use the hex keyboard subroutine as part of your programs if desired.

After loading EHOPS in memory, you can use it as follows. To load a byte into any memory location from the hex keyboard, set the toggles to 02 and flip the RUN switch up. The 02 toggles tell EHOPS that you want to store bytes in

memory. On the hex keyboard, press the most-significant digit of a memory address followed by the least-significant digit. This address byte will be displayed and tells EHOPS where you want to start loading bytes in memory. You can now load a sequence of bytes into memory via the hex keyboard. Just press the two digits (most significant first) of each byte you want to load and they will be stored sequentially in memory starting at the selected location.

To examine any memory location (without changing its contents), set the toggles to 01 before you flip the RUN switch up. Using the hex keyboard, enter the one-byte starting address of the sequence of memory locations you want to examine. Press any hex key twice to step through memory and display the stored bytes.

To run a program you've loaded using EHOPS, set the toggles to 00 before flipping the RUN switch up. Using the hex keyboard, enter the one-byte starting address of your program. It will begin running with R3 as the program counter.

EHOPS controls the hex keyboard with two subroutines called BSUB and HSUB. BSUB calls HSUB by changing the program counter to R6 with a D6 instruction. HSUB continuously scans all 16 hex keyswitches until one is pressed. It provides a switch debounce delay and waits until the key has been released. It then returns control to BSUB with the value of the pressed key in the least-significant digit of the byte in D and M2.

BSUB is called by changing the program counter to R5 with a D5 instruction. It waits until two hex keys have been pressed before returning control to the calling program with the values of the two keys in the two digits of the byte in D and M2. The most-significant digit represents the first key pressed. Any program you write with R3 as the program counter can call BSUB to obtain a byte from the hex keyboard. If you drive a speaker with the Q lines as described in the September article, you will hear an audible click each time a hex key is pressed.

Program 3 can be loaded and run us-

PROGRAM 4

```

*CO F8 F0 AA RA.0=F0
C3 F8 08 A8 R8.0=08
C6 D5 5A BSUB, MA=D
C8 1A 28 A+1, R8-1
CA 88 3A C6 M(C6) if R8.0≠00
*CD F8 F0 AA RA.0=F0
D0 F8 08 A8 R8.0=08
D3 EA F0 A7 R7.0=MA
D6 64 28 Show MA, A+1, 8-1
D8 F8 FF AC RC.0=FF
DB 7B 87 Q=1, D=R7.0
DD FF 01 D-01
DF 3A DD M(DD) if D≠00
E1 7A 87 Q=0, D=R7.0
E3 FF 01 D-01
E5 3A E3 M(E3) if D≠00
E7 2C 8C RC-1
E9 3A DB M(DB) if RC.0≠00
EB 88 3A D3 M(D3) if R8.0≠00
EE 30 CD M(CD) if R8.0=00
FO-F7 = Table of tone values
    
```

ing either ETOPS or EHOPS: This program continuously counts up at a rate determined by the byte at M(5E). Be sure to start execution at M(50).

Program 4 should be loaded and run using EHOPS. You should also have a speaker attached to the Q line. Start this program at M(C0) with EHOPS. You can then enter eight bytes via the hex keyboard. These bytes should have values between 02 and 7F for best results. Each byte represents the frequency of a tone you will hear via the speaker. After

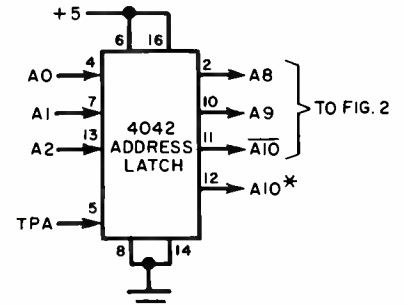


Fig. 1. Address latch. *Connect pin 19 of original 2101 RAM's to A10 instead of ground.

PROGRAM 5

```

0000 F8 00 B1 R1.1=00
03 F8 FF A1 R1.0 = work
06 F8 00 51 M1=00
09 E1 64 21 Show M1
0C F0 FC 01 51 M1+1
10 F8 10 B2 R2.1 = delay
13 22 R2-1
14 92 3A 13 M(13) if R2.1≠00
17 30 09 Repeat M(09)
    
```

you enter the eighth byte you'll hear the eight-tone sequence repeated over and over. You can restart the program at M(CD) to hear a previously entered tone sequence.

An operating system can be designed to incorporate any desired feature. For example, you might want to examine the contents of internal 1802 registers or control the operation of a cassette recorder. As more features are needed,

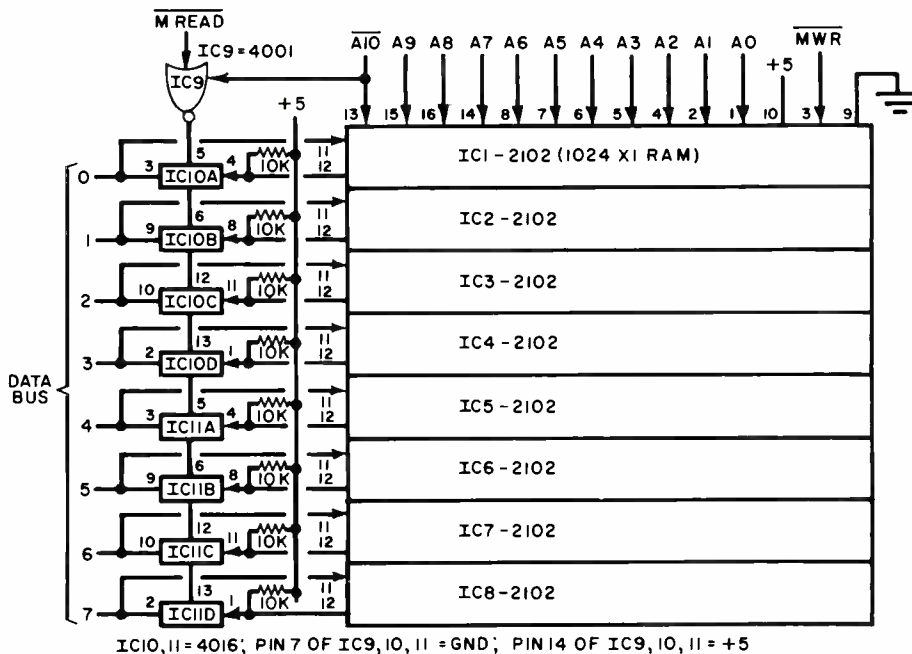


Fig. 2. Eight low-cost, readily available 2102 RAM's (1024 x1) and two transmission gate packages.

IC10, 11 = 4016; PIN 7 OF IC9, 10, 11 = GND; PIN 14 OF IC9, 10, 11 = +5

you may want to dedicate the entire 256 bytes of memory in the basic system to your operating system and add another section of memory for your other programs. The 256-byte operating-system memory can be battery-powered and protected from modification by the MP switch so that it is always ready for use.

Memory Expansion. You can add 1024 bytes of memory to an Elf microcomputer using inexpensive, readily available 2102-type static RAM's as shown in Figs. 1 and 2. The 10k bus pull-up resistors are required if the high-output level of the RAM chips isn't at least 3 volts. Bits 0 and 1 of the high-order address byte are clocked into the address latch with TPA (Fig. 1). These two latched bits are used with the low-order COSMAC address byte to provide the required 10-bit address for the 2102 RAM's. Bit 2 of the high-order address byte is clocked into the address latch for use in selecting either the original 256-byte RAM or the added 1024-byte section of RAM. Disconnect pin 19 of the original two 2101 RAM chips from ground and connect to pin 12 of the 4042 address latch in Fig. 1.

The original 256-byte memory will now be addressed as 0000-00FF and the new 1024-byte memory will be addressed as 0400-07FF. Since all of the previous programs assumed one-byte addresses, they will *not* run in this expanded memory system. Programs for systems with more than 256 bytes of memory must have both the high-order and low-order bytes of address registers properly set. The previous programs can be easily modified to run in the expanded system by initializing both high- and low-order bytes of any 16-bit register used to address memory. The foregoing counting program could be modified to run at M(0000) in an expanded RAM system as shown in Program 5. In general, it adds only a few bytes to program for an expanded-memory system. By adding bits to the address latch of Fig. 1, you could address up to 64k bytes of RAM. Instead of addressing extra memory, the high-order address bits could be used to select input/output circuits or devices.

Don't forget that adding memory will increase system power requirements. As the system is expanded, make sure your external power supply can handle the increased current requirements. With this in mind, you'll find that the Elf can be tailored to your needs at low cost. ◇

A READER'S ELF PROGRAMS

I recently constructed the COSMAC Elf described in your August (1976) issue and thoroughly enjoyed the construction and testing of this microprocessor system. I build approximately two projects a month that are illustrated in your magazine—plus some from other sources. This particular project turned out to be the most interesting I have ever constructed. Here are three programs that I found useful in illustrating various system functions.

Program I is simply an expansion of your Q-light program with additional decisions that alternately turn the Q light on and off when the input switch is depressed.

Program II displays and increments successive hex characters each time the input button is depressed. To do this, it was necessary to learn how to input to and output from the memory, using pointers in registers, and also to do simple arithmetic through the accumulator (D register).

Program III plays SOS in Morse code. The program should be loaded through the system switch registers if you have a half hour without interruption. With this program, registers are used for pointers to subroutine loops set up for time delay. Three subroutines for 0.5 second, 1 second and 3 seconds are established, addressed by changing the program counter. The main program simply turns the Q light

on and off at intervals determined by the subroutines. The memory provided in the basic Elf system (256 bytes) is enough for approximately 19 code elements. Each code element requires only 10 instructions for an on and off interval in the main program. The timing loops require the use of two registers to provide a sufficient time. In my Elf, I used a 1-MHz crystal. Obviously, changing one instruction in the loop subroutines will vary the time as necessary. Changing or adding to the main program can change the code.

Try loading this program with the switch register if you have enough patience.

—Robert Klein

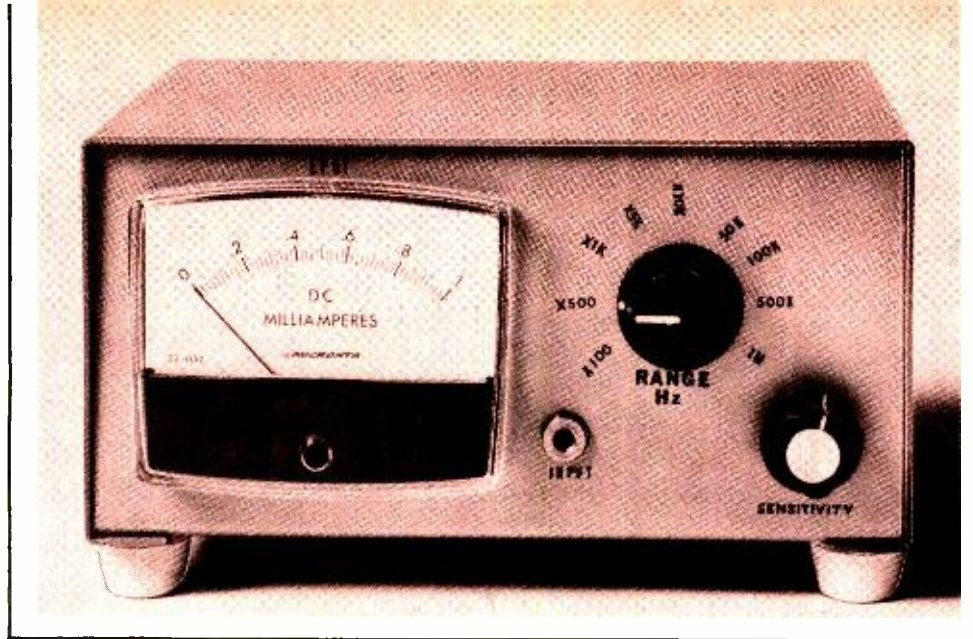
PROGRAM I

SWITCH ON AND OFF	3F
	00
	37
	02
IF Q OFF GO TO 09	39
	09
IF Q ON, TURN OFF AND RETURN TO 00	7A
	30
	00
IF Q OFF, TURN ON AND GO TO 00	7B
	30
	00

PROGRAM II

STORE DEPENDENT VARIABLE 00	E4
IN LOCATION 77 WITH POINTER	F8
IN R4--DESIGNATE R4 AS RX	77
	A4
	F8
	00
	54
STORE INDEPENDENT VARIABLE 01	F8
IN LOCATION 76 WITH POINTER	76
IN R5	A5
	F8
	01 (size of INCR)
	55
DISPLAY AND DECREMENT RX	64
	24
LOOK FOR INPUT SWITCH ON AND OFF	3F
	0F
	37
	10
ADD TWO VARIABLES AND PUT RESULT IN LOCATION 77 (can be changed to subtract to count down)	05
	F4 (F5 subtract)
	54
RETURN TO START OF LOOP	30
	07

PROGRAM III			
MAIN PROGRAM			
INITIALIZE	F8		7B
POINTERS	65 *	THIRD DOT	D3
	A3		F8
	F8		65 *
	79 *		A3
	A4		7A
	F8		D3
	8D *		F8
	A5		65 *
			A3
			7B
			D4
			F8
			79 *
			A4
			7A
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3
			F8
			65 *
			A3
			7B
			D3



Uses readily available components and an analog readout.

BY JOHN F. HOLLABAUGH

Build A 10-Hz To 1-MHz EPUT Meter

THE EPUT (Events Per Unit Time) meter is an inexpensive frequency counter that can measure sinusoidal and complex waveforms over a range from 10 Hz to 1 MHz. It uses inexpensive TTL logic, a FET front end, and an analog readout. Accuracy is quite good, as the 60-Hz power-line frequency is used as a calibration reference. A trigger

sensitivity control is included to set the input signal threshold. The front end has a resistive input impedance of 100,000 ohms. A 1.5-millivolt (minimum) input will result in a stable EPUT reading.

About the Circuit. The schematic diagram of the EPUT meter is shown in Fig. 1, with circuit details for the input

amplifier, counting stages, and power supply shown in Figs. 2A, 2B, and 2C, respectively. A portion of the input signal is taken from the wiper of *R1*, the SENSITIVITY control, and applied to the gate of *Q1*, an n-channel FET, which functions as a source follower. Voltage gain is provided by the bipolar transistor *Q2*. This transistor boosts the input signal to a

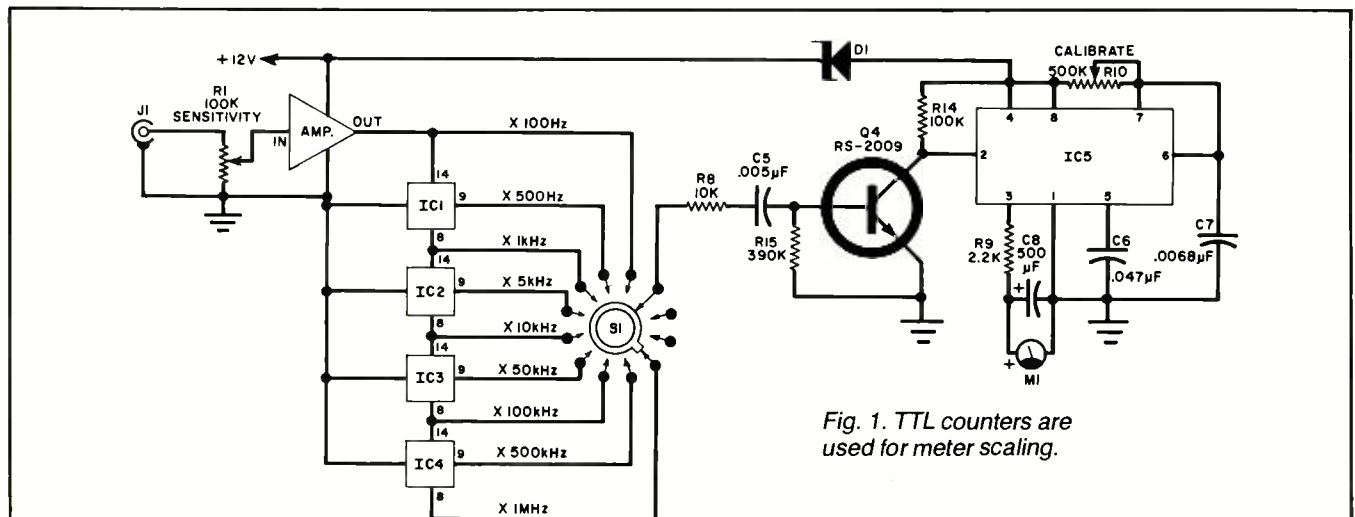


Fig. 1. TTL counters are used for meter scaling.

PARTS LIST

C1, C3, C6—0.047- μ F, 50-V Mylar capacitor
 C2—10- μ F, 15-V electrolytic capacitor
 C4—22- μ F, 15-V electrolytic capacitor
 C5—0.005- μ F disc ceramic capacitor
 C7—0.0068- μ F disc ceramic capacitor
 C8—500- μ F, 15-V electrolytic capacitor
 C9—1000- μ F, 35-V electrolytic capacitor
 D1—4-V, 1/2-W zener diode
 IC1-IC4—7490 decade counter
 IC5—555 timer
 IC6—LM309 5-volt regulator
 J1—RCA phono jack

M1—0-to-1-mA meter (Radio Shack 22-052 or equivalent)
 Q1—N-channel FET (Radio Shack RS-2028 or equivalent)
 Q2-Q4—npn silicon switching transistor (Radio Shack RS-2009 or equivalent)
 All fixed resistors are 1/2-watt, 10% tolerance:
 R1—100,000-ohm linear taper potentiometer
 R2—150,000 ohms
 R3, R5, R7, R9—2200 ohms
 R4, R6—220,000 ohms

R8—110,000 ohms
 R10—500,000-ohm linear taper potentiometer (screwdriver adjust)
 R11, R13—1 megohm
 R12—3300 ohms
 R14—100,000 ohms
 R15—390,000 ohms
 S1—1-pole, 12-position nonshorting rotary switch (Lafayette 30 R 40144 or equivalent)
 S2—SPST toggle switch
 T1—12-V, 500-mA transformer
 Misc.—Hookup wire, suitable enclosure, IC sockets or Molex Soldercons (if desired), printed circuit or perforated board, 1/4-inch spacers, machine hardware, solder, etc.

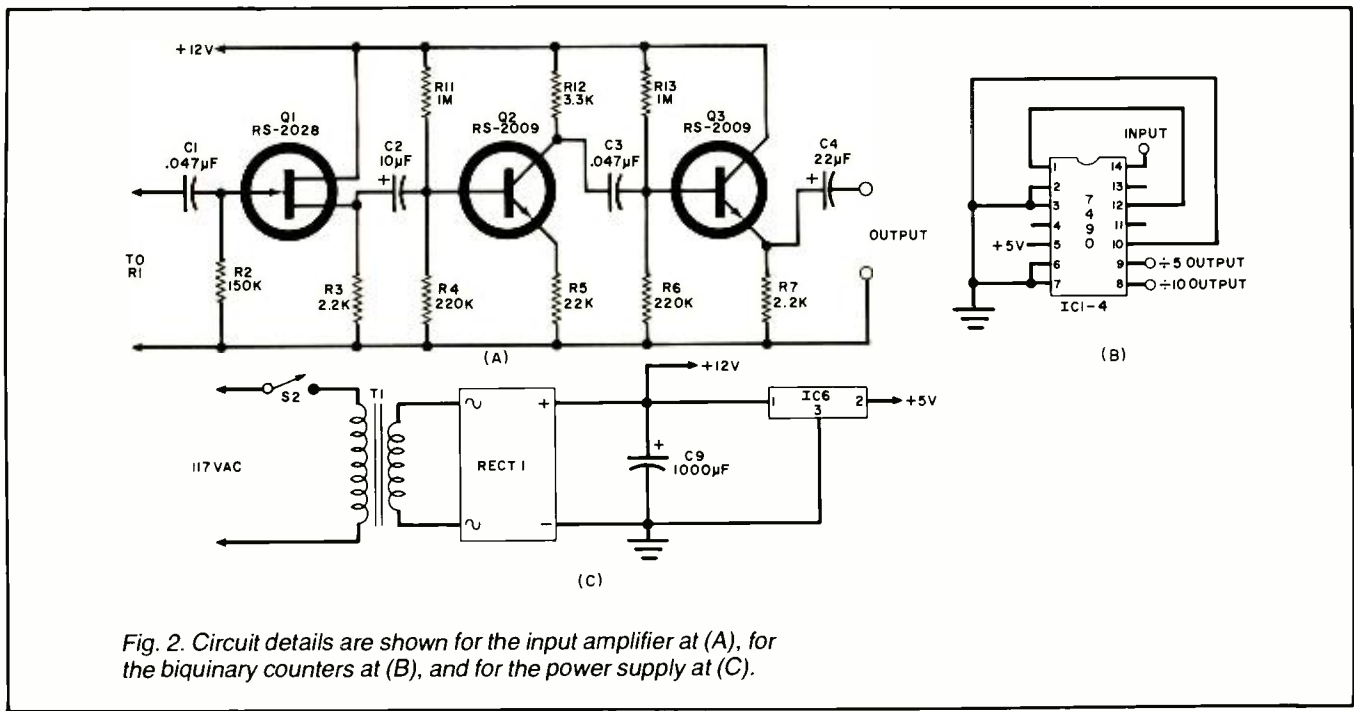


Fig. 2. Circuit details are shown for the input amplifier at (A), for the biquinary counters at (B), and for the power supply at (C).

level exceeding the 2-volt, logic-one threshold of the TTL counter inputs. The current required to drive counter IC1 is furnished by Q3, an emitter follower.

Biquinary counters IC1 through IC4, each of which comprises four flip-flops and an AND gate, provides outputs whose frequencies are one-fifth and one-tenth that of the input. These are used for range expansion of the analog meter, whose associated circuitry measures frequencies from zero to 100 Hz only. The 0-to-1-mA meter is connected to the output of IC5, a 555 timer operating in the one-shot mode. The average value of the pulse output is directly proportional to the number of pulses occurring each second, and this rate is governed by the frequency of the signal that triggers IC5.

The trigger signal, which is provided by the amplifier in the direct ($\times 100$ Hz) mode, and by the outputs of the counters on the higher ranges, is inverted by Q4 to make the negative-edge triggering of IC5 compatible with the positive-edge triggering of the TTL counters. The width of the pulse output of IC5 is determined by the setting of R10. This is the only calibration adjustment required, because the meter circuit always works with signals below 100 Hz. Switch S1 selects which signal will trigger the 555.

To eliminate the need for an expensive meter with good dynamic damping, electrolytic capacitor C8 is connected across the meter. This provides stable readings down to 10 Hz. Without the capacitor, the meter specified vibrates very severely below 20 Hz.

Construction. Because the EPUT circuit is fairly simple, it can be assembled on a printed circuit or perforated board. The use of an LM309 voltage regulator (IC6) is strongly recommended, because 7490's are very intolerant of even brief overvoltages. Try to keep the board layout clean, and by all means use the minimum amount of heat and solder necessary for good, clean connections. Integrated circuits can be soldered directly to the circuit board, or if desired, IC sockets or Molex Soldercons can be used. Use a metal utility box as an enclosure. A 6" \times 4½" \times 3" (15.2 \times 11.4 \times 7.6 cm) utility box provides ample space for all components. Bolt the regulator IC to the enclosure using ¼-inch (6.4-mm) spacers. This is done to provide a good heat sink and to ground the case of the integrated circuit.

Calibration. Connect a source of low-voltage, 60-Hz ac to input jack J1 using a length of shielded or small coaxial cable. A 6.3-volt filament transformer makes a fine signal source. Higher voltages can be used, but don't exceed 12 volts peak at this or any other time. Use a resistive voltage divider, if necessary, to attenuate the input signal. With RANGE switch S1 in the "X 100 Hz" position, advance SENSITIVITY control R1 until a reading is obtained on the meter. Then adjust R10, the CALIBRATE control, for a reading of 0.6 mA on the meter. This corresponds to a reading of 60 Hz (0.6 \times 100 Hz). This is the only calibration adjustment necessary. Of course, you can check for proper counter opera-

tion with a 100-kHz or 1-MHz frequency standard.

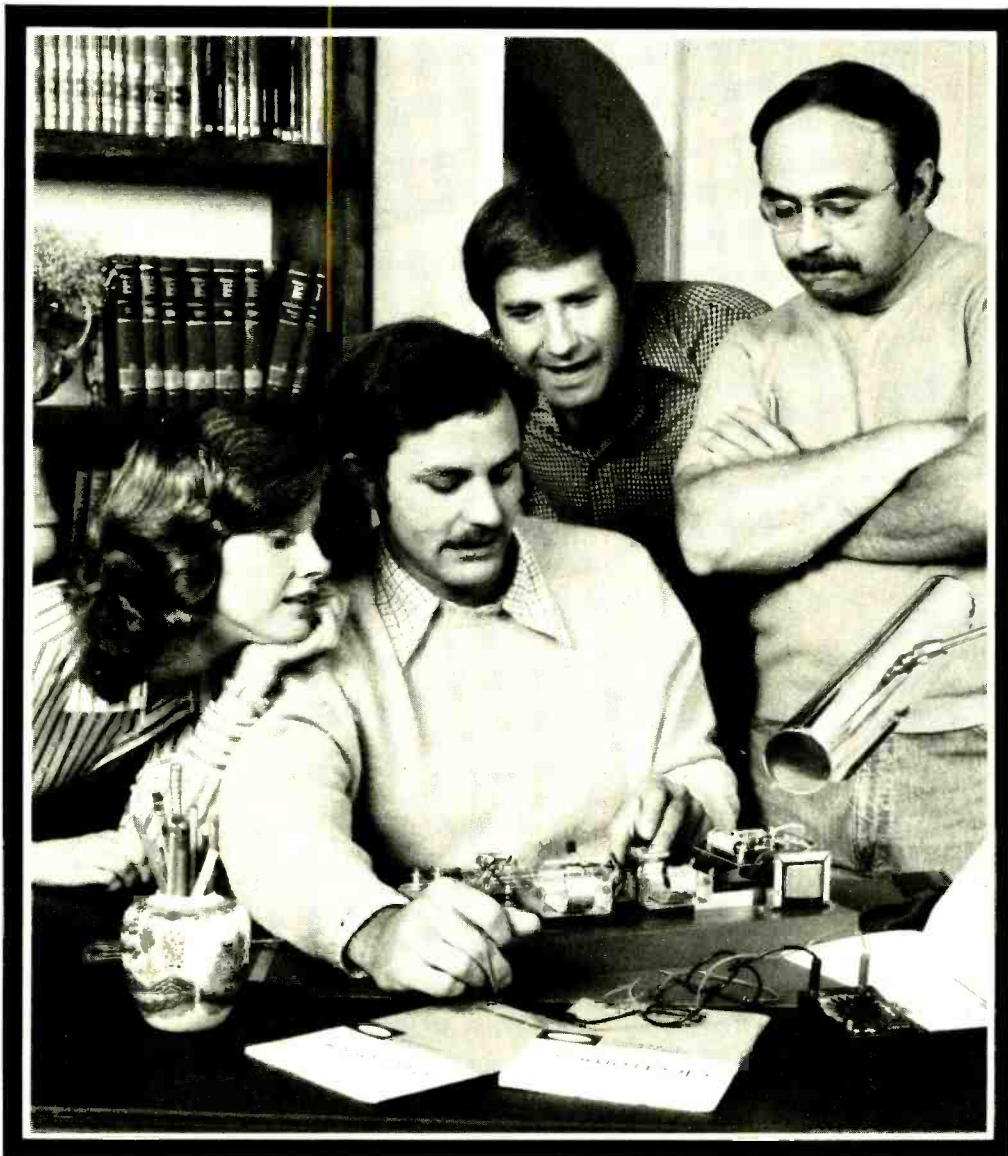
Operation. You can use the EPUT meter to measure complex waveforms or sine waves up to a frequency of 1 MHz. Just be sure that you don't exceed 12 volts peak input. Use shielded cable for the input signal to minimize noise pickup. If you want to measure an unknown frequency, start with S1 in one of its higher ranges. Adjust R1 until you get some needle movement in M1. If the needle stays at the lower end of the scale, go to a lower position of the RANGE switch until a usable reading is obtained. \diamond



"Ten-Four!"

Herb Laney's a tough-minded optimist. How about you?

Herb takes his future seriously. Without worrying about it. He knows his CIE training is giving him valuable skills in electronics. Skills a lot of people will be glad to pay for. And that's good reason for all the optimism in the world. How about you?



Learning new skills isn't something you just breeze through. Especially in electronics. You've got to really *want* success if you're going to build your skills properly.

Herb knew that right from the start. But he also knew what rewards he could earn if he took some time and did it right. He knew that, in today's world, people who really *know* electronics find a lot of other people . . . even whole industries . . . looking for their help.

How about you? How much do you want that thrilling feeling of success . . . of being in demand? Enough to work for it?

Why it pays to build skills and know-how.

One of the things that got Herb interested in electronics is that electronics seems to be something just about *everybody* needs. Almost everywhere you look these days—in a business office . . . a manufacturing plant . . . a department store . . . a doctor's office . . . a college . . . even your own home you'll find all kinds of electronic devices.

That spelled "opportunity" to Herb. Plus he liked the idea of having a set of skills that might lead to jobs in places as different as a TV station . . . a hospital . . . an airport . . . a petroleum refinery.

But what Herb liked *most* about electronics is that it's just plain *interesting*. Even though it takes time and effort to learn, the subject is so fascinating it *almost* doesn't seem like "studying" at all!

How CIE keeps you interested.

CIE's unique study methods do a lot to *keep* you interested. Since electronics starts with ideas . . . with principles . . . CIE's Auto-programmed "Lessons help you get

the idea—at your own most comfortable pace. They break the subject into bite-size chunks so you explore each principle, step by step, until you understand it thoroughly and completely. *Then* you start to use it.

How CIE helps you turn ideas into reality.

Depending on the program you choose, CIE helps you apply the principles you learn in a number of different ways.

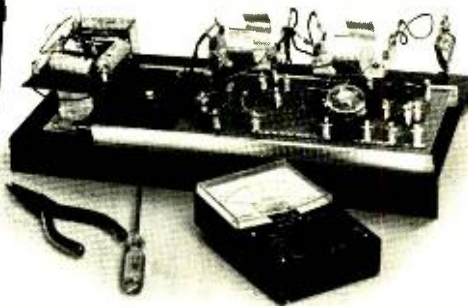
If you're a beginner, you'll likely start with CIE's Experimental Electronics Laboratory. With this fascinating workbench lab, you actually perform over 200 experiments to help you grasp the basics! Plus you use a 3-in-1 precision Multimeter to learn testing, checking, and analyzing.

In some programs, you build your own 5MHz triggered-sweep, solid-state oscilloscope—and learn how to "read" waveform patterns . . . how to "lock them in" for closer study . . . how to understand and interpret what they tell you.

To help you develop practical, skill-building knowledge you then receive a Zenith 19" diagonal



solid-state color TV featuring nine removable modules. You learn how to trace signal flow . . . how to detect and locate malfunctions . . . how to restore perfect operating standards.



What to do first.

Get all the facts. Send for CIE's FREE school catalog and career information package TODAY. Check *all* the CIE programs—and see which one's right for you. Do it now.

Why it's important to get your FCC License.

More than half of CIE's courses prepare you for the FCC License exam. In fact, based on continuing surveys, better than 4 out of 5 CIE graduates who take the exam get their License!

That's important. For some jobs in electronics, you *must* have your FCC License. For others, employers often consider it a mark in your favor. It's *government-certified proof* of specific knowledge and skills!

Free catalog!

Mail the card. If it's gone, cut out and mail the coupon. If you prefer to write, mention the name of this magazine. We'll send you a copy of CIE's FREE school catalog—plus a complete package of independent home study information! For your convenience, we'll try to have a representative call to help you with course selection. Mail the card or coupon . . . or write: CIE, 1776 East 17th Street, Cleveland, Ohio 44114.



CIE **Cleveland Institute of Electronics, Inc.**
 1776 East 17th Street, Cleveland, Ohio 44114
 Accredited Member National Home Study Council

YES . . . I want to succeed in electronics. Send me my FREE CIE school catalog—including details about all electronics courses—plus my FREE package of home study information! PE-30

NAME _____ (please print)

ADDRESS _____ APT. _____

CITY _____

STATE _____ ZIP _____

AGE _____ PHONE (area code) _____

Check box for G.I. Bill information: Veteran Active Duty

Mail today!

Manufacturers of high-fidelity audio amplifiers like to stress the type of circuit—class A, B, C, D, or G—used in their latest products. Let's take a look at what all these various types are and why some of them have taken on special meaning in recent years. Despite the fact that class-B amplifiers are by far the most widely used, we'll start at the beginning of the alphabet.

Class-A Amplifiers. Amplifiers are grouped in classes primarily on the basis of the period of conduction of a given amplifying device. In a class-A amplifier, a single output transistor conducts current continuously. An audio signal applied to the amplifier stage (Fig. 1A) varies the amount of current in the output according to the transfer characteristic shown in Fig. 1B. Quiescent current I_c flowing through the transistor in the absence of an audio signal must be great enough so that even during negative half-cycles of the audio waveform, the output is not cut off completely. Thus the output waveform is a more or less exact replica of the input.

The chief disadvantage of the class-A amplifier is its inefficiency. Since average current flow is the same whether or not a signal is applied to the input, class-A amplifiers have an overall efficiency of between 20% and 30%. Only about 25% of the energy applied to the transistor gets converted into useful output power. The rest of the energy must be dissipated as heat, within the transistor itself or into a heat sink to which the transistor is thermally coupled. Class-A amplifier stages are frequently used in low-powered products. Since these products are generally designed to produce only a fraction of a watt of audio output, the poor efficiency of class-A operation is not a problem. Recently, the advantage of the extreme linearity of the class-A circuit has prompted some hi-fi amplifier manufacturers to resort to this mode of operation even in higher-powered audio amplifiers. Such designs, however, have necessitated the use of extremely large heat sinks and oversize power supplies.

Class B. In the class-B audio amplifier, each of two transistors is biased very nearly to cutoff, as shown by the transfer characteristic of Fig. 2B. Since a single transistor now conducts during only half the applied signal, two transistors must be used to reproduce the entire waveform—each arranged to handle one alternation of the waveform. One way of doing this is to use the transformer-cou-

CLASSES of AUDIO AMPLIFIERS

What the various types mean to today's audiophile.

BY LEN FELDMAN

pled push-pull transistor stage in Fig. 2A. Here, the waveform applied to the base of Q2 has a polarity that is the opposite of that applied to the base of Q1. Each transistor, therefore, conducts during opposite halves of the signal waveform's excursions. The two halves of the amplified waveform are combined in the primary winding of T2, the secondary of

which feeds the speaker load. Transformer T2 is easily eliminated by using a complementary pair of output (matched npn and pnp) transistors so that each handles half the input signal waveform. A capacitor-coupled output stage is shown in Fig. 3A, while Fig. 3B shows how, by means of positive and negative power supplies, the output capacitor can

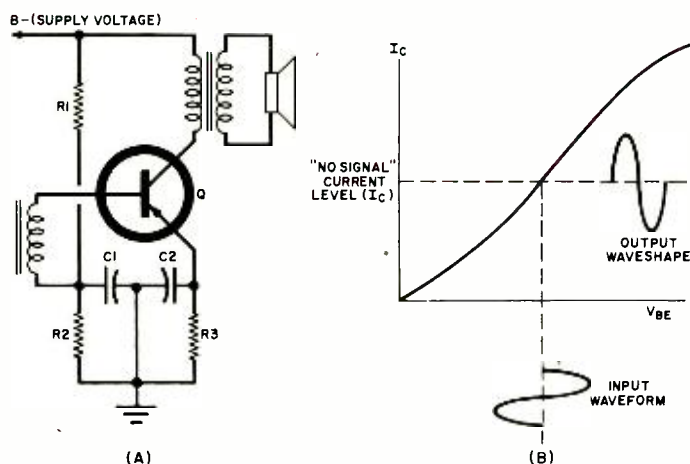


Fig. 1. At (A) is typical class-A circuit. Transfer characteristic (B) shows how stage is biased into heavy conduction.

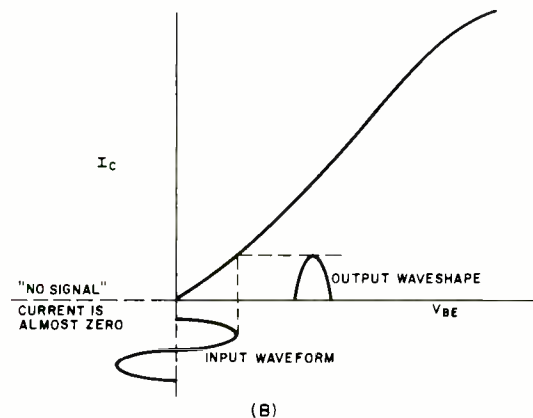
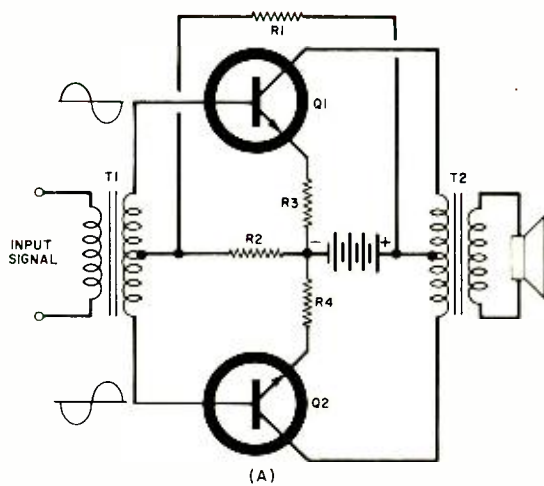


Fig. 2. Circuit (A) and transfer characteristic (B) for class-B amplifier, biased near cutoff.

be eliminated to produce the popular "direct-coupled" output stage featured in most currently produced solid-state hi-fi amplifiers.

The great advantage of class-B operation is higher efficiency than in class-A amplifiers. In typical class-B circuits the efficiency can range as high as 65%. The chief disadvantage of this circuit lies in the fact that the transition between conduction of one transistor and the other may be less than perfect. If one transistor stops conducting just a bit before the other begins to conduct, the output waveform may contain a discontinuity, which is generally referred to as "notch distortion" or "crossover distortion." This condition is illustrated in Fig. 4. Unlike overload or clipping distortion, which occurs only when an amplifier is driven beyond its rated power output, notch distortion can occur at all listening levels. In fact, it is more bothersome at low output levels, where it constitutes a greater percentage of the total output. In addition, notch distortion generally produces higher order harmonics (seventh, ninth, etc.) that are usually more audibly annoying than equivalent percentages

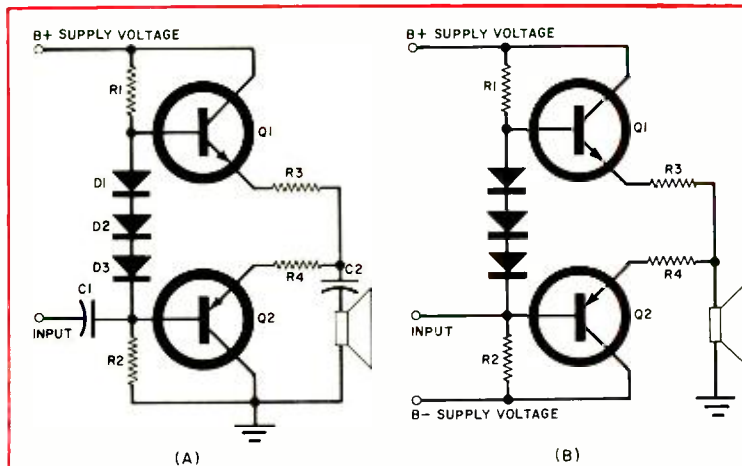


Fig. 3. Complementary npn-pnp class-B circuit, capacitor-coupled (A) and direct-coupled (B).

notch distortion is eliminated because, during the critical transition from positive to negative polarity of the input signal waveform, both output transistors are conducting. The efficiency of a class-AB circuit is also somewhere between that of classes A and B circuits.

Class C. In the class-C amplifier, conduction occurs over less than half a waveform cycle, as illustrated in the transfer diagram of Fig. 6. Class-C amplifiers are not used in audio applications because there is no way for such an amplifier to follow the complex waveform shapes of an audio signal. Rather, class-C amplifiers find application in radio-frequency (r-f) amplification, where a single frequency is to be amplified. Resonant LC (inductive-capacitive) circuits incorporated at the input and output sides of a class-C amplifier provide a so-called "flywheel" or "pendulum" effect that recreates the "missing" portion of each cycle of the input waveform. In effect, energy is supplied to the associated resonant circuits for a short period during each alternation in much the same way that a light tap applied to the

of second- and third-harmonic distortion most commonly associated with "clipping" or overload conditions in an audio amplifier.

Class AB. This type of operation falls midway between classes A and B. While neither of the two transistors in a class-AB output stage conducts over the full audio input signal waveform, each continues to conduct for more than a half-cycle. The operating point for a transistor biased for class AB operation is shown in Fig. 5. In class-AB circuits,

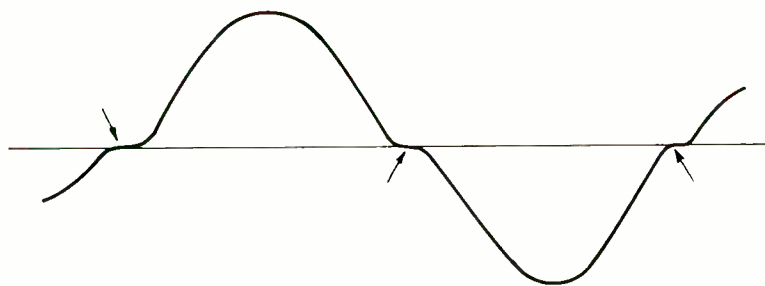


Fig. 4. Extreme example of notch distortion possible with poorly designed class B output circuits.

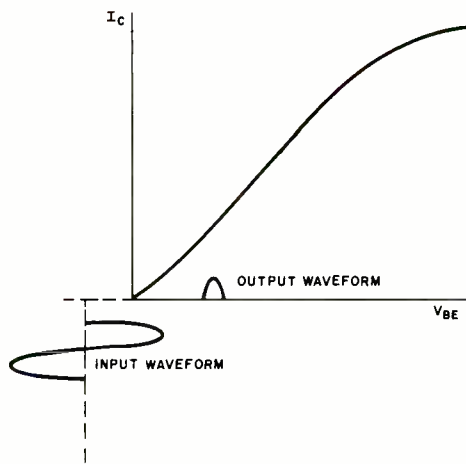


Fig. 5. Class AB requires two transistors in push-pull, operates between class A and B.

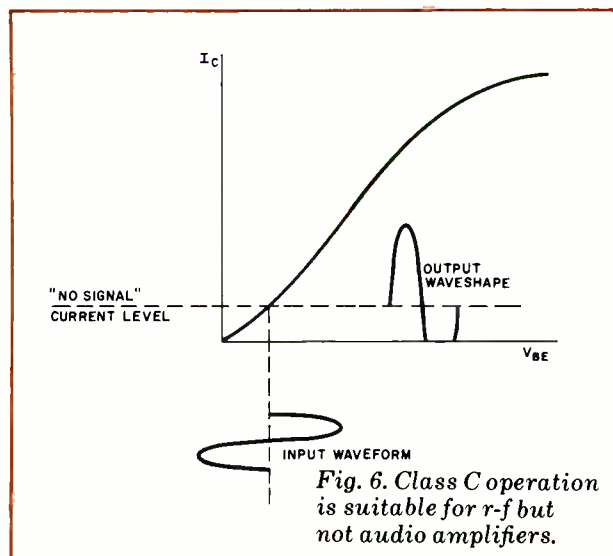


Fig. 6. Class C operation is suitable for r-f but not audio amplifiers.

lower portion of a swinging pendulum every time the pendulum reaches one end of its swing can keep it swinging over a wide arc. The efficiency of a class-C amplifier is high—between 65% and 85%—since the amplifying stage itself is called upon to conduct for a very short portion of the waveform cycle.

Class D. So-called class-D circuits have been used in military and high-power applications for some time. In audio applications, class-D circuitry is new. Instead of using transistors as linear amplifiers (as is the case for all the other classes of amplifiers we have discussed so far), the transistor is used as a switch. Audio input signals are first converted to pulses of varying widths. These pulses switch the transistors on and off at a super-audible high-frequency rate (as high as 500,000 times per second). By having the audio signal control when the transistor switches high voltages and currents, the signal is amplified. The output pulses are "summed" or integrated by a filter or smoothing network to produce an output signal that resembles the input audio waveforms.

Switching amplifiers can and do run at efficiencies of greater than 95%. Infinity Systems, Inc. introduced the first such amplifiers. The high efficiency of the amplifier drastically reduces heat-sink requirements and makes for a very compact amplifier package. The Infinity Systems amplifier is said to be capable of delivering continuous 250 watts per channel under any line conditions from 96 to 240 volts while remaining cool. At \$1850, the class D amplifier is expensive, but if it proves its claims, we are likely to see more versions designed for audio applications from a number of manufacturers in the future.

Class G. We have not inadvertently skipped "classes E and F." In fact, when Hitachi first developed its high-efficiency circuit, the company had called it class E. Later, it was discovered that there already existed amplifier configurations that had been assigned the designations class E and class F. Accordingly, Hitachi elected to call its high-efficiency amplification scheme class G, though in some of the literature you may find that the system is still referred to as a Series E audio amplifier.

In a class-G amplifier, double pairs of output transistors are used in push-pull operation (Fig. 7). When the input voltage is lower than V_1 (or V_1'), Q_2 and Q_2' are cut off and current flows through Q_1 and Q_1' to the load. Once the input voltage exceeds V_2 , the current to the load is through Q_2 - Q_1 and Q_2' - Q_1' . For music reproduction, the amplifier operates most of the time with V_1 and V_1' (more than 90%) and a very small fraction of the time from V_2 and V_2' . Power dissipation is thus low.

Crossover distortion from V_1 to V_2 and vice versa is minimized by using high-speed transistors and diodes. Residual switching spikes or instantaneous signal dropout are minimized by circuit design techniques.

Although the efficiency of a class-B amplifier can be as high as 65%, it should be understood that this level is reached only when the amplifier is delivering its rated output. At all lower levels, efficiency is considerably less. For the class-G circuit, since each transistor is operating closer to its optimum efficiency point more of the time, the overall efficiency of the system is improved to about 75% or 80% for much of the time that conduction of audio signals actually occurs.

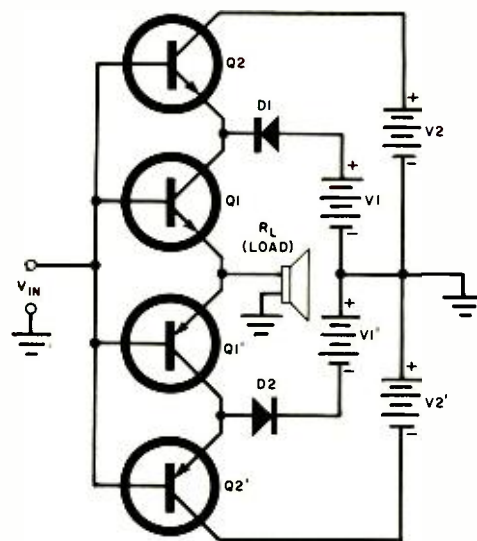
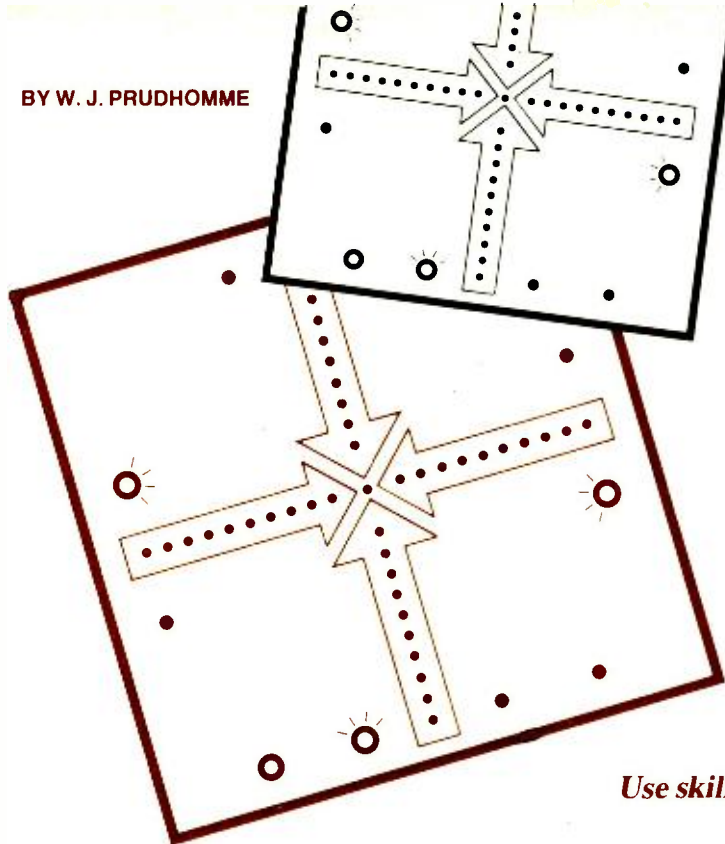


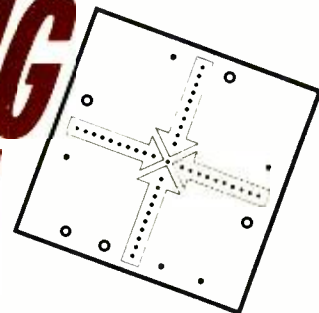
Fig. 7. Simplified diagram of class G amplifier stages.

Summing Up. It should be clear from this brief analysis of the various amplifier classes that each has its advantages and disadvantages. Manufacturer's claims notwithstanding, to say that a class-A amplifier is inherently better than a class-B amplifier or that a class-D switching amplifier is better than a class-G amplifier is an oversimplification at best. Since all classes of amplifiers are currently used in modern amplifier designs, we must conclude that the choice of class involves a series of trade-offs and that properly executed designs in each amplifier class can result in high-fidelity audio amplifiers that come close to faithful reproduction of sound. And faithful reproduction of sound is, after all, the end goal of all hi-fi products. ◇

BY W. J. PRUDHOMME



MULTIPLAYER LED RACING GAME



Use skill as well as chance
to win the game of "Strategy."

MOST electronic games, like dice and roulette, depend purely on luck. The "Strategy" game presented here, however, depends on the player's skill and the strategic maneuvers one exercises to win. Each of up to four players tries to get "home" before the others. A player can move directly toward home, a step at a time, or use strategy to move an opponent backward, while sacrificing a chance to move forward. In either case, a relative degree of skill is required, the amount of skill determined by a variable-rate blinking LED.

Directly in front of each player's position on an 18" (45.7-cm) square playing field is a set of 10 LED's arranged inside a colored arrow that points toward the center of the field. At the center of the field is a master LED that blinks at an adjustable rate. As each player's turn comes up, he tries to score and move one step closer to the point of his arrow by pressing his SCORE pushbutton switch. Here is where the skill comes in because the SCORE button must be pressed at the exact instant the master LED flashes on. If the SCORE button is pressed too soon or too late, the player fails to score. Since the SCORE button generates only a short pulse when it is operated, timing is very critical. Holding down a SCORE button will be ineffective because this pulse is generated only when the button is initially pressed. Changing the flash rate of the master LED determines the level of difficulty in playing the game.

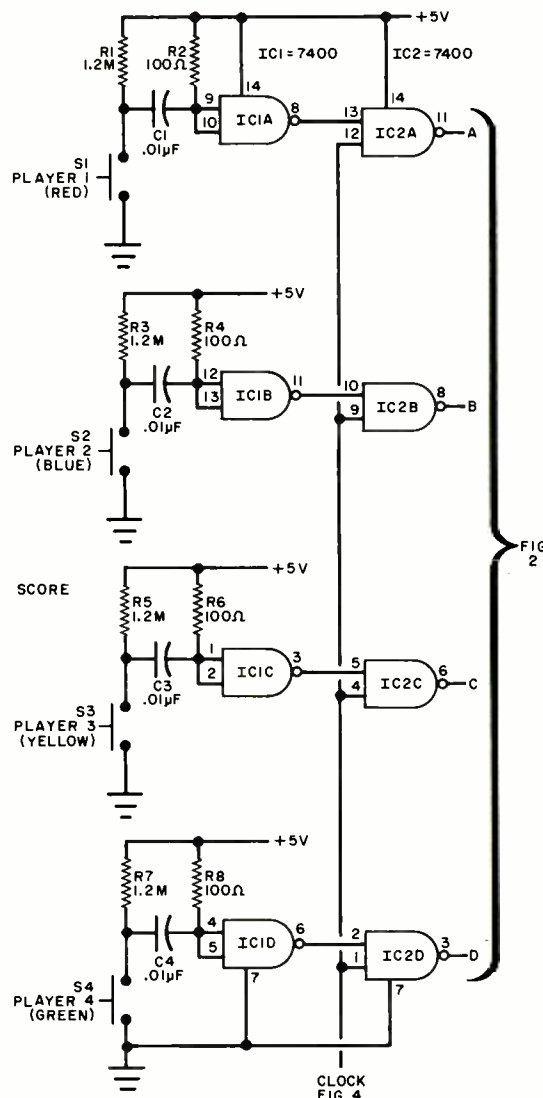


Fig. 1. Each time a player's pushbutton is operated, a single pulse is generated by its IC1.

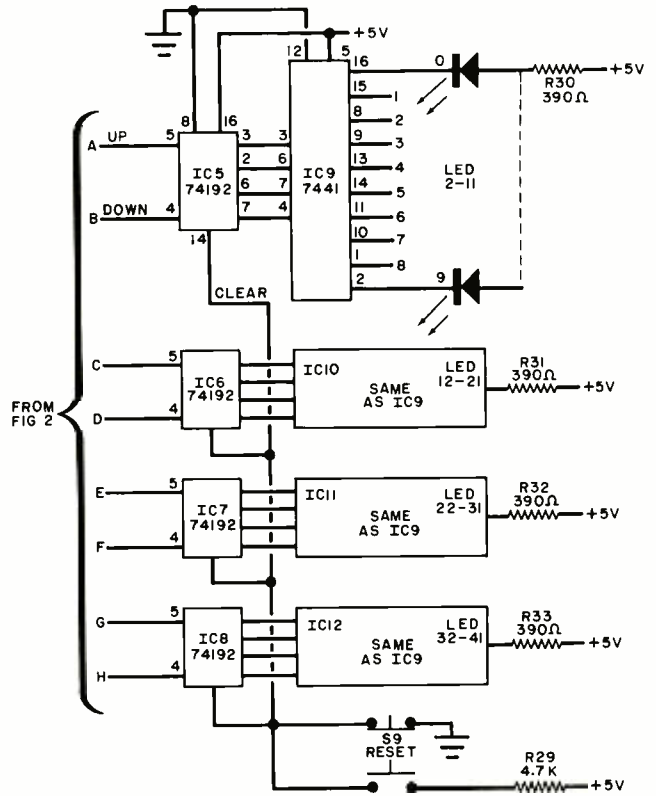
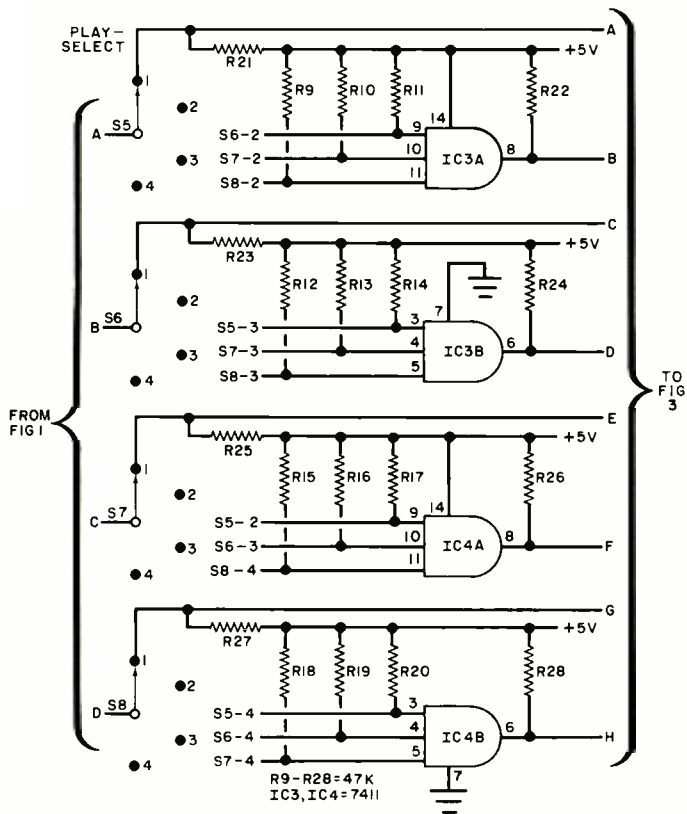


Fig. 2. Pulses are applied to player's LED or opponent's. Fig. 3. Each counter drives its decoder to turn on LED's.

PARTS LIST

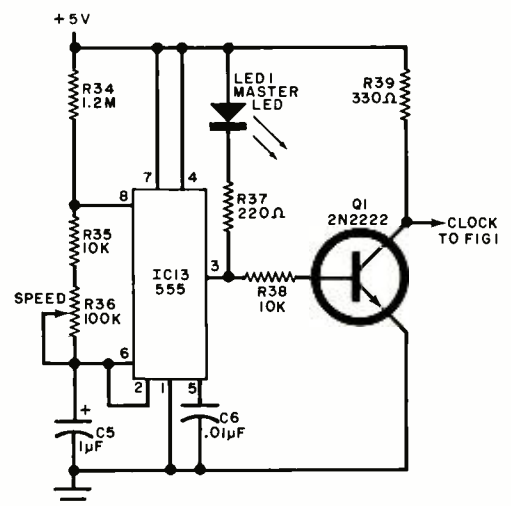
C1, C2, C3, C4, C6, C8—0.01- μ F disc capacitor
 C5—1- μ F, 15-V electrolytic capacitor
 C7—1000- μ F, 25-V electrolytic capacitor
 C9—1- μ F, 15-V nonpolarized capacitor
 D1 through D4—1N4002 rectifier diode
 F1— $\frac{1}{2}$ -ampere standard fuse
 IC1, IC2—7400 quad 2-input NAND gate
 IC3, IC4—7411 triple 3-input NAND gate
 IC5 through IC8—74192 up/down decade counter
 IC9 through IC12—7441 one-of-10 decoder/driver (see text)
 IC13—555 timer
 IC14—LM309K 5-volt regulator
 Q1, Q2—2N2222 transistor
 Q3—Programmable unijunction transistor (Radio Shack No. 276-119 or similar)

The following resistors $\frac{1}{2}$ -watt, 10%
 R1, R3, R5, R7, R34—1.2 megohms
 R2, R4, R6, R8—100 ohms
 R9 through R29, R40—4700 ohms
 R30 through R33—390 ohms
 R35, R38—10,000 ohms
 R37—220 ohms
 R39—330 ohms
 R41—22,000 ohms
 R43—27,000 ohms
 R44—56,000 ohms
 R36—100,000-ohm potentiometer with spst switch
 R42—10,000-ohm potentiometer
 S1 through S4—Spst normally open pushbutton switch
 S5 through S8—Single-pole, four-position nonshorting rotary switch
 S9—Momentary-action pushbutton switch

with one set each normally open and normally closed contacts
 S10—Spst switch (part of R36)
 SPKR—8-ohm miniature speaker
 T1—6.3-volt, 1.5-ampere transformer
 Misc.—Two 19 $\frac{1}{2}$ " lengths of 1" \times 3" pine for frame sides; two 18" lengths of 1" \times 3" pine for frame sides; two 18" lengths of 1" \times 2" pine for cleats; two 16 $\frac{1}{2}$ " lengths of 1" \times 2" pine for cleats; one 18"-square piece of $\frac{1}{4}$ " plywood or Masonite for playing field; one 18"-square piece of $\frac{1}{4}$ "-thick Masonite peg-board for bottom plate; fuse holder; printed circuit or perforated board; IC and transistor sockets (optional); paint; sandpaper; line cord; rubber feet (4); white glue; finishing nails; woodscrews (1" long); control knobs (4); hookup wire; solder; etc.

In addition to being able to adjust the difficulty of play with the TIMING control, each player has a PLAY/SELECT switch that he can use to attempt to prevent his opponents from scoring. With this switch, a player can elect to advance his own position on the board or cause an opponent to retreat one step. The latter strategy is useful when an opponent is getting too close to home and a player is willing to sacrifice his own advancement to send him back.

Fig. 4. The 555 operates at about 1 Hz, but its duty cycle can be varied by control R36.



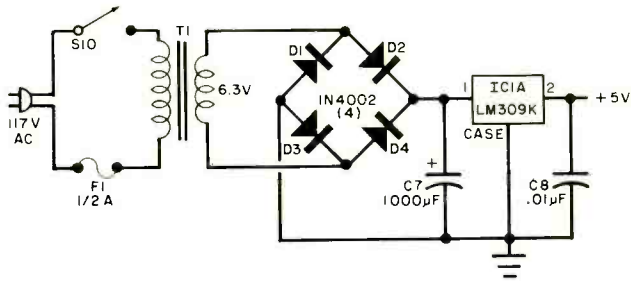


Fig. 5. Power supply is conventional regulated 5-volt system.

About the Circuit. The complete schematic diagram of this game is shown in Fig. 1 through Fig. 4, while the power supply common to all circuits is shown schematically in Fig. 5. Starting with Fig. 1, when a player presses his SCORE button (S1, S2, S3, or S4), the inputs of the appropriate NAND gate in IC1 are grounded by the capacitor (C1, C2, C3, or C4). Since the inputs to the NAND gate are also connected to the common +5-volt line through separate 100-ohm resistors, the capacitor quickly charges, returning the output of the gate to its original low state. When the SCORE

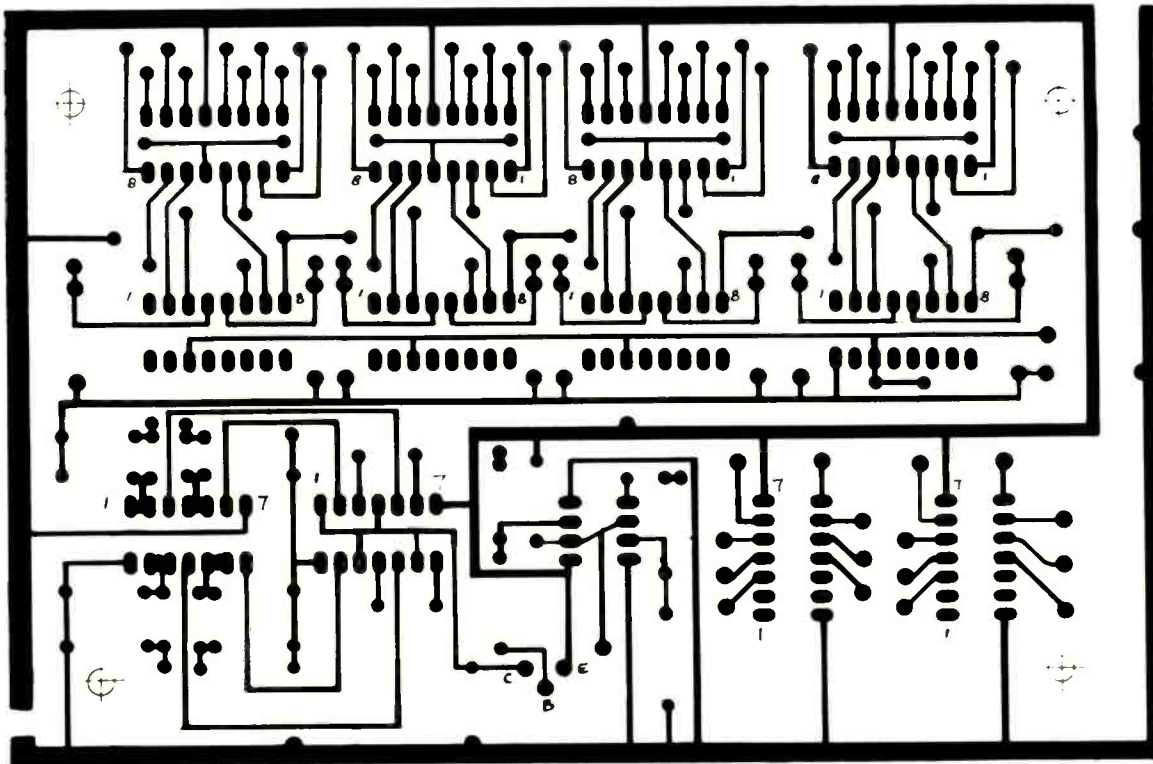
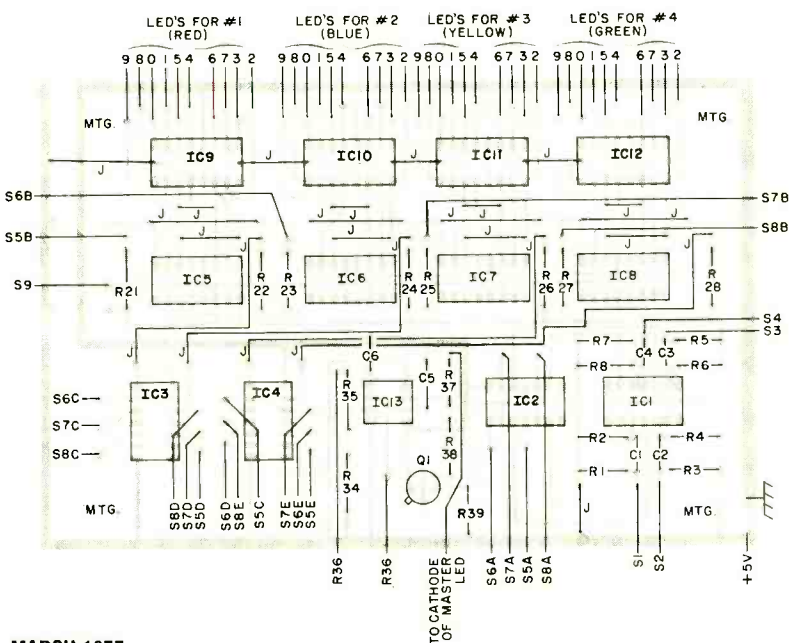


Fig. 6. Actual-size etching and drilling guide is shown above with component layout at left. External connections are also shown at left.



Learn electronics easier... with HEATHKIT

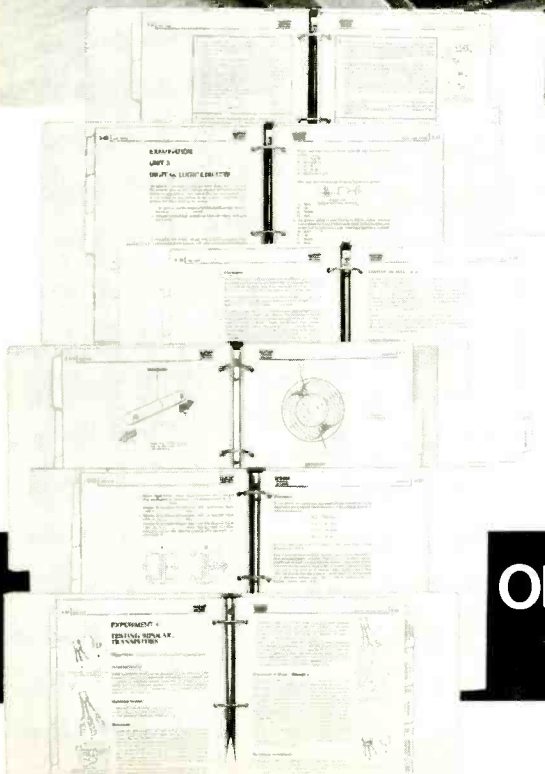
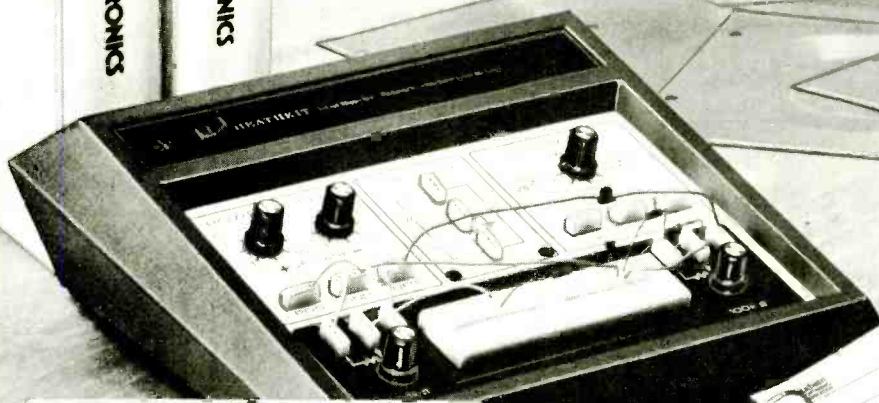
MONEY-BACK GUARANTEE

We're so confident you will enjoy and benefit from these five courses, that if for any reason you are dissatisfied, we will refund the full purchase price of the course text material.

Unique Heathkit Electronics Courses are designed to provide you with a complete overview of basic and advanced electronics.

You learn at your own pace, without pressure or deadlines, and all material is presented in a clear, logical, step-by-step fashion. It's the ideal, effective way to learn about electronics if you're a beginner, or to "brush up" on the latest techniques and theory.

Courses start as low as **\$39⁹⁵** (less trainer)



Thousands of people just like you have already learned electronics the easy Heathkit way — and you can, too. The secret is our efficient approach to self-learning with easy, step-by-step "programmed" instructions; audio records to introduce and reinforce key concepts; self-evaluation quizzes to test your understanding; and interesting experiments that let you learn the easy "hands-on" way. All you need is a record player, small tools and a VOM. The optional Heathkit experimenter/trainer is specifically designed to help you do the experiments in each course, and when you finish the course, you can use it to design and breadboard your own circuits. After completing each course, you can take the optional final exam (passing grade 70%) and receive both a Certificate of Achievement and Continuing Education Units, a nationally recognized way of acknowledging participation in non-credit adult education.

ORDER NOW
and **SAVE!**

Buy Any Single Course
with Trainer and —
SAVE \$9⁹⁵

Buy Courses 1 thru 4
with Trainer and —
SAVE \$24⁹⁵

Heath Company, Dept. 10-271 Benton Harbor, Michigan 49022

www.americanradiohistory.com

faster...at lower cost... Self-Learning Courses!

COURSE 1: DC Electronics

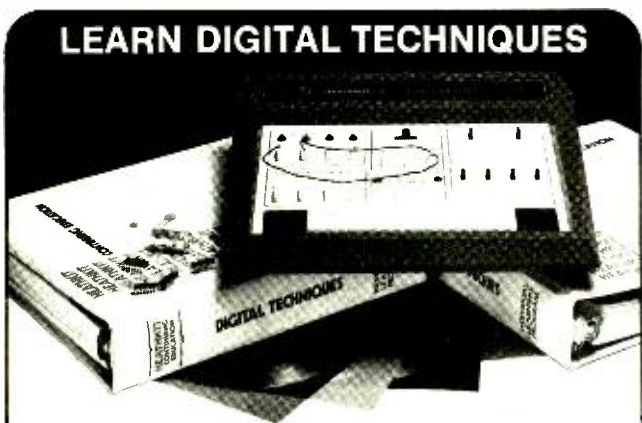
An ideal introduction to electronics. Covers current, voltage, resistance, magnetism, Ohm's law, electrical measurements, DC circuits, inductance and capacitance. Discusses matter, atoms, current, flow, voltage rises and drops, series and parallel connections, magnetic fields, voltage dividers, network theorems, more. Includes text, records and 56 parts for 20 different experiments. Average completion time, 20 hours. 2.0 Continuing Education Units and certificate for passing optional final exam.

Course EE-3101 39.95

COURSE 3: Semiconductor Devices

Essential for understanding latest solid-state equipment. Covers fundamentals, diodes, zener diodes, special diodes, bipolar transistor operation and characteristics, FET's, thyristors, integrated circuits and optoelectronics. Discusses holes, current flow, N and P types, biasing, tunnels and varactors, PIN, IMPATT, gain, cutoff and leakage current, SCR's, bi-directional triodes, light sensitive and light emitting devices, more. Includes text, records and 27 parts for 11 different experiments. Average completion time, 30 hours. 3.0 Continuing Education Units and certificate for passing optional final exam.

Course EE-3103 39.95



LEARN DIGITAL TECHNIQUES

Our most advanced self-learning course prepares you for the world of computers and microprocessors, with particular emphasis on circuit design. Covers digital fundamentals, semiconductor devices for digital circuits, digital integrated circuits, Boolean algebra, flip-flops and registers, sequential logic circuits, combinational logic circuits, digital design and digital applications. Discusses TTL, ECL, CMOS, PMOS, NMOS; integrated circuits; SSI, MSI and LSI; ROM's, PLA's, microprocessors,

computers and more. Assumes completion of Heathkit courses 1 through 4 above, or equivalent knowledge. The special digital techniques experimenter/trainer helps you perform all the experiments in the course, and when you complete the course, build and design your own circuits. Course includes text, records and 44 parts for 24 different experiments. Average completion time, 40 hours. 4.0 Continuing Education Units and a certificate for passing final exam.

ORDER DIGITAL TECHNIQUES PROGRAM AND TRAINER ... \$109⁹⁵

HEATH IM-17 VOLT-OHM METER

All Electronic Learning Programs require a VOM to make electrical measurements. We suggest the Heath IM-17 as the ideal "all-purpose" unit. All solid state with FET input for better accuracy. Portable battery operation, zero and ohms adjust, accessory probe jack. Comes with DC polarity switch, three test leads; batteries not included. Easy 3 hour assembly.

ORDER KIT IM-17 \$32⁹⁵



COURSE 2: AC Electronics

Provides an understanding of most commonly used circuits. Covers alternating current, AC measurements, capacitive and inductive circuits, transformers and tuned circuits. Discusses waveforms, period and frequency, meters, scopes, series and parallel circuits, RC filters, dividers, phase shifts, reactance, vectors, transformer theory and characteristics, series and parallel resonance, more. Includes text, records and 16 parts for 8 different experiments. Average completion time, 15 hours. 1.5 Continuing Education Units and certificate for passing optional final exam.

Course EE-3102 39.95

COURSE 4: Electronic Circuits

Outstanding explanations of basic circuits. Covers basic amplifiers, special purpose amplifiers, operational amplifiers, power supplies, oscillators, pulse circuits, modulation and demodulation. Discusses amplifier functions and configurations, class of operation, audio characteristics, video amplifiers, buffers, IF's, rectifiers, voltage multipliers, voltage regulation, basic oscillators, RC waveshaping, clipping, AM, FM and SSB, modulation fundamentals and more. Assumes knowledge of courses 1 through 3 or equivalent and requires an oscilloscope for some experiments. Includes text, records and over 110 parts for 18 different experiments. Average completion time, 30 hours. 3.0 Continuing Education Units and certificate for passing optional final exam.

Course EE-3104 49.95

HEATHKIT EXPERIMENTER/TRAINER

For use with Heathkit Electronics Courses 1 through 4 — helps you perform all the experiments quickly and easily. Has solderless breadboarding sockets, dual variable power supply for positive and negative voltages, sine and square wave signal source, center-tapped line transformer. After you complete the course, the trainer is ideal for experimenting and breadboarding with your own circuit designs.

Kit ET-3100 \$59⁹⁵

HEATH

Schlumberger

Order Form/Agreement

Heath Company, Dept. 10-271
Benton Harbor, Michigan 49022

Please send me items checked below and include FREE \$7.95-value Weller Soldering Iron (GDP-1105). (See Order Card)

- Send one course (checked below) with the *Experimenter/Trainer* (ET-3100) at the special price of only \$89.95 plus \$3.00 shipping and handling.
- DC (EE-3101) AC (EE-3102) Semiconductors (EE-3103)
- Send me the *Electronic Circuits Course* (EE-3104) with the *Experimenter/Trainer* (ET-3100) at the special price of only \$99.95 plus \$3.00 shipping and handling.
- Send all four of the courses above (EE-3101, 3102, 3103, 3104) with the *Experimenter/Trainer* at the special price of just \$199.95 plus \$4.50 shipping and handling.
- In addition, please send the following courses (less trainer):
- DC (EE-3101) AC (EE-3102) Semiconductors (EE-3103) for just \$39.95 plus \$1.50 shipping and handling each.
- Electronics Circuits (EE-3104) for just \$49.95 plus \$1.50 shipping and handling.
- Send me the *Digital Techniques Course* (EE-3201) with its *Experimenter/Trainer* (ET-3200) for only \$109.95 plus \$3.00 shipping and handling.
- Also send me that IM-17 VOM kit for just \$32.95 plus \$1.50 shipping and handling.

Michigan residents add 4% sales tax.

I enclose check money order for \$_____ ; or, Charge to my:

- BankAmericard Acct. No. _____ Exp. Date _____
- Master Charge Acct. No. _____ Exp. Date _____
- If Master Charge, include Code No. _____

Signature: X_____

Name (please print)_____

ADDRESS_____

CITY_____ STATE_____ ZIP_____

Popular Electronics ED-105

GAME RULES

- 1—Rotate SPEED control clockwise to turn on power and adjust level of game difficulty.
- 2—Press and release RESET switch.
- 3—Choose (by lot, with dice, or by cutting cards) starting player.
- 4—First player begins by setting his PLAY/SELECT switch to his own color and trying to press his SCORE button at exact instant master LED turns on.
- 5—If a player is successful in scoring a point, his LED will advance one step. Whether or not the first player scores, next play goes to the next player in a clockwise direction around the board.
- 6—When an opponent gets near the finish line, it is possible for any other player to move him back one step by setting his PLAY/SELECT switch to the other player's color and operating his SCORE button. The same odds apply whether a player wishes to advance his own score or send another player back one step. A player who elects to send an opponent back forfeits his chance to score.
- 7—First player to reach home is the winner. If desired, the game can be played to determine the second- and third-place winners.
- 8—Players can mutually agree to change the rules to add variety to the game. For example, instead of one play at a time, each player can be allowed to score as many points as possible in a given period of time. Another possibility is to allow each player two scoring attempts per turn. In this case, he can elect to score twice, move one or two opponents back, or move one player back and also score.

button is released, the output remains low and the capacitor discharges through the 1.2-megohm resistor until the circuit is again ready to generate a pulse. The RC charge/discharge time, consequently, becomes an effective debounce circuit.

The output from the IC1 NAND gate is coupled to one input of NAND gate IC2, where it is combined with the output pulse from the clock generator (Fig. 4). These gates determine if the player "scores" by detecting simultaneous inputs to the IC2 gate. The logic rules for a two-input NAND gate require that if either input is low, the output will be high. Also, if both inputs are high, the output will be low. Hence, if the positive-going pulse generated by operation of the SCORE button and the positive-going clock pulse are present at the same instant, the output of that particular gate in IC2 will go low for the duration of the pulse-coincidence interval. If the two pulses do not occur simultaneously, the output of the IC2 gate will remain high, as it does between plays, and the player will not score.

When each player has taken his turn, the next player has the option of either advancing his own position or sending his opponent's position back one step. He does this by setting his PLAY/SELECT switch (S5 through S8 in Fig. 2). This circuit routes the player's pulse to the up-count input of his own counter (IC5, IC6, IC7, or IC8 in Fig. 3) or to the down-count input of the opponent's counter selected by the PLAY/SELECT switch.

The up/down counters shown in Fig. 3 will advance one count for each low-to-high transition of the up-count input when the down-count input is held high and the clear input is held low, the latter via S9 in Fig. 3. Conversely, the counter will back up one count for each high-to-low transition at the down-count input when the up-count input is held high and the clear input is held low. At the end of each game, S9 must be pressed mo-

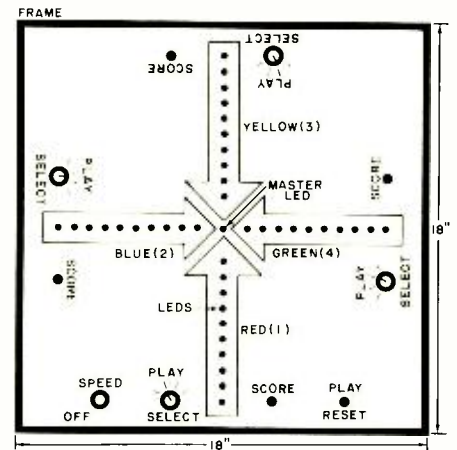


Fig. 7. Diagram shows layout of top of prototype game. Arrows are color-coded on 18" frame.

mentarily to reset the system for a new game.

The BCD output of each up/down counter is decoded by a 1-of-10 decoder (IC9 through IC12 in Fig. 3), with each of the 10 outputs connected to its own LED. Hence, there are 10 LED's for each player, all of which are driven by their own decoder. Only one LED at a time is on at any given time for each player. The glowing LED determines the player's position during the game. As the player advances position, the next LED toward the point of his arrow comes on and the position vacated extinguishes. Needless to say, the player who reaches the point of his arrow first is the winner of the game. Because only one LED for each player is on at any given time, only one current-limiting resistor (R30 through R33) is required for each player position. The absolute maximum current output of the decoder specified in the Parts List is 10 mA. If you choose LED's that require more current, substitute 7445 IC's in place of the 7441's specified. The 7445's are capable of delivering up to 80 mA per output.

The clock circuit shown in Fig. 4 contains a 555 timer-IC oscillator whose time constant is approximately one pulse/second. Adjustment of potentiometer R36 determines the on time of master indicator LED1. With the component values specified, the on time of the LED can be varied from about 0.01 to 0.1 second. This particular time span was selected because most people have a reflex action time of 0.3 second or longer. The intent here is that a player will not be able to wait for LED1 to flash and then try to score by operating his SCORE switch. To be successful in scoring, a player must anticipate the flash. For this

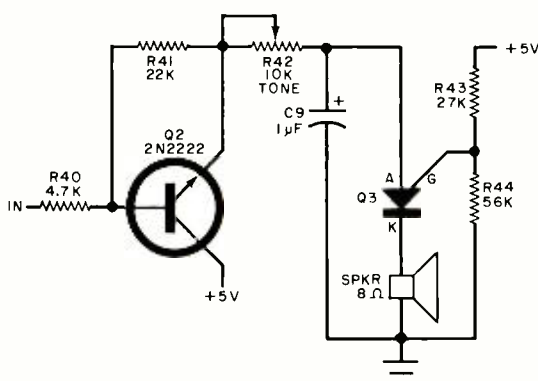


Fig. 8. Optional tone control can be connected to different portions of circuit (experimentally) to make the desired sound effect.

reason, the game challenges a person's timing skill, rather than his reflexes.

Transistor Q1 is used as an inverter and TTL level converter. The power supply shown in Fig. 5 employs full-wave bridge rectification of the stepped-down ac and a 5-volt IC regulator.

Construction. Except for the LED's, switches, and power supply, the complete circuit can be assembled on a single printed circuit board. The etching and drilling and component-placement

guides for the pc board are shown in Fig. 6. To conserve space on the pc board, pull-up resistors R9 through R20 mount directly on PLAY/SELECT switches S5 through S8.

The playing field should be mounted in a frame that leaves enough depth under the field to accommodate the circuit board assembly and power supply. If you have a miter box, you can construct the frame with miter joints, in which case use four 19½" (49.5-cm) long pieces of 1" x 3" (25.4 x 76.2-mm) pine. Otherwise, simple butt joints will serve just as well. Fasten the joints together with finishing nails and white glue.

Glue and nail the 1" x 2" (25.4 x 50.8-mm) pine to the inner walls of the frame, spacing it ¾" to ½" (9.5 to 12.7 mm) from the top edge of the frame. This will provide a convenient platform on which to mount the playing field board. Smoothly sand and paint or varnish the frame, making sure you do not paint or varnish the inside cleat.

Smoothly sand and paint the top surface of the playing field board white. When the paint has completely dried, drill the LED and control holes as illustrated in Fig. 7. Then paint on the color coded arrows. Apply a liberal bead of white glue to the upper surfaces of the cleats and lower the playing field board into place. Weight down the board with a few books until the glue has set.

Mount the LED's in the playing field's holes, using small dots of glue to hold them in place. Then mount the four SCORE, four PLAY/SELECT, and single SPEED controls in their respective locations. The main circuit board and power supply can be mounted on the peg board used as the bottom plate of the project. Route the line cord through one of the holes on the pegboard, after first enlarging it. Secure the bottom plate to the frame with eight woodscrews. Finally attach rubber feet to the frame.

Sound Effects. If you want sound effects with your game, you can use the experimental circuit shown in Fig 8. This circuit employs driver transistor Q2 to trigger programmable unijunction transistor Q3. It can be connected to various points in the main circuit, such as the master LED, to produce an audible "beep" when the LED flashes.

You can try wiring a 555 into the circuit to serve as an oscillator that produces various sounds. As an example, you can set the sound-effect system to produce a low-pitched tone for an unsuccessful scoring attempt and a high-pitched tone for a successful attempt. ◇

Teach Yourself! Digital Electronics

These courses were written by experts in electronics and learning systems so that you could teach yourself the theory and application of digital logic. You work at your own pace and must respond by answering questions on each new piece of information before proceeding.



Design of Digital Systems is written for the engineer seeking to learn more about digital electronics. Its six volumes — each 11-1/2 in. x 8-1/4 in. — are designed to lead you step-by-step through number systems and Boolean algebra, to memories, counters, arithmetic circuits, and finally to a complete understanding of the design and operation of calculators and computers.



Digital Computer Logic and Electronics is designed for the beginner. No mathematical knowledge other than simple arithmetic is assumed. It consists of four volumes and serves as an introduction to the subject of digital electronics. Everyone can learn from it.

SEVEN-DAY MONEY-BACK GUARANTEE

Technology Trends PE377
P.O. BOX 732, MANHASSET, NY 11030

PLEASE SEND ME:

- ___ sets of Design of Digital Systems at **\$19.88**
- ___ sets of Digital Computer Logic and Electronics at **\$14.88**
- ___ sets of both courses at **\$29.90**
(add \$2.50 shipping and handling)

Enclosed is my check or M.O. for \$ _____

Charge my: BankAmericard Master Charge

No: _____

M.C. Bank No. _____ Exp. Date: _____

Signature _____

Name _____

Address _____

City/State/Zip _____

NY residents add City and/or State Sales Tax.

CIRCLE NO 59 ON FREE INFORMATION CARD

MARCH 1977

Want to OWN YOUR OWN Western Auto Associate Store?

You can go into business for yourself in the city or community of your choice as a Western Auto owner.

Western Auto helps with your site selection and with your lease. We have a "total" program including training, advertising, bookkeeping, display and financing of customer purchases.

We have no contract fee, franchise fee or royalty on sales. Your investment goes into your store and cash operating reserve. If you qualify for a Western Auto loan we can even help you finance your store, where you can be your own boss.

Why don't you join the 500 people who become Western Auto Associate Store owners each year? For more information, call today TOLL FREE

1-800-821-7700

Ext. 818

Missouri Residents Call
1-800-892-7655, Ext. 818

Mail to: R. T. Renfro, V.P.,
Western Auto
2107 Grand Avenue,
Kansas City, Mo. 64108



I'd like to know more about owning my own Western Auto store. Please send free information.

Name: _____

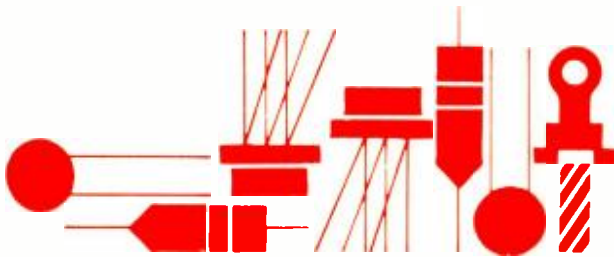
Address: _____

City: _____ State: _____ Zip: _____

Phone: _____



OVER 4,000 ASSOCIATE STORES IN 40 YEARS.
CIRCLE NO 62 ON FREE INFORMATION CARD



Solid State

By Lou Garner

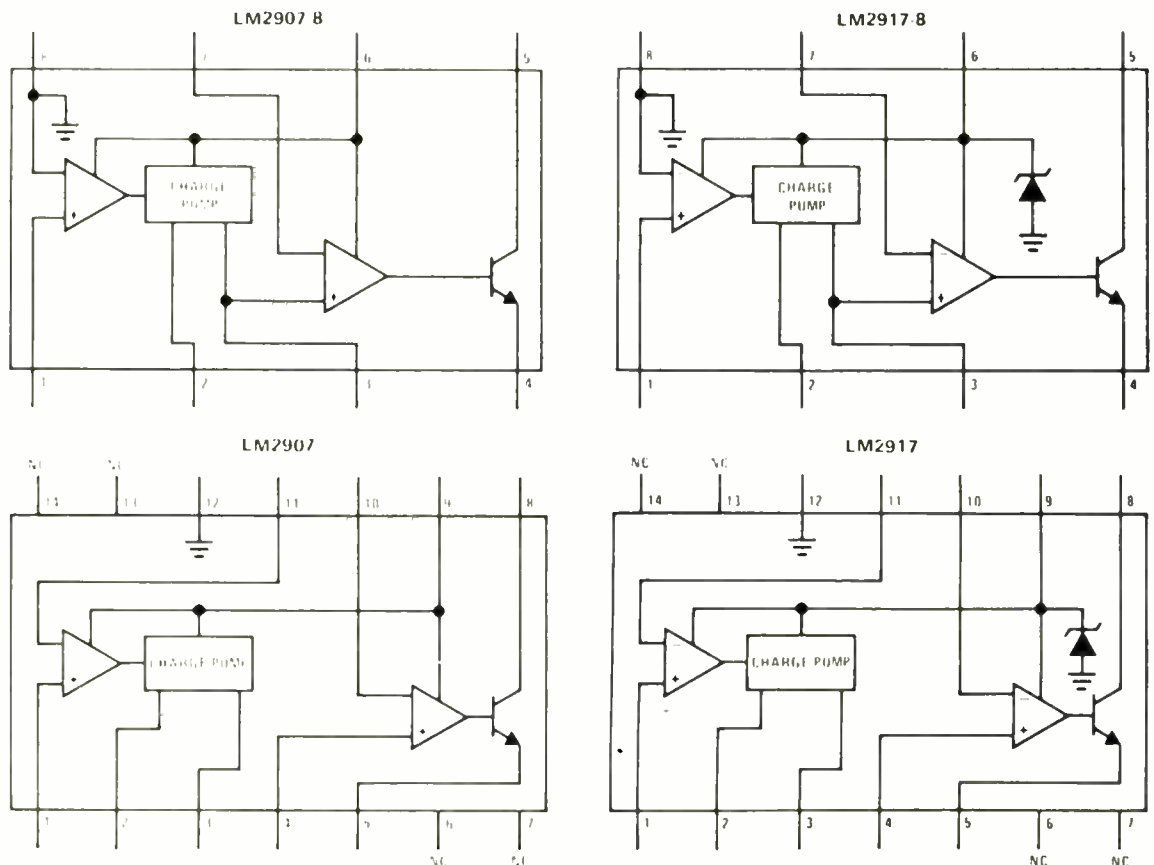
TACHOMETER-SPEED SWITCHES

LAST November, you may recall, we discussed a number of lesser known semiconductor devices which we dubbed *rara avis*—rare birds. This month, let's take another visit to the rare-bird house and examine a family of interesting special-purpose IC's introduced recently by the *National Semiconductor Corporation* (2900 Semiconductor Drive, Santa Clara, CA 95051). As shown in the functional block and pin connection diagrams, Fig. 1, the family includes four members—types LM2907, LM2907-8, LM2917, and LM2917-8. Described as "tachometer-speed switches," all four devices use the same basic monolithic chip, and each comprises a frequency-to-voltage converter and op amp/comparator. Supplied in 14-pin DIP's, the LM2917 differs from the LM2907 in that an on-chip zener regulator circuit is connected in the former to provide extra input protection. The "8" suffix versions are assembled in 8-pin DIP's and differ from the standard configurations in offering a ground-referenced input together with an internal connection between the frequency-to-voltage converter (tachometer) output and the op amp noninverting input. All four IC's can sink or source output currents of up to 50 mA, offer a typical linearity of $\pm 0.3\%$, can dissipate up to 500 mW, and are designed for operation on dc sources of up to a maximum of 28 volts.

Despite their special-purpose designation, the tachometer-speed switches are exceptionally versatile devices and may be used in a variety of exciting and valuable projects. Depending on the peripheral circuitry and types of input and/or output devices used, these IC's can serve effectively in speed alarms, over/under speed monitors and controls, frequency-to-voltage converters, speedometers, breaker-point dwell meters, speed governors, tachometers, cruise controls, touch- or sound-activated switches, automatic door lock, clutch and horn controls, capacitance meters, delay switches, and anti-skid sensor/controls. Operating on 6-to-28-volt dc supplies, the devices can be driven by voltage or current sources or by special sensors, such as magnetic pickups, and can be used to drive LED's, power transistors, relays, SCR's, meters, and similar units requiring currents of up to 50 mA.

Although the tachometer-speed switch internal circuitry is relatively complex, its basic principle of operation is comparatively simple and straightforward. An external pulsating dc or ac signal, derived from a sensor or other source, is applied to a differential amplifier driving a positive feedback flip-flop. The flip-flop, in turn, controls a charge pump which charges or discharges an external capacitor between two voltage levels. The capacitor's average pump current is directly proportional

Fig. 1. Block and pin connection diagrams.



to the supply voltage, the capacitor's value, and the charging rate. Since the capacitor's value is fixed and the supply voltage constant, the pump current is *directly proportional to the input frequency*. Parallel drivers furnish a current identical to the pump current to an external load resistor, bypassed by a second capacitor to filter the ac ripple components. As a result, the average dc voltage across the external load resistor is also directly proportional to the input frequency. This portion of the IC—the input differential amplifier, flip-flop, and charge pump—constitute a basic frequency-to-voltage converter, or tachometer.

The tachometer section's output is coupled to an operational amplifier driving a medium-power-output transistor. Depending on the external connections, the op amp may be operated either as a conventional amplifier or as a voltage comparator. If the op amp is used as a voltage comparator, its output remains essentially at zero until the input frequency (hence the tachometer section's output voltage) reaches a predetermined value established by a fixed bias applied to its inverting input terminal. Driven by the op amp, the output transistor, an npn type, has uncommitted emitter and collector terminals, permitting it to serve either as a sink or source to an external load device such as a meter, LED, etc.

Typical application circuits for the tachometer-speed switch IC's are illustrated in Figs. 2, 3, and 4. Abstracted from the 14-page data brochure for the LM2907/LM2917 family published by National Semiconductor, these circuits are intended as general guides rather than as detailed construction plans and are suitable for use by more advanced experimenters and hobbyists as well as technicians and engineers. In some cases, not all component values are specified, for these must be determined by the individual designer to meet his specific performance requirements or to match external load devices, such as meters. On the other hand, as long as good wiring practice is observed, neither layout nor lead dress should be overly critical, permitting the individual designer/builder to use his own choice of assembly techniques, including perf board, pc board, or chassis construction and point-to-point wiring. Generally, all resistors are half-watt units, all capacitors either low-voltage ceramic or plastic film types, and all external diodes general-purpose devices.

Featuring the LM2907-8, a minimum component tachometer circuit is given in Fig. 2A. Here, a variable reluctance magnetic pick-up driven by a toothed wheel serves as the input sensor. The external charge pump capacitor is a 0.01- μ F unit, while a 100,000-ohm resistor bypassed by a 1.0- μ F capacitor serves as the tachometer section output load. The final output load is a 10,000-ohm resistor. In operation, the dc voltage developed across the output resistor is directly proportional to the input frequency and hence to the wheel rpm. If a suitable high-impedance voltmeter is connected across the output load, it can be calibrated directly in terms of rpm.

A few of the many possible automotive applications for the tachometer-speed switch IC are illustrated in Figs. 2B, 3A and 3B. A breaker point dwell meter circuit using the LM2917 is shown in Fig. 2B, while engine rpm meter circuits using the same device are given in Figs. 3A and 3B. The latter two circuits clearly illustrate the different ways in which the power output transistor may be used to drive an external load. The first, Fig. 3A, uses an emitter resistor as the output load to drive a dc voltmeter. With the component values given, an output of 6 volts dc is developed across the 10,000-ohm emitter resistor with an input frequency of 400 Hz, representing an 8-cylinder engine speed of 6000 rpm. The second design, Fig. 3B, employs a milliammeter as the output transistor's collector

1702A MANUAL EPROM PROGRAMMER

Features hex keypad, two digit hex address and two digit hex data display. Controls include load, clear, go! (step), key/copy, data in/data out, and counter up/down. Profile card includes high voltage pulse regulator, timing, 8 bit address and 8 bit data drivers/receivers. Two 6½" x 9" stacked cards with spacers. Allows programming in 20 minutes — copying in 5 minutes. Requires +5, -9, and +80 volts.



ASSEMBLED \$299.95
KIT \$189.95

NOW

The best of two worlds... use our 1702 EPROM programmer as a manual data/address entry programmer... or connect it to your processor.

IMSAI/ALTAIR computer interface (requires 3 output ports, +1 input port) and software \$49.95

Briefcase unit with power supplies and interface connectors (assembled and tested only) \$599.95

ANNOUNCING

Our NEW 16K Byte Pseudo-Static, IMSAI/ALTAIR compatible RAM. Single card slot. Uses less power than equivalent low power RAM. All memory chips socketed. Uses all prime, factory fresh ICs. High quality, two-sided, through-hole-plated circuit board. Crystal controlled, totally invisible refresh system requires NO software management. Just plug it in and use like STATIC memory.

Complete kit \$349.95
Assembled, tested, and burned in \$549.95

ASSOCIATED ELECTRONICS

12444 Lambert Circle • Garden Grove, CA 92641
(714) 539-0735

CIRCLE NO 9 ON FREE INFORMATION CARD

COMING UP IN THE APRIL

Popular Electronics®

**HOW TO DX EARTH
BROADCASTS FROM OUTER SPACE
SIX CMOS CIRCUIT APPLICATIONS
FOR HOBBYISTS
DIGISTART—THE ELECTRONIC COMBINATION
LOCK FOR STARTING IGNITION SYSTEMS**

PRODUCT TEST REPORTS:

**Rotel RX-7707 Stereo
FM/AM Receiver
Garrard DD-75 Direct-Drive
Turntable
Shure 526T Base-Station
CB/Ham Microphone
Tennelec MCO-1 Memory
Scanner**



DVM36 \$158
 3½ digit LED display,
 .5% DCV accuracy,
 battery or AC operated



DVM32 \$198
 3½ digit LED display,
 .5% DCV accuracy,
 battery or AC operated
 with automatic battery saver



DVM38 \$348
 3½ digit LED display,
 .1% DCV accuracy,
 AC operated, auto-ranging,
 auto-zero, king size pushbuttons



4 BATTERY SAVING FEATURES WHEN INSTRUMENT IS NOT IN USE so you can be sure that your meter will be ready the next time you need it. Push the button on the probe on the DVM35 and DVM36 and only then do you start drawing current from your battery. An automatic patented circuit does the same job for you automatically when you apply voltage to the DVM32. The DVM38 is AC operated.

TEN DAY FREE TRIAL

5 10 DAY FREE TRIAL to be sure that Sencore digitals are all that we say they are. Simply march into your Sencore distributor and ask for a free trial or pay cash with a promise of a 10 day money back guarantee, if not 100% satisfied. Or, write Sencore, and we will see that our distributor contacts you.



5 100% MADE RIGHT LIFETIME GUARANTEE so you can be sure your meter was made right. If at any time you discover that a Sencore DVM was not made right, Sencore will make it right, parts and labor free of charge, for the lifetime of the product.

Plus other "make sure" features such as direct reading with no parallax error - no effect from magnetic fields such as motors & RF fields - lab accuracy with high resolution - auto-polarity auto-zeroing and auto-ranging on the DVM38 - and you can see why you can be sure more times, in more circuits, than with any other multimeter on the market today - and for less money than old fashioned analog meters.

SENCORE 3200 SENCORE DRIVE
 SIOUX FALLS, S.D. 57107

CIRCLE NO. 53 ON FREE INFORMATION CARD

the value of the charge pump capacitor (indicated as 0.033 microfarads).

Reader's Circuits. Our correspondent in Florida, Ted Reiter (1442 Brook Drive, Titusville, FL 32780), is back again this month with more of his interesting circuits. Feeling that many of his fellow experimenters might require time sequencing circuits for their projects, Ted suggests the designs given in Fig. 5 as simple solutions for problems which might otherwise require relatively complex circuits or expensive components. An "active low" sequencer circuit is shown in Fig. 5A, an "active high" in Fig. 5B. Both require only a 555 timer, a SN7495N 4-bit shift register, and a minimum of additional components. Both are designed to operate on a standard 5-volt dc power supply. Finally, both are not overly critical as far as parts placement and wiring dress are concerned and, therefore, may be duplicated with any preferred construction technique from solderless breadboarding to pc board assembly.

Referring to the active low sequencer circuit, Fig. 5A, the 555 is wired as a pulse generator or "clock," with its pulse rate (frequency) adjustable by means of a 1-megohm potentiometer. In operation, the shift register outputs at pins 13 (A), 12 (B), 11 (C), and 10 (D) are high initially. When normally closed switch S1 connected to mode input pin 6 is opened momentarily, the next negative-going clock edge switches pin 13 (A) to low. Each following negative edge then moves the low one position to the left from A to D. In logic symbols, using "1" for high and "0" for low, the sequence is as follows:

D-C-B-A

Originally:

1-1-1-1

Initiate:

1-1-1-0

1-1-0-1
 1-0-1-1
 0-1-1-1
 1-1-1-0
 1-1-0-1

Recycle:

and so on, recycling as long as power is supplied and the clock is on. Using the same clock circuit, the active high sequencer operates in similar fashion, except that the shift register outputs are low (logic 0) initially and a high (logic 1) is sequenced from A to D after the *initiate* button is pressed. The clock frequency, of course, establishes the cycling rate.

Although the sequencer outputs are shown in logical order, they can be used to operate external circuitry or devices in any order desired, provided the user remembers that the "A" output is active (high or low) before "B," "B" is active next before "C," and so on.

Sequencer applications are limited only by the imagination and skill of the circuit designer and by the types of peripheral circuitry or external devices controlled. Ted suggests, for example, that a sequencer could be used to cycle several lights on and off for unusual displays, for sequencing several slide projectors for special color-slide presentations, for cycling a CB transceiver through several channels, or for sequencing several audio tones in an electronic "doorbell," as indicated in Fig. 6. Other possible applications include the familiar turn indicator for autos (or bikes), for "bouncing" sound around a room by switching loudspeakers on and off sequentially, or for sequencing test operations in a laboratory. Generally, some type of interface device, such as a relay, power transistor, or SCR will be required between the sequencer output and the controlled device (lamp, loudspeaker, alarm bell, motor, or

Should your career in electronics go beyond TV repair?

**CREI prepares you at home
for broader and more advanced
opportunities in electronics—
plus offers you special arrangements
for engineering degrees**

There is no doubt television repair can be an interesting and profitable career field. TV repair, however, is only one of the many career areas in the fast growing field of electronics.

As an indication of how career areas compare, the consumer area of electronics (of which TV is a part) makes up less than one-fourth of all electronic equipment manufactured today. Nearly twice as much equipment is manufactured for the communications and industrial fields. Still another area larger than consumer electronics is the government area. That is the uses of electronics in such areas as research and development, the space program, and others.

Just as television is only one part of the consumer field, these other fields of electronics are made up of many career areas. For example, there are computer electronics, microwave and satellite communications, cable television, even the broadcast systems that bring programs to home television sets.

As you may realize, career opportunities in these other areas of electronics are mostly for advanced technical personnel. To qualify for these higher level positions, you need college-level training in electronics. Of course, while it takes extra preparation to qualify for these career areas, the rewards are greater both in the interesting nature of the work and in higher pay. Furthermore, there is a growing demand for personnel in these areas.

Unlike most other home study schools, CREI programs are devoted exclusively to preparing you for careers in advanced electronics. All of CREI programs are college level. And CREI gives you both theory and practical experience in advanced electronics.

Unique Design Lab

A unique feature of CREI training is its Electronic Design Laboratory Program, which trains you to actually design circuits. It also helps you understand the theories of advanced electronics and gives you extensive practical experience in such areas as tests and measurements, breadboarding, prototype construction, circuit operation and behavior, characteristics of electronic components and how to apply integrated circuits.

Career Training at Home

Only CREI offers this unique Lab Program. It is a complete college lab and, we believe, better than you will find in most colleges. The "Lab" is one of the factors that makes CREI training interesting and effective. And the professional equipment in this program becomes yours to keep and use throughout your professional career after you complete the training.

Engineering Degree

CREI offers you special arrangements for earning credit for engineering degrees at certain colleges and universities as part of your home study training program. An important advantage in these arrangements is that you can continue your full time job while "going to college" with CREI. This also means you can apply your CREI training in your work and get practical experience to qualify for career advancement.

Wide Choice of Programs

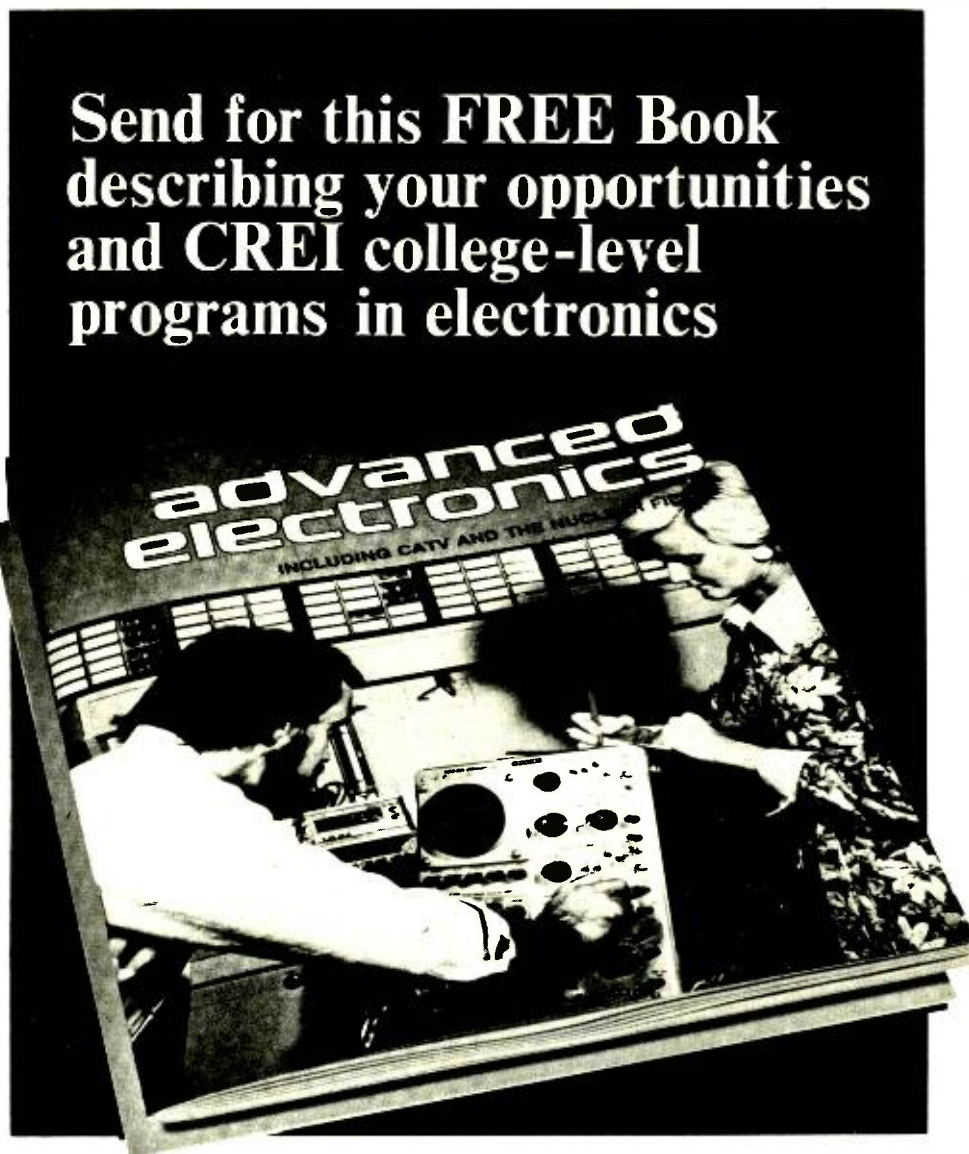
CREI gives you a choice of specialization in 14 areas of electronics. You can select exactly the area of electronics best for your career field. You can specialize in such areas as computer electronics, communications engineering, microwave, CATV, television (broadcast) engineering and many other areas of modern electronics.

FREE Book

In the brief space here, there isn't room to give you all of the facts about CREI college-level, home study programs in electronics. So we invite you to send for our free catalog (if you are qualified to take a CREI program). The catalog has over 80, fully illustrated pages describing your opportunities in advanced electronics and the details of CREI home study programs.

Qualifications

You may be eligible to take a CREI college-level program in electronics if you are a high school graduate (or the true equivalent) and have previous training or experience in electronics. Program arrangements are available depending upon whether you have extensive or minimum experience in electronics.



Send for this **FREE** Book describing your opportunities and CREI college-level programs in electronics

Mail card or write describing qualifications to

CREI **CAPITOL
RADIO
ENGINEERING
INSTITUTE**

McGraw-Hill Continuing Education Center
3939 Wisconsin Avenue Northwest
Washington, D.C. 20016

Accredited Member National Home Study Council

GI Bill

CREI programs are approved for training of veterans and servicemen under the G.I. Bill.

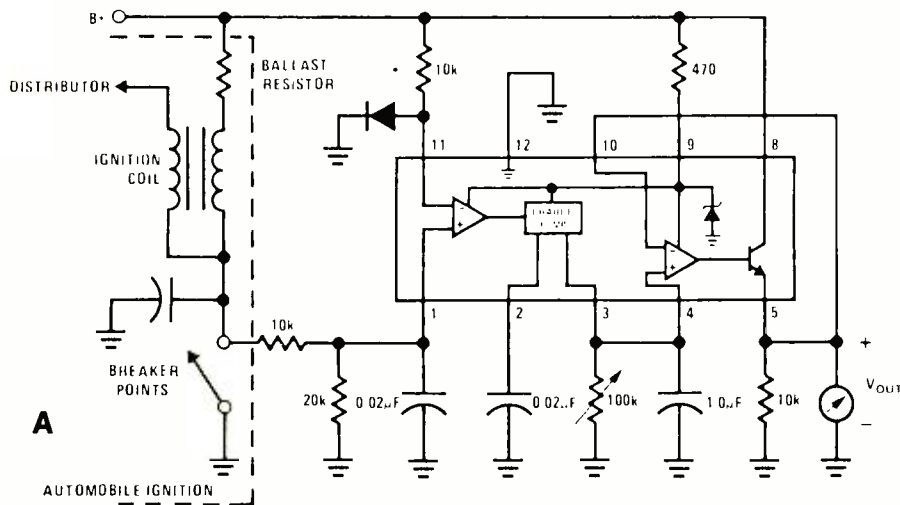


Fig. 3. Automotive tachometer circuits: (A) voltage-driven for 8-cylinder cars; (B) current-driven for 6-cylinder cars.

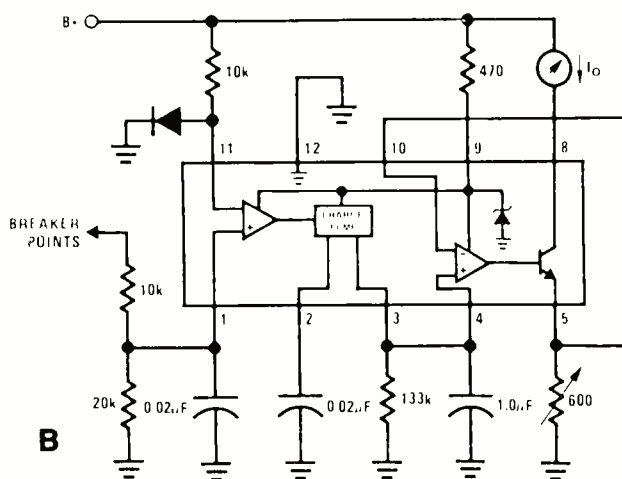
other unit) if moderate to high power levels are involved, with the interface and controlled devices requiring a separate power source.

Device/Product News. If you're working with r-f circuits, either professionally or as a ham, you may want to investigate a pair of solid-state vhf and hf amplifier modules recently introduced by the *Amperex Electronic Corporation* (Hicksville, NY 11802). Containing internal matching networks for broadband applications, each module will deliver better than 18 watts with a drive power of less than 150 mW when operated on a dc supply of 12.5 volts. The BGY32 is designed for operation at 68 to 88 MHz, the BGY36 from 148 to 174 MHz. Their input and output impedances are matched to 50 ohms with no instability at VSWR's of up to 3:1 at all phase angles, but neither will be damaged with VSWR's of up to 50:1 through all phase angles at heat sink temperatures as high as 70°C.

In addition to the new r-f amplifier modules, Amperex has announced a new full-wave silicon bridge rectifier designed specifically for use in semiconductor equipment. Designated type BY225-200, the rectifier has a maximum rms input rating of 80 volts and can supply an average output current of 4.2 A. Suitable for use at frequencies up to 400 Hz, the rectifier consists of four double-diffused diode crystals on a copper comb encapsulated in plastic. Capable of delivering up to 3 A without a heat sink, the device can be used in power supplies for musical instruments, audio amplifiers, boat equipment, burglar and fire alarms, battery chargers, microprocessors, and other equipment requiring up to 90 W output.

The *Fairchild Camera and Instrument Corp.* (Analog Products Division, 464 Ellis St., Mountain View, CA 94042) is producing a hybrid voltage regulator capable of providing 5 A of regulated power at 5 volts with built-in short circuit and safe area protection. The voltage regulator, type 78H05KC, limits the maximum junction temperature of the power output transistor to provide full automatic thermal overload protection. If the safe operating area is ever exceeded, the device simply shuts down rather than failing or damaging other system components. The device is supplied in a standard TO-3 package.

Teledyne Semiconductor (1300 Terra Bella Ave., Mountain View, CA 94042) has added two new up-down (reversible) counters to its growing family of high-noise immunity logic devices. The HiNIL 373 (decade) and 374 (hexadecimal) counters feature master-slave flip-flops with active outputs triggered by a low-to-high level transition of either of two clock in-



puts while the other is high. Pulsing one clock input causes the device to count up; pulsing the other causes it to count down. Other features include the high noise immunity—3.5 V minimum, carry and borrow outputs for N-bit cascading, clear input independent of count and load, individual preset for each flip-flop, and synchronous operation. Furnished in standard 16-pin plastic and ceramic DIP's, the HiNIL 373 and 374 counters are suitable for critical control, medical instrumentation and marine electronic applications.

Motorola Semiconductor Products, Inc. (P. O. Box 20294, Phoenix, AZ 85036) has added four new npn power Darlington to its expanding line of "Switchmode" products. Designated types MJ10004, MJ10005, MJ10006 and MJ10007, the units are designed specifically for fast switching applications where high voltage, high current and high gain are required. Maximum currents are 40 A for the MJ10006 and MJ10007, both of which offer a minimum h_{FE} of 40 (@ I_C of 2.5 A), and 50 A for the MJ10004 and MJ10005, which offer a minimum h_{FE} of 50 (@ I_C of 5 A). The devices feature typical fall and storage times of 100 ns and 850 ns, respectively, for the MJ10004/5 and 90 ns and 780 ns, respectively, for the MJ10006/7, when switching an inductive load of 180 μ H with the devices clamped at their rated $V_{CEX(sus)}$ and at case temperatures of 100°C. The minimum $V_{CEX(sus)}$ at a case temperature of 100°C is 400 volts for the MJ10004/6 and 450 volts for the MJ10005/7.

Finally, *RCA's Solid State Division* (Box 3200, Somerville, NJ 08876) has added three new sensitive-gate SCR series, S106, S107, and S108, to its line of silicon-controlled-rectifiers. The new SCR's have an rms on-state current rating of 4

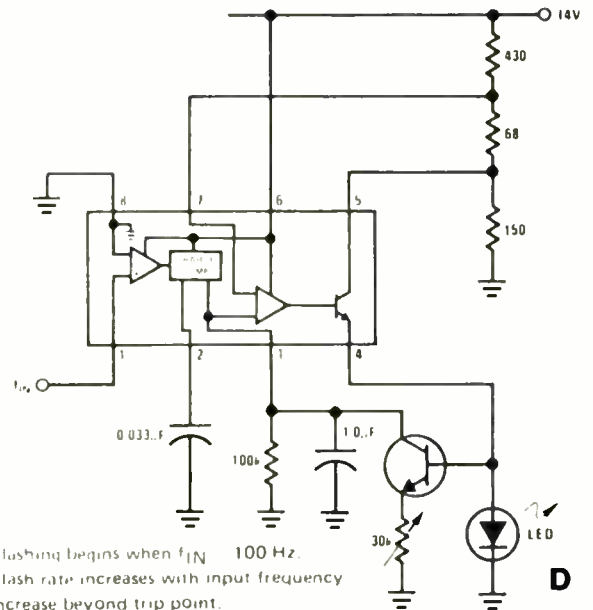
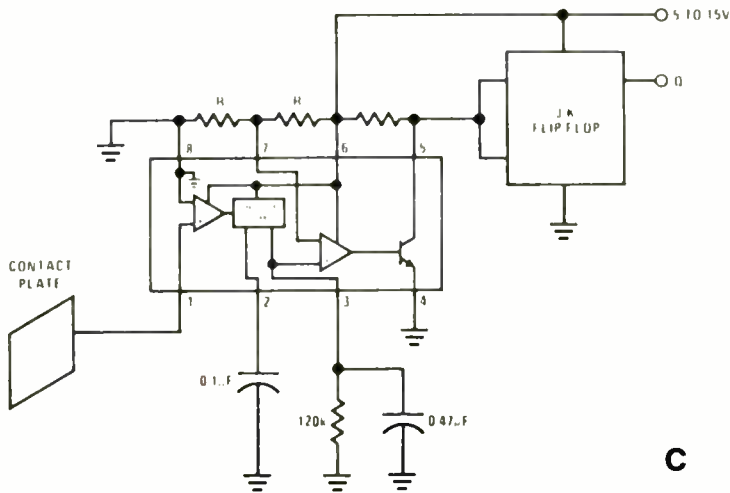
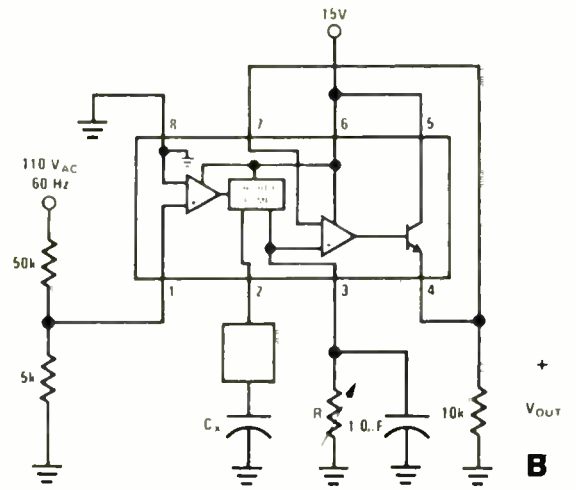
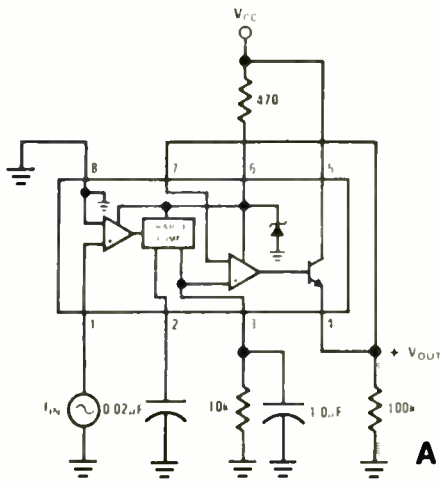


Fig. 4. Additional tachometer-speed switch applications circuits: (A) frequency-to-voltage converter; (B) capacitance meter; (C) finger-touch circuit; (D) overspeed monitor and indicator alarm.

Flashing begins when $f_{IN} = 100$ Hz. Flash rate increases with input frequency increase beyond trip point.

A. Each series includes nine types with voltage ratings of 15, 30, 50, 100, 200, 300, 400, 500, and 600 V, and all utilize the standard JEDEC TO-202AB package. The new series of devices is intended for lighting, power-switching, motor-speed controls and for gate-current amplification for driving larger SCR's, while the gate-current characteristics of the S108 series makes it ideal for low-level logic circuit applications. \diamond

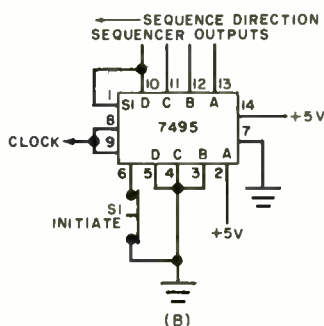
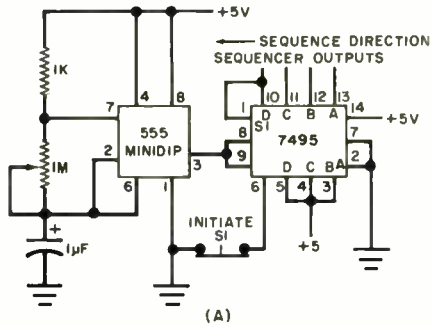


Fig. 5. Reader's sequencer circuits: (A) active low; (B) active high.

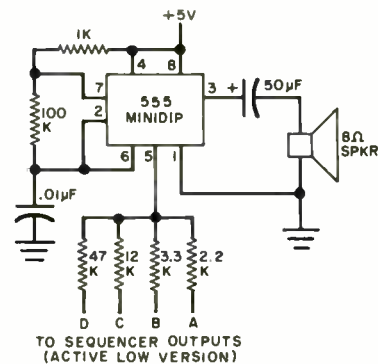


Fig. 6. Possible application of sequencer to an electronic "doorbell."

HAM CB SWL

they come through **LOUD AND CLEAR** in the all-new **1977 COMMUNICATIONS HANDBOOK**

Here is everything you want to know — **need to know** about Citizens' Band Amateur Radio Shortwave Listening.



DON'T TURN A DIAL. In fact don't even buy a dial or anything else until you've checked out the 1977 Communications Handbook. Whatever your radio specialty — whether you're an old hand or just getting started — this vital "how-to" guide will help you get greater value, greater enjoyment out of every minute you spend with your equipment.

The all-new 1977 **COMMUNICATIONS HANDBOOK** is scheduled to go on sale nationally March, 1977

YOU CAN RESERVE YOUR COPY NOW AT THE SPECIAL PRE-PUBLICATION PRICE OF ONLY \$1.50 POSTPAID.

Regular newsstand price is \$1.95; mail order \$2.50.

So to make sure you come through "Loud and Clear" in 1977...

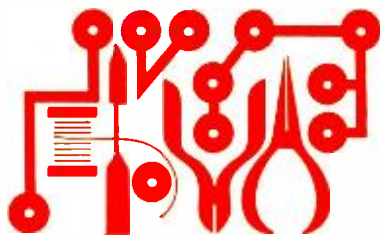
RESERVE YOUR COPY NOW AND SAVE WITH THIS SPECIAL PRE-PUBLICATION OFFER AVAILABLE TO READERS OF POPULAR ELECTRONICS MAGAZINE ONLY.

PRE-PUBLICATION RESERVATION FORM

Communications Handbook PE-377
Consumer Service Division
595 Broadway, New York, N.Y. 10012

Enclosed is \$1.50. Please reserve my copy of the 1977 Communications Handbook to be mailed to me when published. (Residents of Cal., Col., Fla., Ill., Mich., Mo., N.Y. State, D.C. and Tex. add applicable sales tax.) OUTSIDE U.S.A. \$2.

Print Name _____
Address _____
City _____
State _____ Zip _____



Experimenter's Corner

By Forrest M. Mims

FLIP-FLOPS AND DECADE COUNTERS—PART 2

WE HAVE previously seen (February 1976) how a clocked flip-flop can be used as a binary counter. We built a two-bit binary counter from both halves of a 7473 dual JK flip-flop. And we assembled a limited range (0-9) four-bit counter from a 7490 decade counter, a medium-scale integrated circuit (MSI) which incorporates four flip-flops on a single chip.

Now, let's see how to add an additional chip or two to the 7490 to make it a more versatile counter. We'll also examine several ways to convert the 7490 into a divide-by-n counter.

Binary-Coded Decimal. Four clocked flip-flops have the potential of counting from 0000 to 1111 in binary (or 0 to 15 in decimal). The 7490, however, is internally connected to automatically reset to 0000 when the count exceeds 1001 (9). This feature gives the decade counter its name and makes it ideal for converting binary information into a decimal format.

A pure binary counter is very easy to

build, but our decimal-trained minds would have considerable difficulty relating to it. It's not too hard to learn the binary equivalents of 0-9, but how about the binary equivalent of a number like 215? The binary number in this case requires 8 bits and is a very cumbersome 11010111.

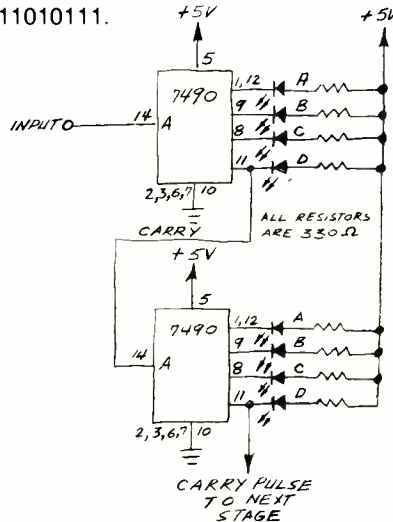


Fig. 1. How to connect two or more 7490 counters in series.

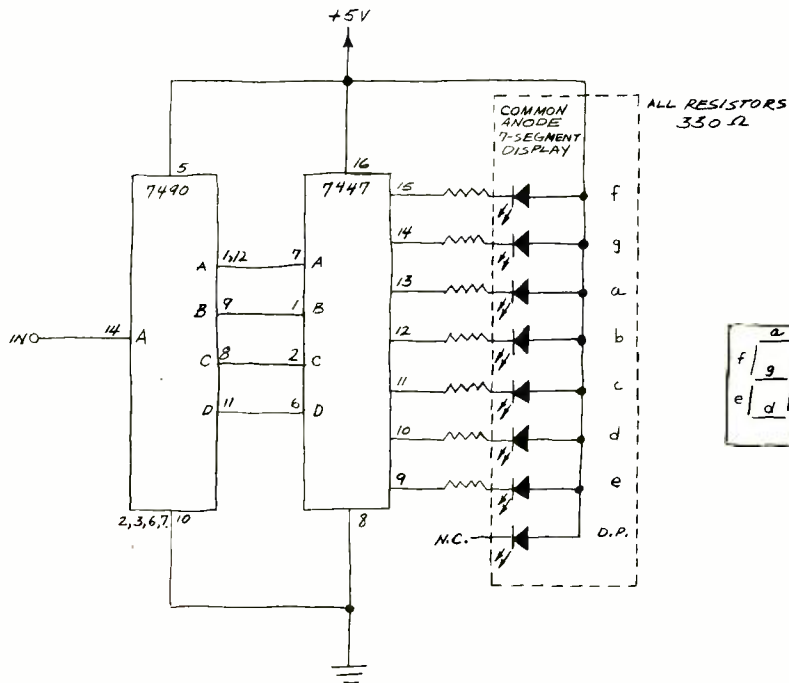


Fig. 2. Converting 4-bit BCD output of 7490 to decimal.

Fortunately, there's an easier way to work with binary numbers. It's called *binary-coded decimal* or BCD for short. The four-bit outputs of individual 7490's can form a binary-coded decimal number. The elegance of BCD is its simplicity. Since each counter stage represents one decimal digit position, only the binary equivalents for the digits 0-9 need be learned to interpret the pattern of glowing LED's connected to each 7490. For example, assuming a dark LED is 0 and a glowing LED is 1, 215 would be represented in BCD as 0010 0001 0101, instead of 11010111 in pure binary.

It's not even necessary to memorize any binary numbers to read a BCD LED display since you can use a simple trick to convert any binary number to its decimal equivalent. Here's how it works: The positions of bits in a binary number represent ascending powers of two (just as the positions of digits in a decimal number represent ascending powers of ten). For example, the decimal values for each position in a four-bit binary number

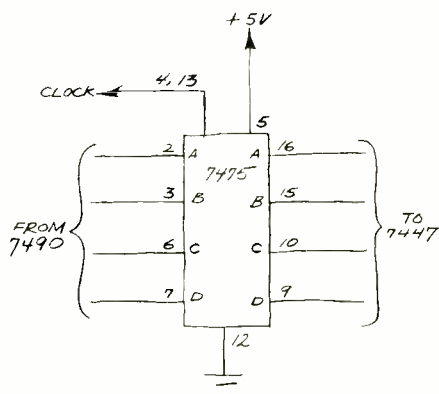


Fig. 3. How to connect a latch between a 7490 counter and a 7447 decoder.

are: $2^3-2^2-2^1-2^0$ or simply $8-4-2-1$. This means that by ignoring the 0 bits and adding the powers of two at the positions with a 1 bit you can quickly arrive at the decimal equivalent for a binary number. For example, 1001 is $9 (8 + 0 + 0 + 1)$, and 0111 is $7 (0 + 4 + 2 + 1)$.

The 7490 Decade Counter. A look at the pin diagram of the 7490 shows its four output pins are given the conventional BCD designation DCBA. The pin diagram doesn't reveal a carry pin so it would seem the 7490 cannot be used for multiple digit applications. Fortunately, however, it's possible to use the D output as a carry pin. All that's required is to connect pin 11 of the 7490 in the first

counter stage to the A input of the 7490 in the second stage (pin 14) as shown in Fig. 1. This neat solution to the absence of a carry pin works since the 7490 in the second stage triggers when the count from the first 7490 recycles from 1001 (9) to 0000. Also, it can be applied to a succession of counter stages.

Several counter stages can be used to make an eight-, twelve-, sixteen-, or more bit BCD counter. Each counter's four-bit row of LED's would represent a single BCD digit. But though this arrangement is very economical, it's not as convenient as a digital output.

play. The 7447 includes several useful features. Grounding the lamp test input (pin 3) will light all seven segments of the display. Grounding the ripple blanking input (RBI; pin 5) will blank the display if a 0 is being displayed. And grounding the ripple blanking output (RBO; pin 4) will blank the readout no matter what digit is being displayed.

The 7475 Four-Bit Latch. The multi-digit counter circuit in Fig. 1 is adequate for counting a series of events or the passing of time up to the maximum digit capability. Many counting applications, however, require the measurement of frequency (the count rate per unit time). For example, a frequency counter counts the number of incoming pulses during a preset time interval (say, 1 second), then recycles and begins counting again. In cases like this the 7490 is always busy counting and all seven display segments will blur into a meaningless "8" if the count exceeds several pulses per second.

The simplest way around this problem is to connect a temporary memory between the 7490 counter and the 7447 decoder. The ubiquitous flip-flop comes to our rescue again, this time in the form of a four-bit data register called the 7475

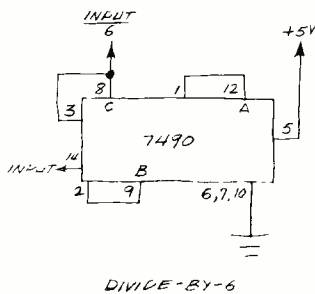
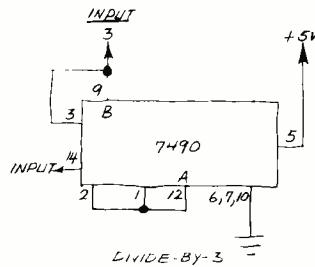
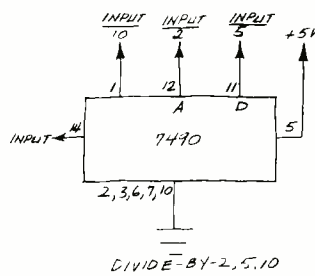


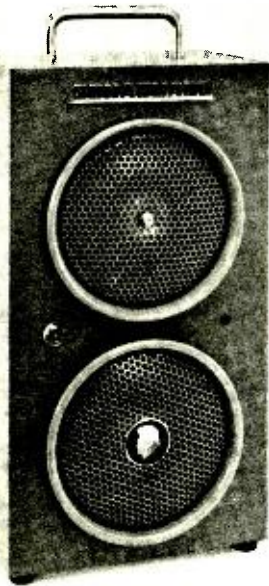
Fig. 4. How to use the 7490 as a divide-by-n counter.

quad-latch. This handy chip contains four flip-flops and interfaces between the counter and display circuitry as shown in Fig. 3

The 7475 accepts BCD data and passes it to the display when its clock inputs (pins 4 and 13) are high (ungrounded). When the clock inputs are grounded, the 7475 stores whatever data was last present at its inputs and the display is activated accordingly.

7490 Divide-by-n Circuits. So far, we've covered the most important decade counter applications for the 7490. By now, in fact, you should be able to trace your way through much of the circuit diagram of a professional frequency counter! The 7490 has a number of divider applications also, and Fig. 4 shows how to connect it to achieve division.

The divide-by-2, 5, and 10 circuits are made possible by the internal arrangement of the 7490 as a single flip-flop and three interconnected flip-flops. The divide-by-3 and -6 circuits are made possible by connections between the BCD outputs and the appropriate reset inputs of the 7490 which automatically reset the counter to 0000 when the desired count is reached. The result is one pulse out for every n pulses in. ◇



STOP BURGLARS! with

“SONAGUARD”

The SONAGUARD PORTABLE INTRUSION ALARM

A fully-portable, self contained unit that keeps burglars away. The SONAGUARD sets up an audible sound pattern that covers over 10,000 feet. Any thief who tries to get into your place and breaks that pattern will find that the SONAGUARD blasts out an audible pitch that stops any burglar instantly from doing what he set out to do.

For Further Information, call or write:

SONAGUARD

Somerville, Mass. (617) 623-3200

WE ALSO CARRY A COMPLETE LINE OF ALARMS FOR YOUR CAR, TRUCK, CAMPER, MOTOR HOME.

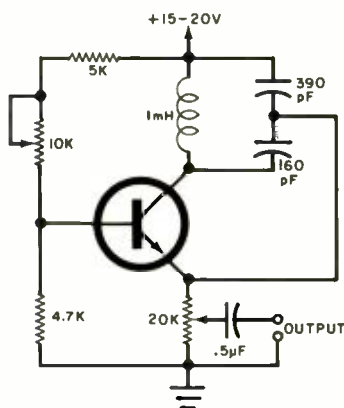


By John McVeigh

RECEIVING SSB

Q. I have a Heathkit SW-717 short-wave receiver that works very well, but I can't copy most ham voice stations. They all sound garbled. I was told that this is normal as they are using single sideband transmitters. Is there a circuit I can build that will enable me to understand what they're saying?—Harry Muller, Elkins Park, PA.

A. What you need is a beat frequency oscillator or bfo to re-insert the suppressed carrier of the SSB signals. The circuit shown will work with your receiver. Its output signal can be introduced at either the 455-kHz i-f strip or at the diode detector. In some cases, merely con-



necting a length of hookup wire to the output and positioning it close to the i-f circuitry will provide enough coupling. Otherwise, you can connect the other end of the wire to the anode of the detector. Adjust the 10,000-ohm potentiometer for maximum output and the 20,000-ohm potentiometer for greatest intelligibility. By the way, you will also be able to use this bfo for hearing Morse code signals.

FAST AND SLOW SCAN TV

Q. I recently read in an article covering the Viking mission that TV transmissions are being sent on the 20-meter band. As I understand it, the

picture is converted into a 3000-Hz tone and sent by "radio." Is it possible to convert these tones back into video and feed it to my TV receiver? Incidentally, the call of the station sending the pictures is N6V. —Craig Keithley, Northridge, CA.

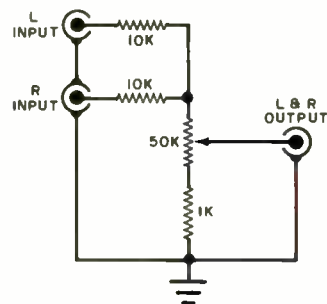
A. The article was referring to slow-scan television, as opposed to the conventional fast-scan system broadcasters use. The great advantage of slow-scan is that it requires no more spectrum space ("bandwidth") to send a picture than is needed for a voice signal—about 3000 Hz. However, the bandwidth of a communications channel has a direct influence on the maximum rate at which data can be sent over the channel. Because slow scan is a narrow bandwidth system, it takes much longer to send a picture over it than a fast scan link. The actual figures are about 8 seconds for a slow-scan picture as compared with 1/30th of a second for fast scan—but fast scan requires about 4 MHz (!) of spectrum space. If I recall correctly, the Viking project uses a slow-scan technique for sending back pictures, requiring about 30 minutes for the entire image to be transmitted.

The N6V station is a special events Amateur Radio station operating from the Jet Propulsion Laboratory in Pasadena. Although I did work it on 20-meter SSB (voice), I was not monitoring the station when they were sending slow-scan images of the "marscapes" received from Viking. Slow-scan pictures can not be applied directly to a TV set. They must be processed by a "scan converter"—a complex circuit that changes them to fast-scan signals. Scan converters are very expensive, and slow-scan images do not have the high resolution that fast-scan ones have. However, such books as *The Radio Amateur's Handbook* and *Specialized Communications Techniques for the Radio Amateur* (both published by the ARRL, 225 Main Street, Newington, CT 06111) contain plans for SSTV monitors and adapters for use with oscilloscopes.

PASSIVE MIXER

Q. I would like to play a stereo tape deck through a monaural amplifier. Is there a network that will combine both channels?—John Riley, Burbank, CA.

A. The circuit shown will combine the stereo input and provide a balanced monaural output. This passive mixer includes an attenuation control which determines the amount of signal that will be passed to the power amplifier. You



can set the playback level controls on the deck fairly high and cut back to the desired level by adjusting the 50,000-ohm potentiometer.

RANGE OF CB HANDHELDS

Q. I recently purchased a pair of CB handhelds which supposedly have an r-f power output of four watts. So far, I haven't been able to communicate with them over a range greater than three miles or so. Is there any way I can increase their range with boosters, or whatever?—Bruce Leavenworth, New Preston, CT.

A. First of all, "boosters" such as linear amplifiers are *strictly* prohibited. Penalties for use are severe, and the FCC is interpreting "possession" as implying "use." Therefore, I strongly discourage your thoughts along those lines. But I don't think that a 3-mile maximum is unreasonable. That figure is typical for many mobile installations, and even though mobile antennas are not very efficient, I think they perform better than the telescoping whips of handhelds. If your transceivers have external antenna jacks, try using a more efficient base or marine-type antenna. That's the only recommendation for increasing range that I can make.

Have a problem or question on circuitry, components, parts availability, etc? Send it to the Hobby Scene Editor, POPULAR ELECTRONICS, One Park Ave., New York, NY 10016. Though all letters can't be answered individually, those with wide interest will be published.



Product Test Reports

OK MODEL WSU-30 WIRE-WRAP TOOL

Manual Wire-Wrapping tool for solderless breadboarding.

Experimenters and hobbyists, and even many engineers, generally reach for soldering iron and hookup wire when it comes to assembling a circuit. The more ambitious people lay out a printed circuit board, make the board, and then wire it in the conventional manner—still having to use a soldering iron. Recently, Wire Wrap has become a popular wiring medium, especially where hundreds and thousands of connections must be made in very complex projects.

Though Wire Wrapping is not new to the electronics industry, it has been relatively rare among hobbyists. Now, a battery of new and inexpensive tools is coming on the market. One such tool is the Model WSU-30 at \$5.95 from OK Machine & Tool Corp.

The Model WSU-30 Wire Wrap tool features all-metal construction. Measuring 4½" (11.4-cm) long, it weighs a mere 0.5 ounce (15.5 g). The tool serves three functions. First, it has a built-in stripper for removal of the special Kynar insulation used on Wire Wrap wire. Second, it is a manual Wire Wrapper. Finally, it is a wire unwrapper.

General Details. The use of a Wire Wrap tool, such as the Model WSU-30, carries with it several advantages that make it attractive to the engineer, experimenter, and hobbyist. Since it is a solderless wiring medium, it eliminates the need for a soldering iron and, thus, the possibility of heat damage to components. While it is essentially a point-to-point wiring medium, Wire Wrapping allows you to make connections with a rapidity that cannot be matched by crimp-and-solder joints. Furthermore, errors in wiring can be corrected and circuit modifications can be made in seconds. In sum, Wire Wrapping is much faster than traditional methods of wiring circuits, including pc board construction, which is not only messy to make but also extremely difficult to modify.

The use of the Model WSU-30 Wire Wrap tool is very simple. You start by inserting the unprepared end of the wire in a V-shaped slot in the body of the tool, press down slightly on the wire to score the insulation, and then draw out the wire. The insulation parts neatly, leaving a bare-wire end. Next, you feed the bare

wire into a small hole in the wrap end of the tool, place the tool over a Wire-Wrap pin on either a socket or component pin, and rotate the tool clockwise. As the tool is rotated, the bare end of the wire wraps tightly around the pin. The recommended number of turns for an optimum joint is seven turns.

Wire-Wrapped joints have high electrical and mechanical integrity because the relatively sharp corners on the wrap pins "bite" into the wire as it is wound around them under tension. Wire Wrap connections have been known to maintain their mechanical and electrical integrity for as many as 40 years. And tests reveal that the typical Wire Wrap joint has a contact resistance of less than 1 milliohm.

To unwrap a connection, you simply invert the tool, slip it over the wrap pin, and rotate the tool counterclockwise. The wire comes away from the post neatly and easily.

User Comment. We tested the Model WSU-30 Wire Wrap tool by assembling several circuits, one of which was a complex computer board. After making a few trial wraps to become familiar with the operation of the tool, the wiring went very quickly and easily. We found that, with a little practice we were making connections, including stripping away of insulation, at a rate of about one every 10 seconds.

We also had a practical opportunity to test the unwrapping feature of the tool. After our computer board was completely wired, we had to make a modification that involved about three dozen conductors. Again, the job went quickly and rapidly.

Comparing this new low-cost tool with an expensive motorized Wire Wrap tool, we determined that both produced the same high-quality, high-reliability connections, although we must admit that the mechanized tool had the edge when it came to speed. But the low cost of the Model WSU-30 had a big edge in the price category.

You can buy the Model WSU-30 Wire Wrap tool only, but it is a good idea to pick it up in the prepackaged kit form, which also contains a 50' (15.2-m) spool and stripped 1" to 6" (2.54- to 15.2-cm) lengths of Kynar insulated wire for \$11.95. Spools containing 50' of wire are also available separately for \$1.95 per spool. The standard wire used with the Model WSU-30 Wire Wrap tool is AWG 30 silver-plated, Kynar insulated interconnection wire.



Strip.

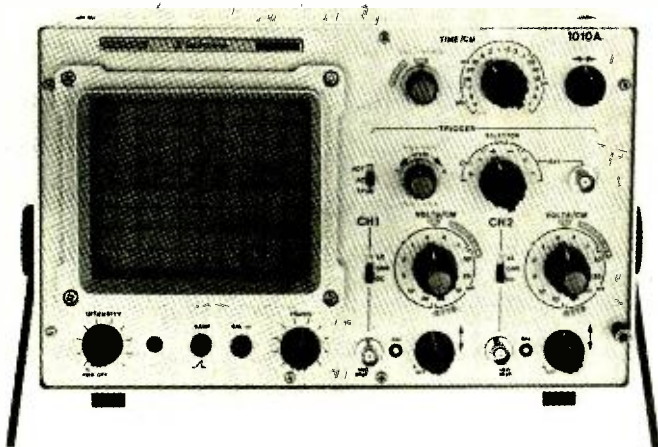


Wrap.

CIRCLE NO. 82 ON FREE INFORMATION CARD

BALLANTINE MODEL 1010A OSCILLOSCOPE

Moderately priced, dual-trace, trigger-sweep, 10-MHz-bandwidth scope.



To properly and efficiently perform design, troubleshooting, and maintenance of modern electronic circuits, you need a full-featured oscilloscope. It should have a relatively wide bandwidth, dc coupling throughout, triggered sweep, and a frequency and interval counter that is not sensitive to waveform shape. More than one input channel will make such a scope all the more versatile. The Ballantine Model 1010A oscilloscope fills the bill for most modern electronics work.

The Model 1010A scope features a 5" (12.7-cm) flat-screen CRT; two fully independent input channels that operate on either the alternate or chop mode to provide two traces from the single beam; dc-to-10-MHz bandwidth (at the 3-dB-down points); and triggered sweep.

The scope measures 16 5/8"D × 11 3/8"W × 7"H (42.2 × 29 × 17.8 cm) and weighs 15 lb (7 kg). \$595.00. A number of options are available, including the No. 10600 probe kit for \$35, No. 10850B r-f detector probe to allow the scope to be used out to 700 Mhz for \$85, a vinyl carrying case, and front-panel cover.

General Description. The two identical vertical input channels have a deflection factor of from 20 mV to 20 volts/cm. The deflection factor desired is selectable by a front-panel switch that has 12 calibrated positions. The direct-coupled bandwidth is stated to be at least dc to 10 MHz at -3 dB, while on ac coupling, the lower-frequency 3-dB-down point is at approximately 5 Hz. The input impedance, identical for both channels, is 1 megohm paralleled by 28 pF. Both inputs are protected up to 400 volts dc or peak ac.

The triggered-sweep section has a range of from 1 μs to 0.5 second/cm in 18 switch-selectable ranges. The accuracy here is stated to be within 5%. A ×10 magnifier, available at the flip of a front-panel switch, makes the fastest sweep 100 ns/cm. The sweep circuit also features a vernier control that is continuously variable between time-base steps. It extends the sweep to 1.25 seconds/cm. The sweep can be triggered either automatically or manually from either channel's signal or from an external source. The three trigger coupling modes provided are AC, ACF (ac fast with low-frequency rejection), and TVF (TV frame rate).

Each of the two vertical channels can be selected for single-trace display only. Setting the scope to the dual-channel mode allows both traces to appear on the CRT screen simultaneously, with the alternate or chop mode automatically selected by the choice of sweep speeds.

In addition to intensity (Z-axis) external modulation, the scope also features a 1-volt ±2% square-wave output, available at a jack on the front panel, that can be fed back into the scope for calibration purposes. This output signal's frequency is the same as the line-power frequency. There is also a sweep-synced ramp output, available from a separate front-panel jack, that goes from 0 to 10 volts.

The input to the power transformer can be selected to allow operation from 95 to 260 volts ac, with line frequencies ranging from 45 to 400 Hz.

User Report. Using an oscilloscope like the Model 1010A is pure pleasure. Aside from the fact that it is a really versatile instrument, this scope is light

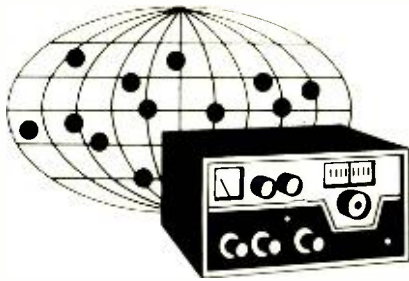
enough in weight to carry from one job to another without tearing your arm from its socket. It is also quite rugged, capable of withstanding mechanical shocks that might ordinarily knock other scopes out of calibration. A couple of weeks of lugging it around in a field-service van confirmed this point admirably. Needless to say, the Model 1010A is as good as a field-service performer as it is on a fixed rack (it is available in rack mount) and bench.

Ballantine has not sacrificed creature comforts in keeping the price down. For example, all front-panel control knobs are large and have flutes for easy grip and manipulation. They operate smoothly and positively. And the knobs have full-length white index marks that, in addition to the large and easy-to-see panel legends, make settings easier to see and interpret than is usually the case. The flat-faced CRT has a P31 blue phosphor that is easy on the eyes, and its 8 × 10-cm graticule is clean and bold.

Another nice feature is the carrying handle. It has a locking mechanism that can be set for carrying the instrument from one job to another or adjusted to serve as a tilt stand on a service bench. The heavy-duty aluminum handle has a plastic grip with molded finger ridges. This grip also serves as an anti-skid "foot" when the handle is used as a tilt stand. When the optional molded faceplate cover is in place and the handle is hinged up, the two lock together. On the test bench, we discovered that this scope could resolve nanosecond trigger waveforms that we presumed were beyond the limits of the instrument. Even at these extreme limits, the sync held rock steady, and the trace was quite "readable" at the very high writing speeds used. A hallmark of this scope is clearly its bright, sharp trace at high speeds. Performing calibration tests, we also determined that the scope operated well within its published specifications. After stints on a service bench and in the field, where we made no particular efforts to treat it with any special care, we again subjected the scope to calibration tests. There was no detectable difference in any area we tested.

Considering the versatility, performance, and portability of this general-purpose oscilloscope, we feel it is an especially fine value for the bench and for the field-service technician and serious experimenter/hobbyist. One can easily get less scope for the money than the Ballantine Model 1010A. Equivalent specifications don't tell the whole story.

CIRCLE NO. 83 ON FREE INFORMATION CARD



DX Listening

By Glenn Hauser

THE SOVIET PULSER

PULSES at the rate of ten per second have been disrupting shortwave communications since the middle of last year. These clicks follow no particular frequency schedule, but they often fall within shortwave broadcast bands. Having one channel at a time disrupted this way would not be so bad, but a single transmitter of this type may spread over a 300-kHz range, messing up an entire band at once. And some monitoring stations have reported three different pulse transmitters operating simultaneously.

Several press reports on this have been widely syndicated. They result from complaints the FCC has been receiving from amateur operators, point-to-point and maritime communications

services using hf. It seems that the FCC has heard relatively little from shortwave listeners, who are less able to identify and combat this interference than "professional" users of the hf bands. In fact, reading the reports, one would never know that the pulsers cause havoc in international broadcasting.

FCC and equivalent administrations in other friendly countries have pinpointed the signals as coming from either "the Baltic area," or somewhere near Minsk in the Byelorussian SSR. As a result, numerous official protests have been filed with Soviet authorities.

In December, the USSR finally said it would try to reduce the disturbances in response to the complaints.

The purpose of the pulses has been a matter of wide speculation. Jim Vastenhoud of Radio Nederland likens them to ionospheric sounders for scientific research. Larry Magne of IBA observes that they seem to "ride the MUF," which means they operate at whatever frequency is the highest that will propagate at any given moment. Bob Thomann of the Swiss shortwave service thinks they carry intelligence, using "shotgun communication" so that, if one frequency is blocked, another will get through. But other observers find no evidence of intelligence in the transmissions.

David Mackes, a radar authority in Baltimore, is certain that we have been witnessing a new kind of long-distance radar which is called over-the-horizon backscatter.

Conventional radar uses more rapid pulses at super-high frequencies, which has the advantage of relatively high resolution, being able to track swiftly-moving objects. But the disadvantage is its limited range.

Mackes says a wideband pulse is transmitted, but is compressed in the receiver, making the pulse seem much greater in amplitude. He thinks linear FM is the modulation method; that is, the signal is most likely being chirped. Further studies of the pulses on a spectrum analyzer should give the answer.

Strong broadcast signals are capable of overriding the pulser, but it pops in between channels, making reception of weaker stations impossible. If you hear it on a single frequency, it's probably being relayed inadvertently, such as from BBC-Antigua or Radio Nederland-Bonaire.

Some authorities believe the 10-per-second rate is far too slow to detect aircraft, even though it can reach beyond the horizon. This leaves shipping in the North Atlantic as the most likely target—certainly beyond the range of conventional radar based in the USSR. Other engineers think the Doppler effect is used, with performance good enough for tracking aircraft, according to Mackes. He also observed one pulse transmission centered on 6050 kHz, with 50-kHz bandwidth, followed by a CW station on the center frequency. We have noted the pulser at various times centered on 5.980, 7.635, 9.150, 9.600 and 11.715 MHz. Reception correlates well with that of Radio Moscow transmissions from the same geographical area.

Communications technicians in the Canadian north suspect the pulses had defense implications, as did Italian authorities last summer when the pulses first appeared, coinciding with NATO exercises.

More Change in the Air. Continuing our discussion of band reallocation, which began in the November 1976 DX Listening column, the present sharing of the 3- and 7-MHz bands between amateur radio and broadcasting has proven to be a terrible nuisance to broadcasters, hams, and listeners alike. There is no reason why this should continue beyond 1979. It is proposed that the hams give up the 3900–4000-kHz portion of 80 meters, while broadcasting gives up the 7100–7300-kHz portion of 40 meters. Of course, the amateur radio lobby has launched its own campaign for expanded and additional bands. There should be enough formerly IFPS spectrum for both broadcasting and amateur radio to have expanded, additional, and exclusive bands. An ARRL representative has been observing the IBSG meetings.

Mediumwave Band. The Mediumwave (or mf) band has already been reallocated outside the Americas, with an effective date in the fall of 1978. All European channels will move 1-kHz higher, which will result in a different selection of DX possibilities for American listeners. Even more radical is the adop-

HEAR-IT-YOURSELF KIT



This is a Speakerlab 7, a 4-element acoustic suspension speaker kit you can assemble yourself in an hour with simple tools.

It saves you up to 50% over comparable ready made systems. Read about the S7 and other systems and raw speakers we sell in a new 40 page catalog. It's a fact-packed manual with chapters on acoustic theory, enclosures, choosing drivers and design principles.

And it's free. Just write us and ask for the most complete catalog/manual ever written on speaker building.

Speakerlab
Dept. PE.10 5500 35th NE Seattle WA 98105

tion of Eurafra's 9-kHz spacing, instead of 10, in Asia and the Pacific. Though American DX listeners have had to tune for these areas on the same channels as domestic stations, the shift will open up many "splits," allowing propagation and receiver selectivity to determine DX success, rather than domestic interference!

The IBSG has also considered changing the present 5-kHz spacing in the hf bands to 7.5 kHz. This might appear to be a loss, rather than a gain, but the argument is this: when combined with wider bands, the increased spacing would mean a net gain of usable channels. Every channel could be used effectively to the same area at the same time. Now, a channel 5 kHz away from a powerhouse on either side is best skipped, though some stations have to use such channels for lack of anything better. For example, strong stations on 11,720 and 11,730 would make 11,725 useless. If the strong ones were on 11,715 and 11,730 instead, the 11,722.5-kHz channel in the middle could also be used; and there would be no stations on 11,720 or 11,725.

Compatible single sideband would

help make this work, replacing the present double sideband (AM). In CSSB, the carrier remains, though it may be slightly reduced. But there is only one sideband. This means a "narrower" signal, still conveying the essential audio that is now needlessly duplicated on the other sideband. The remaining carrier makes it compatible—that is, receivable—on ordinary tuners, unlike amateur SSB which suppresses the carrier.

CSSB adoption would also make stereo broadcasting possible on hf by reinstating the other sideband, but with right and left channel, rather than identical audio. This would be restricted to single-hop transmission paths as fading would ruin shortwave stereo. The technique for CSSB has been known for a long time. Stereo AM has already been tested at WFBR in Baltimore and XETRA, Tijuana. The proposal for 7.5-kHz spacing, CSSB, and shortwave stereo comes from Arthur Thompson of WYFR.

Stereo shortwave may be a long shot, and there are no consumer receivers designed for it yet. However, two separate receivers—one tuned to the upper sideband, one to the lower—would produce the effect. ◇

ENGLISH-LANGUAGE SHORTWAVE BROADCASTS FOR MAR. & APR.

By Richard E. Wood

TO EASTERN NORTH AMERICA

TIME-EST	TIME-GMT	STATION	QUAL*	FREQUENCIES, MHz
6:00-6:25 a.m.	1100-1125	Tirana, Albania	F	9.48, 11.865
6:00-8:30 a.m.	1100-1330	London, England	G	5.99 (via Sackville), 6.195 (via Antigua), 15.07
6:00-8:00 a.m.	1100-1300	Melbourne, Australia	G	9.58
6:00-9:00 a.m.	1100-1400	**VOA, Washington, USA	G	5.955, 9.73
6:05-7:25 a.m.	1105-1225	Trans-World Radio, Bonaire, N.A.	G	11.815
6:30-9:00 a.m.	1130-1400	**Montreal, Canada (Northern Service)	G	5.96, 9.625 (includes French, etc.)
6:45-7:05 a.m.	1145-1205	**Montreal, Canada	G	9.56, 11.72
7:00-7:30 a.m.	1200-1230	Jerusalem, Israel	G	15.10, 17.815
7:00-7:55 a.m.	1200-1255	Peking, China	F	11.685
7:10-7:30 a.m.	1210-1230	**Santiago, Chile	F	9.566, 11.81, 15.15
7:15-7:30 a.m.	1215-1230	Athens, Greece	F	15.345, 17.83
		HCJB, Quito, Ecuador	G	11.745
7:30-8:00 a.m.	1230-1300	Stockholm, Sweden	G	15.305
7:30-11:30 a.m.	1230-1630	HCJB, Quito, Ecuador	G	11.745, 15.115
8:15-8:45 a.m.	1315-1345	Berne, Switzerland	G	15.14
8:30-9:00 a.m.	1330-1400	Helsinki, Finland	G	15.17
9:00-9:15 a.m.	1400-1415	**Montreal, Canada	G	15.325, 17.74
9:00-9:30 a.m.	1400-1430	Oslo, Norway	G	17.80 (Sun.)
		Stockholm, Sweden	G	15.305
9:00 a.m.-7:00 p.m.	1400-2400	**Montreal, Canada (Northern Service)	G	9.625, 11.72
9:30-10:00 a.m.	1430-1500	Helsinki, Finland	G	15.11
10:00-11:00 a.m.	1500-1600	London, England	G	17.84 (via Ascension), Sat., Sun. also 9.58 (via Sackville)
10:15-10:30 a.m.	1515-1530	Athens, Greece	P	11.73, 15.345, 17.83
11:00-11:15 a.m.	1600-1615	London, England	G	9.58 (via Sackville) 17.84 (via Ascension)
11:00-11:30 a.m.	1600-1630	Oslo, Norway	G	15.17 (Sun.)
11:15 a.m.-1:30 p.m.	1615-1830	London, England	G	9.58 (via Sackville)
12 noon-3:00 p.m.	1700-2000	**Kuwait, Kuwait	F	9.555, 11.845
12:04-12:56 p.m.	1704-1756	**Paris, France	G	15.155, 15.20, 15.30, 15.315, 17.72, 17.85, 17.865, 21.58, 21.62

New Slim-Body scope probes from B&K-PRECISION ...cost effective and really rugged!

B&K-PRECISION's new line of 10:1 direct scope probes is designed to be compatible with most scopes available, up to 50MHz. All are rated at 500Vp-p. B&K-PRECISION slim-body probes range in price from \$25-\$35.



Model	Connector	Bandw.	Matches
PR30	UHF	10MHz	15-120pF
PR31	BNC	10MHz	15-120pF
PR34	UHF	15MHz	10-35pF
PR35	BNC	15MHz	10-35pF
PR36	BNC	50MHz	10-35pF

Available for immediate delivery at your local distributor. Write for a free copy of the latest B&K-PRECISION catalog.

B&K PRECISION
DYNASCAN CORPORATION

6450 West Cortland Avenue
Chicago, Illinois 60635 • 312/889-9087
In Canada: Atlas Electronics, Ontario

The "Click and Pop" machine

only by

SAE



Ever since the invention of the recorded disc annoying "clicks" and "pops" caused by scratches, static and imperfections have consistently disturbed the listening pleasure of music lovers.

Now, SAE introduces the unique model 5000, an Impulse Noise Reduction System which eliminates those unwanted sounds with no adverse effect on the quality of the recorded material.

This breakthrough in electronic circuitry is so demonstrably effective that the SAE 5000 is destined to become an essential part of any sound system.

The SAE 5000 is compact and sleek, built to SAE's exacting standards, and ready to enhance the performance of any system, from the standard receiver/turntable combination, to the most sophisticated audiophile components.

SAE is proud to add the 5000 to their broad line of *Components for the Connoisseur*.

SAE PL-37

Scientific Audio Electronics, Inc.
P.O. Box 60271, Terminal Annex
Los Angeles, Cal. 90060

Please send more information on the 5000.

Name _____

Address _____

City _____

State _____ Zip _____

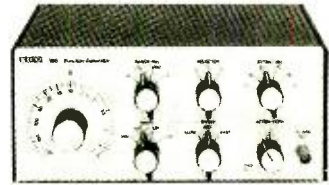
1:00-1:30 p.m.	1300-1830	**Montreal, Canada	G	15.325, 17.82
1:30-2:00 p.m.	1830-1900	**Montreal, Canada	G	9.685, 11.855
2:00-2:30 p.m.	1900-1930	**Montreal, Canada	G	9.625, 11.83, 15.325, 17.82
2:00-3:00 p.m.	1900-2000	**Algiers, Algeria	F	9.78, 11.91, 15.42 (variable)
2:00-5:00 p.m.	1900-2200	**Jeddah, Saudi Arabia	F	11.855
2:30-3:00 p.m.	1930-2000	**Montreal, Canada	G	9.685, 11.855
3:00-3:30 p.m.	2000-2030	**Tehran, Iran Jerusalem, Israel	F G	9.022, (11.77 alternate) 5.90, 7.395, 9.815
3:00-4:00 p.m.	2000-2100	Accra, Ghana	F	11.85
3:00-4:20 p.m.	2000-2120	**Hilversum, Holland	G	11.73 (via Talata)
3:50-4:50 p.m.	2050-2150	**Havana, Cuba	G	11.865, 17.75
4:00-4:50 p.m.	2100-2150	**Johannesburg, S. Africa	G	7.27, 9.585, 11.80, 11.90
4:00-5:00 p.m.	2100-2200	**Brasilia, Brazil	G	15.245 (11.78 alternate)
4:15-5:45 p.m.	2115-2245	London, England	G	9.58 (via Ascension), 11.78, 15.26 (via Ascension)
4:30-5:00 p.m.	2130-2200	Sofia, Bulgaria	F	6.07, 9.70
4:30-5:50 p.m.	2130-2250	Hilversum, Holland	G	9.715, 11.73 (Sun.: Dutch)
5:00-5:15 p.m.	2200-2215	**Belgrade, Yugoslavia	F	6.10, 7.24, 9.62
5:00-5:30 p.m.	2200-2230	**Montreal, Canada Oslo, Norway	G F	5.925, 9.445 11.87 (Sun.)
5:00-6:15 p.m.	2200-2315	**Caracas, Venezuela	F	15.40 (varies, Mon.-Fri.)
5:00-7:30 p.m.	2200-0030	**Cairo, Egypt	G	9.805
5:30-6:00 p.m.	2230-2300	Ankara, Turkey Jerusalem, Israel Moscow, U.S.S.R.	G G G	9.515, 11.88 7.412, 9.815, 11.645, 12.025 5.94, 7.105, 7.115, 7.15, 7.205, 7.355, 7.40, 9.655, 9.72, 9.745, 11.77, 11.90
5:30-6:20 p.m.	2230-2320	Johannesburg, S. Africa	G	5.98, 9.585, 11.80, 11.90
5:45-11:30 p.m.	2245-0430	London, England	G	5.975, 7.325, 9.58 (via Ascension)
5:50-6:10 p.m.	2250-2310	**Santiago, Chile	P	9.566, 11.81, 15.15
6:00-6:30 p.m.	2300-2330	Stockholm, Sweden Moscow, U.S.S.R. Vilnius, U.S.S.R.	F G G	6.045, 9.605, 11.705 5.94, 7.105, 7.115, 7.15, 7.205, 7.355, 7.40 7.29, 7.32, 7.55, 9.655, 9.72, 9.745, 11.77 11.90 (Sat., Sun.)
6:00-6:50 p.m.	2300-2350	**Buenos Aires, Argentina	G	11.71 (Mon.-Fri.)
6:00-8:00 p.m.	2300-0100	Montreal, Canada	G	5.96 (Mon.-Fri.)
6:30-7:00 p.m.	2330-2400	Helsinki, Finland **Radio Clarin, S. Domingo, Dom. Rep.	P G G	11.755 11.70 (irregular) 5.94, 7.105, 7.115, 7.15, 7.165, 7.205, 7.235, 7.355, 9.79, 9.80 6.13, 9.64, 11.74
6:30-7:30 p.m.	2330-0030	Moscow, U.S.S.R.	G	
6:45-7:00 p.m.	2345-2400	**Voice of Org. of American States Washington, USA	G	
6:45-7:45 p.m.	2345-0045	Tokyo, Japan	F	15.27, 15.30
7:00-7:25 p.m.	0000-0025	Tirana, Albania	G	7.065, 9.75 (varies)
7:00-7:30 p.m.	0000-0030	Oslo, Norway	F	6.185 (Sun.)
7:00-7:55 p.m.	0000-0055	Sofia, Bulgaria Peking, China	F F	9.705 (alternate 9.70) 11.945, 15.06, 15.52, 17.673
7:00-9:00 p.m.	0000-0200	**Luxemburg	F	6.09
7:00-8:00 p.m.	0000-0100	**VOA, Washington, USA	G	6.19, 9.67, 11.83, 11.895
7:00 p.m.-1:06 a.m.	0000-0606	**Montreal, Canada (Northern Service)	F G	6.065, 9.625 9.75, 9.76, 11.73
7:15-7:30 p.m.	0015-0030	Athens, Greece	F	9.725
7:15-7:45 p.m.	0015-0045	Brussels, Belgium	F	6.055, 9.74
7:30-7:55 p.m.	0030-0055	Prague, Czechoslovakia	F	11.955
7:30-8:00 p.m.	0030-0100	Stockholm, Sweden Kiev, U.S.S.R. Moscow, U.S.S.R.	P G G	7.15, 7.205, 5.94, 7.105, 7.115, 7.355, 7.40, 7.44
7:40 p.m.-12 mdt.	0040-0500	HCJB, Quito, Ecuador	G	6.095, 9.56, 11.915
8:00-8:15 p.m.	0100-0115	Vatican, City	G	5.995, 6.015, 9.605
8:00-8:20 p.m.	0100-0120	Rome, Italy	G	6.01, 9.575
8:00-8:30 p.m.	0100-0130	Moscow, U.S.S.R. Vilnius, U.S.S.R. Montreal, Canada	G G G	5.94, 7.105, 7.115, 7.205, 7.355, 7.40, 7.44 7.15, 7.215, (Sat., Sun.) 9.535
8:00-8:45 p.m.	0100-0145	Berlin, Ger. Dem. Rep.	P	9.73
8:00-8:55 p.m.	0100-0155	Peking, China Prague, Czechoslovakia	G G	7.12, 9.78 (via Tirana), 11.685, 11.945, 15.06, 15.52 5.93, 7.345, 9.54, 9.63, 9.74
8:00-10:00 p.m.	0100-0300	Melbourne, Australia	F	15.32, 17.795
8:00-10:30 p.m.	0100-0330	Havana, Cuba	G	11.725, 11.93
8:00-11:00 p.m.	0100-0400	Madrid, Spain	G	6.065, 11.88 (Mon.-Sat.)
8:10-8:30 p.m.	0110-0130	**Santiago, Chile	F	9.566, 11.81, 15.15
8:30-8:50 p.m.	0130-0150	Cologne, Ger. Fed. Rep.	G	6.01, 6.04 (via Antiqua), 6.075, 9.565, 9.605
8:30-8:55 p.m.	0130-0155	Tirana, Albania Vienna, Austria	G P	6.20, 7.30 6.155, 9.77
8:30-9:00 p.m.	0130-0200	Moscow, U.S.S.R.	G	5.94, 7.105, 7.115, 7.15, 7.205, 7.215, 7.355, 7.40, 7.44, 9.705 (alt. 9.70 via Sofia)
8:30-9:25 p.m.	0130-0225	Bucharest, Rumania	F	5.99, 9.57, 9.68, 11.775, 11.94
8:45-9:15 p.m.	0145-0215	Berne, Switzerland	G	5.965, 6.135, 9.725, 11.715

9:00-9:30 p.m.	0200-0230	Budapest, Hungary	G	6.00, 7.215, 9.585, 9.833, 11.91 (Exc. Sun.)
		Oslo, Norway	F	6.185 (Sun.)
		Montreal, Canada	G	6.065, 9.535
9:00-9:55 p.m.	0200-0255	Peking, China	F	11.965, 12.055, 15.06
9:00-10:00 p.m.	00-0300	Moscow, U.S.S.R.	G	5.94, 7.105, 7.115, 7.205, 7.355, 9.705 (alt. 9.70 via Sofia)
9:00-10:20 p.m.	0200-0320	Hilversum, Holland	G	6.165 (via Bonaire)
9:00-10:30 p.m.	0200-0330	Cairo, Egypt	G	9.475
9:10-9:30 p.m.	0210-0230	**Santiago, Chile	P	9.566, 11.81, 15.15
9:30-9:55 p.m.	0230-0255	Tirana, Albania	G	6.20, 7.30
9:30-10:00 p.m.	0230-0300	Lisbon, Portugal	F	6.025, 11.935
		Stockholm, Sweden	P	6.045, 9.695
10:00-10:30 p.m.	0300-0330	Budapest, Hungary	F	6.00, 7.215, 9.585, 9.833, 11.91
		Kiev, U.S.S.R.	G	7.15, 7.205, 7.24, 7.26, 7.40
10:00-10:35 p.m.	0300-0335	Warsaw, Poland	P	6.095, 6.135, 7.27, 9.675, 11.815, 11.84, 15.12
10:00-10:55 p.m.	0300-0355	Peking, China	G	7.12, 9.78 (via Tirana)
10:00-11:00 p.m.	0300-0400	Buenos Aires, Argentina	G	9.69 (Mon.-Fri.)
		Prague, Czechoslovakia	G	5.93, 7.345, 9.54, 9.63, 9.74
		Moscow, U.S.S.R.	G	5.94, 7.115, 7.355, 7.44
10:00-11:26 p.m.	0300-0426	**Johannesburg, S. Africa	F	3.995, 5.98, 7.27
10:10-10:30 p.m.	0310-0330	**Santiago, Chile	F	9.566, 11.81, 15.15
10:30-10:55 p.m.	0330-0355	Tirana, Albania	G	6.20, 7.30
		Vienna, Austria	P	6.155, 9.77
10:30-11:30 p.m.	0330-0430	London, England	G	5.975, 9.58 (via Ascension)
10:30-11:50 p.m.	0330-0450	Havana, Cuba	G	11.725, 11.76, 11.93
11:00-11:15 p.m.	0400-0415	Budapest, Hungary	G	6.00, 7.215, 9.585, 9.833, 11.91 (Tues., Fri.)
11:00-11:25 p.m.	0400-0425	Bucharest, Rumania	F	5.99, 6.155, 6.19, 9.57, 9.68, 11.775, 11.94
11:00-11:30 p.m.	0400-0430	Oslo, Norway	P	6.185, 9.61 (Sun.)
11:30 p.m.-2:30 a.m.	0430-0730	London, England	G	6.175 (via Antiqua)
11:50 p.m.-1:00 a.m.	0450-0600	Havana, Cuba	G	11.725, 11.76
12 mdt.-12:15 a.m.	0500-0515	Jerusalem, Israel	G	5.90, 7.412, 9.009
12 mdt.-2:00 a.m.	0500-0700	HCJB, Quito, Ecuador	G	6.05, 9.56

TO WESTERN NORTH AMERICA

TIME-EST	TIME-GMT	STATION	QUAL*	FREQUENCIES, MHZ
3:00-3:15 a.m.	1100-1115	Tokyo, Japan	P	5.99
3:00-4:25 a.m.	1100-1225	Trans-World Radio, Bonaire, N.A.	G	11.815
3:00-5:30 a.m.	1100-1330	London, England	G	5.99 (via Sackville), 11.75 (via Tebrau)
3:00-6:00 a.m.	1100-1400	**VOA, Washington, USA	G	5.955, 9.73
4:00-4:15 a.m.	1200-1215	Tokyo, Japan	P	5.99
4:00-4:30 a.m.	1200-1230	**Tashkent, U.S.S.R.	F	6.025, 9.60, 11.925
4:10-4:30 a.m.	1210-1230	**Santiago, Chile	F	6.195, 9.566, 11.81, 15.15
4:15-4:30 a.m.	1215-1230	HCJB, Quito, Ecuador	G	11.745
4:30-6:00 a.m.	1230-1400	Trans-World Radio Bonaire, N.A.	G	15.255 (Sat., Sun.)
4:30-8:30 a.m.	1230-1630	HCJB, Quito, Ecuador	G	11.745, 15.115
5:00-5:15 a.m.	1300-1315	Tokyo, Japan	P	5.99
5:30-7:00 a.m.	1330-1500	**Delhi, India	F	11.81, 15.345
6:00-6:30 a.m.	1400-1430	Tokyo, Japan	G	5.99
		**Tashkent, U.S.S.R.	F	9.60, 11.925
6:00-7:20 a.m.	1400-1520	**Hilversum, Holland	G	11.73 (via Talata)
6:00-8:55 a.m.	1400-1655	Manila, Philippines (VOP)	F	9.58 (Closes 1555 Sun.)
7:00-7:15 a.m.	1500-1515	Tokyo, Japan	G	5.99
7:00-8:00 a.m.	1500-1600	London, England	G	17.84 (via Ascension) Sat., Sun. also 9.58 (via Sackville)
8:00-8:15 a.m.	1600-1615	Tokyo, Japan	G	5.99
		London, England	G	9.58 (via Sackville), 17.84 (via Ascension)
8:15-10:30 a.m.	1615-1830	London, England	G	9.58 (via Sackville)
8:42-8:51 a.m.	1642-1651	Hilversum, Holland	G	11.82, 15.19 (via Bonaire, Mon.-Fri.)
9:00-9:15 a.m.	1700-1715	Tokyo, Japan	G	5.99
10:00-10:15 a.m.	1800-1815	Tokyo, Japan	G	9.505
10:00-10:30 a.m.	1800-1830	Oslo, Norway	F	11.895 (Sun.)
11:00-11:07 a.m.	1900-1907	**Papeete, Tahiti	F	11.825, 15.17 (exc. Sun.)
11:00-11:15 a.m.	1900-1915	Tokyo, Japan	G	9.505
11:00 a.m.-12 noon	1900-2000	Taipei, Taiwan	G	9.51, 11.86, 15.225
12 noon-12:15 p.m.	2000-2015	Tokyo, Japan	G	9.505
12 noon-1:20 p.m.	2000-2120	**Hilversum, Holland	G	11.73 (via Talata)
1:00-1:15 p.m.	2100-2115	Tokyo, Japan	G	9.505
1:15-3:00 p.m.	2115-2300	London, England	G	9.58 (via Ascension)
2:00-2:15 p.m.	2200-2215	Tokyo, Japan	G	15.105
2:00-2:30 p.m.	2200-2230	**Caracas, Venezuela	F	15.40 (varies; Mon.-Fri.)
2:00-4:00 p.m.	2200-2400	**VOA, Washington, USA	G	17.82, 17.895, 21.61
2:30-3:00 p.m.	2230-2300	Jerusalem, Israel	F	7.412, 9.815, 11.645, 12.025
2:30-3:20 p.m.	2230-2320	Johannesburg, S. Africa	G	5.98, 9.585, 11.80, 11.90
2:30-4:30 p.m.	2230-0030	Moscow, U.S.S.R.	G	6.02, 7.26, 9.635, 9.78, 12.05, 15.14, 15.18, 15.455, 17.72

TWO NEW GENERATORS FROM EICO®

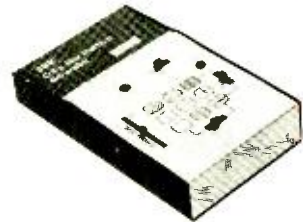


EICO 390 SWEEP/FUNCTION GENERATOR

- .2 Hz to 200 KHz
- Sine, Square, Triangle
- Linear & Log Sweep

Now you can afford a Function Generator that will meet all your signal requirements! The 390 generates discrete sine, square, and triangle waveforms over a very broad frequency range. You have a choice of either linear or logarithmic sweep with slow, medium, or fast rates. The 390 also allows for external frequency control through a rear panel input. With its 50-ohm output impedance and calibrated attenuator, the 390 can handle everything from checking the response of an audio amplifier to driving digital circuits.

Model 390 assembled **\$169.95**



EICO 388 PORTABLE COLOR BAR PATTERN GENERATOR

- Battery Operated with LED Indicator
- IC Digital Circuit Design
- RF Adjustable, Channels 2, 3, 4

The 388 is truly the most advanced pocket-size portable color generator in the field today. A single MOS LSI IC provides 9 digitally controlled, stable patterns. The 388 operates by simply connecting its output cable to the TV's VHF terminals. Two matrix slide switches select any one of the 9 patterns. Crystal controlled chroma and timing oscillators assure precision, accuracy and stability. The 388 is powered by two 9-volt transistor batteries.

Model 388 assembled **\$89.95**

FREE EICO CATALOG

For latest EICO Catalog and name of nearest EICO Distributor, check reader service card or send 50¢ for fast first class mail service.

EICO-283 Malta Street, Brooklyn, N.Y. 11207
Leadership in creative electronics since 1945.

Stamp out



"IC Hotfoot"

Hot soldering irons can be murder on delicate electronic components such as IC's. That's why the DIGI-DESIGNER will become your bugs' best friend. It's a solderless breadboarding instrument that can save you time and burned out parts.

DIGI-DESIGNER comes complete with clock, dual pulsers, logic monitors, voltage switches, built-in 5 volt supply, binding posts for external power, input/output BNC's, and more. Everything you'll need for fast, efficient circuit design.

DIGI-DESIGNER. It means the end of "IC Hotfoot" and the start of efficient, creative circuit design for you. Suggested resale price in U.S.A.—\$77.75 (in kit form). Now available at your nearest computer store.



E&I®

E&I INSTRUMENTS, INC.

61 First Street, Derby, Conn. 06418
(203) 735-8774 Telex No. 96 3536

Dealer inquiries invited.



2:50-3:10 p.m.	2250-2310	**Santiago, Chile	F	6.195, 9.566, 11.81, 15.15
3:00-3:30 p.m.	2300-2330	Tokyo, Japan	G	15.105
3:00-4:30 p.m.	2300-0030	London, England	G	6.175, 9.51 (via Sackville), 9.58 (via Ascension) 5.96
3:00-5:00 p.m.	2300-0100	Montreal, Canada	F	
3:30-4:00 p.m.	2330-2400	**Radio Clarin, S. Domingo, Dom. Rep.	G	11.70 (irregular)
3:45-4:00 p.m.	2345-2400	**Voice of Org. of American States, Washington, USA	G	6.13, 9.64, 11.74
4:00-4:15 p.m.	0000-0015	Tokyo, Japan	G	15.105
4:00-5:00 p.m.	0000-0100	**VOA, Washington, USA	G	11.83, 11.895, 15.40
4:30-5:00 p.m.	0030-0100	Moscow, U.S.S.R.	G	6.02, 7.26, 9.635, 9.78, 12.05, 15.14, 15.18, 15.455, 17.72
4:30-7:30 p.m.	0030 0330	London, England	G	6.175 (via Sackville), 9.51 (via Greenville), 9.58 (via Ascension) 6.095, 9.56, 11.915
4:40-9:00 p.m.	0040-0500	HCJB, Quito, Ecuador	G	
5:00-5:15 p.m.	0100-0115	Tokyo, Japan	G	15.105
5:00-5:30 p.m.	0100-0130	Moscow, U.S.S.R.	G	6.02, 7.175, 9.635, 9.78, 12.05, 15.14, 15.18, 15.455
5:00-7:00 p.m.	0100-0300	Melbourne, Australia	G	15.32, 17.795
5:00-8:00 p.m.	0100-0400	Madrid, Spain	F	6.065, 11.88 (Mon-Sat.)
5:10-5:30 p.m.	0110-0130	**Santiago, Chile	F	6.195, 9.566, 11.81, 15.15
5:30-6:30 p.m.	0130-0230	Tokyo, Japan Moscow, U.S.S.R.	G	15.195, 15.235, 17.725, 17.825 6.02, 7.175, 9.635, 9.78, 11.86, 12.05, 15.14, 15.18, (to 0200), 15.455 (to 0200)
6:00-6:15 p.m.	0200-0215	Tokyo, Japan	G	15.105
6:00-8:00 p.m.	0200-0400	Taipei, Taiwan	F	9.685, 15.425, 17.89
6:10-6:30 p.m.	0210-0230	**Santiago, Chile	F	6.195, 9.566, 11.81, 15.15
6:30-7:00 p.m.	0230-0300	Stockholm, Sweden Moscow, U.S.S.R.	P	9.695, 11.705 6.02, 7.26, 9.635, 9.78, 11.86, 15.14
7:00-7:15 p.m.	0300-0315	Tokyo, Japan	G	15.105
7:00-7:30 p.m.	0300-0330	Kiev, U.S.S.R.	G	7.26, 9.58, 9.635, 9.78, 11.86
7:00-7:55 p.m.	0300-0355	Montreal, Canada Peking, China	G	6.045, 6.065, 9.535, 9.655 7.12, 9.78 (via Tirana), 11.445, 12.055, 15.06, 15.385, 17.735, 17.855
7:00-8:20 p.m.	0300-0420	**Johannesburg, S. Africa	F	3.995, 7.27, 9.58
7:10-7:30 p.m.	0310-0330	**Santiago, Chile	F	6.195, 9.566, 11.81, 15.15
7:20-8:25 p.m.	0320-0425	**TIFC, San Jose, Costa Rica	F	6.035, 9.645, (opens 0300 Sat., Sun.)
7:22-7:28 p.m.	0322-0328	Erevan, U.S.S.R.	G	6.02, 9.54, 9.735, 11.69, 15.14 (Sat./Tue./Wed./Fri.)
7:30-8:00 p.m.	0330-0400	Moscow, U.S.S.R.	G	6.02, 7.26, 9.54, 9.58, 9.635, 9.735, 9.78, 11.69, 15.14
7:30-8:15 p.m.	0330-0415	Berlin, Ger. Dem. Rep.	P	5.955, 6.08, 9.56, 9.73
7:30-8:30 p.m.	0330-0430	London, England	G	6.175 (via Sackville), 9.58 (via Ascension) 15.105
8:00-8:15 p.m.	0400-0415	Tokyo, Japan	G	15.105
8:00-8:30 p.m.	0400-0430	Sofia, Bulgaria Budapest, Hungary	F	9.705 (alt. 9.70) 6.00, 7.215, 9.585, 9.833, 11.91 (Tue., Fri.)
8:00-9:00 p.m.	0400-0500	Montreal, Canada Moscow, U.S.S.R.	G	6.045, 9.655 6.02, 7.175, 7.26, 9.54, 9.58, 9.61 (from 0430), 9.635, 9.735, 9.78, 11.69
8:30-9:00 p.m.	0430-0500	Berne, Switzerland	G	6.045, 9.725
8:30-11:30 p.m.	0430-0730	London, England	G	6.175 (via Antiqua)
9:00-9:15 p.m.	0500-0515	Jerusalem, Israel Tokyo, Japan	F	5.90, 7.395, 7.412 9.505
9:00-9:30 p.m.	0500-0530	Lisbon, Portugal	F	6.025, 11.935 (varies)
9:00-10:20 p.m.	0500-0620	Hilversum, Holland	G	6.165, 9.715, (via Bonaire)
9:00-11:00 p.m.	0500-0700	HCJB, Quito, Ecuador	G	6.095, 9.56
9:00-11:30 p.m.	0500-0730	Moscow, U.S.S.R.	G	6.02, 7.175, 7.26, 9.54, 9.58, 9.61, 9.635, 9.735, 9.78
9:30-9:50 p.m.	0530-0550	Cologne, Ger. Fed. Rep.	G	5.96 (via Antiqua) 6.10 (via Malta), 6.185, 9.545
10:00-10:15 p.m.	0600-0615	Tokyo, Japan	G	9.505
10:00-10:30 p.m.	0600-0630	Oslo, Norway	F	9.645, 11.87 (Sun.)
10:00-11:00 p.m.	0600-0700	Buenos Aires, Argentina	G	9.69 (Mon-Fri.)
10:00 p.m.-12 mdt.	0600-0800	Pyongyang, Dem. Rep. Korea	G	9.82
10:30 p.m.-12:30 a.m.	0630-0830	Havana, Cuba	G	9.525
10:45 p.m.-12:45 a.m.	0645-0845	**Wellington, N.Z.	F	11.78
11:00-11:15 p.m.	0700-0715	Tokyo, Japan	G	9.505
12 mdt.-12:15 a.m.	0800-0815	Tokyo, Japan	G	9.505
12 mdt.-2:00 a.m.	0800 1000	Manila, Philippines (FEBC)	F	11.92
1:00-1:15 a.m.	0900-0915	Tokyo, Japan	G	9.505
2:00-2:30 a.m.	1000-1030	Tokyo, Japan	G	5.99

*Reception quality, East Coast (West Coast) location. G-good, F-fair, P-poor

**Not intended for North America, but receivable satisfactorily

Days refer to local date in target area.



Computer Bits

By Hal Chamberlin

MEMORY TESTING

IT'S LATE at night and you have just finished assembling an expansion memory board for your computer. You turn the computer on and operate the console. It seems to function OK. Now it's time to run a memory test program to make sure that every one of those 4096 new bytes can store and recall data reliably.

A good memory test routine should be able to detect all possible failure modes on the new board. When used at home, it can be run continuously for a day or two to "burn in" the components and detect early failures while the warranty is still in effect. The CPU, data buses, and power supply are also exercised proving their ability to handle the additional load. In a small business application it may be wise to run a memory test (and tests of

other system components as well) before processing sensitive financial data.

A Simple Test Program. Basically a test of memory amounts to checking that each memory byte will correctly read back previously stored data. Since each byte is in turn composed of 8 bits, the data used for checking should try each bit in the "1" and "0" states. Thus a simple test procedure might be first to write all zeroes into a byte, read it back for checking, try all ones, and then go to the next address until all 4096 bytes are tested. Figure 1 shows a flowchart of such a test routine. Actually this is a very poor testing scheme because it will fail to detect a number of common memory board faults.

Shorts between two closely spaced printed circuit traces is a common problem. Assume a solder bridge short between two adjacent data lines on the board. What this means is that those two bits will always be read back identical to each other regardless of what is actually stored in the memory IC's. Usually zeroes will override; meaning that if either of the "paired" data lines has a 0, it will force the other one to a 0 also. Obviously the test scheme in Fig. 1 would not detect this problem since all bits in the byte are identical. Other complementary patterns such as 252 (10101010) and 125 (01010101) (octal) could be used but no such pattern can guarantee detection of a short between *any* pair of data lines.

Shorts or opens in the large number of parallel address lines are even more likely and would not be detected either. The effect of most address line problems is that the actual number of distinct storage locations is less than the 4096 it should be. Another way to think of this is that two or more *different* addresses will refer to the *same* memory cell. Since the routine uses the same data in each location and only one location at a time is checked, it would probably run OK even if *none* of the address lines worked! About the only circuitry this routine does

test is the data buffers (if the board has them) and whatever memory cells that can be addressed correctly.

A Better Test Program. Let us try to design a better testing scheme that detects the common faults noted above. To solve the problem of detecting shorted data lines, we should try to store and recall all 256 possible 8-bit numbers. To detect bad address lines, we should look at all of the other addresses to make

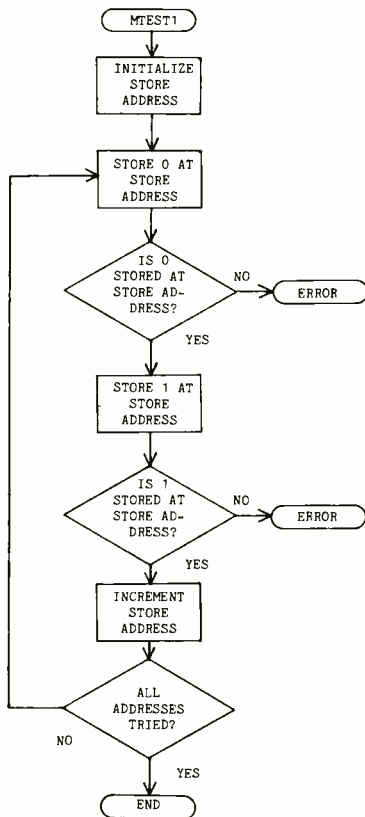


Fig. 1. Simple memory test.

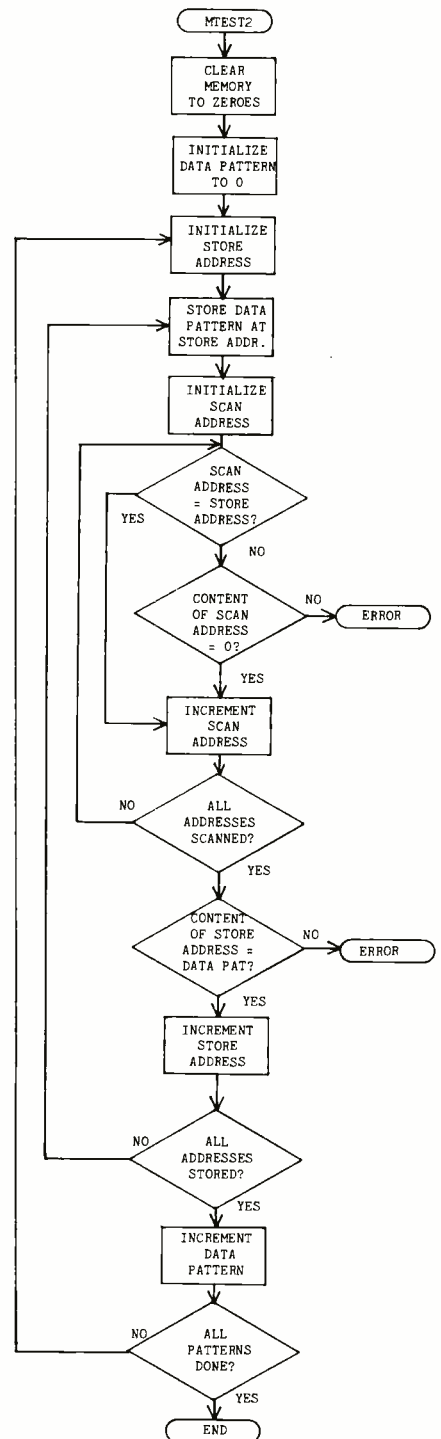


Fig. 2. Better memory test.

sure the data just stored does not pop up someplace else. Figure 2 shows a flowchart for this more effective test procedure. An estimate of the test execution time can be obtained by multiplying the execution time of the inner loop by 4096 locations times 256 data patterns. On a full-speed 8080 this is about 35 microseconds X 4096 X 256 or nearly two days!

This routine is quite effective in locating memory board problems but cannot detect a fairly common (though less so now than in the past) memory *chip* problem that is termed "pattern sensitivity". This is caused by a sort of "spillover" of

bits into their neighbors on the chip and only causes problems with certain patterns of bits. From the memory chip's point of view this routine writes a single "1" bit in a sea of zeroes and checks that the "1" remains stored and that none of the zeroes is disturbed. As the test progresses, the "1" moves around until all locations are tested. Trying all possible bit patterns is not a feasible solution since there are 2^{1024} of them or about 10^{308} on a typical memory IC. It is possible to make a thorough test of pattern sensitivity in a reasonable time but a detailed knowledge of the particular memory chip's geometry is required.

Using Random Numbers. let us now take a look at how computer-generated random numbers can be used in an even better memory test program. Proper functioning of the data and address circuitry can be simultaneously tested by changing the procedure a little and using random data patterns. Instead of testing one location at a time we will first store data in all of the locations to be tested (the store phase) and then come back and see if all of the locations held their data (the verification phase). Also instead of using the same data in all locations, different random numbers will

(Text continued on p 110)

Fig. 3

```

* MEMORY TEST PROGRAM USING RANDOM NUMBERS
* WRITTEN FOR A 4K BLOCK OF MEMORY ON A 4K BOUNDARY

000:000 061 000 001 MTEST LXI SP,400Q      INITIALIZE STACK POINTER
000:003 041 001 000      LXI H,1        INITIALIZE RANDOM NUMBER SEED
000:006 315 130 000 PASS  CALL RAND          NEW PASS, GET A RANDOM NUMBER IN HL
000:011 042 157 000      SHLD SEED       SAVE AS SEED FOR VERIFY
000:014 021 000 020      LXI D,4096     INITIALIZE ADDRESS COUNTER
000:017 315 130 000 STORPH CALL RAND          GET A RANDOM NUMBER IN HL
000:022 315 111 000      CALL MADDR     FORM MEMORY ADDRESS IN BC
000:025 175              MOV A,L        STORE RANDOM BYTE IN MEMORY
000:026 002              STAX B         AT ADDRESS IN BC
000:027 033              DCX D          DECREMENT ADDRESS COUNTER
000:030 173              MOV A,E        TEST IF IT IS ZERO
000:031 262              ORA D
000:032 302 017 000      JNZ STORPH    CONTINUE STORE PHASE IF NOT
000:035 052 157 000      LHLD SEED    RESTORE RANDOM SEED FOR VERIFY PHASE
000:040 021 000 020      LXI D,4096     INITIALIZE ADDRESS COUNTER
000:043 315 130 000 VERFPH CALL RAND          GET A RANDOM NUMBER IN HL
000:046 315 111 000      CALL MADDR     FORM A MEMORY ADDRESS IN BC
000:051 012              LDAX B        GET DATA FROM MEMORY
000:052 275              CMP L        COMPARE WITH WHAT WAS STORED
000:053 302 067 000      JNZ ERRLOG   GO TO ERROR LOG IF NOT THE SAME
000:056 033              DCX D        DECREMENT ADDRESS COUNTER
000:057 173              MOV A,E        TEST IF IT IS ZERO
000:060 262              ORA D
000:061 302 043 000      JNZ VERFPH    CONTINUE TEST PHASE IF NOT
000:064 303 006 000      JMP PASS     GO FOR ANOTHER PASS
000:067 062 161 000 ERRLOG STA WAS        STORE ERRONIOUS DATA IN ERROR LOG AREA
000:072 175              MOV A,L
000:073 062 162 000      STA SHLDDBE  STORE CORRECT DATA
000:076 170              MOV A,B
000:077 062 164 000      STA ERADDR+1 STORE ADDRESS OF ERROR
000:102 171              MOV A,C
000:103 062 163 000      STA ERADDR
000:106 166 000 000      HLT         HALT OR JUMP TO ERROR PRINT

* SCRAMBLED MEMORY ADDRESS FORMATION ROUTINE
* USES ADDRESS COUNTER IN DE AND RANDOM NUMBER IN SEED
* TO FORM A SCRAMBLED ADDRESS IN BC

000:111 072 157 000 MADDR LDA SEED      GET LOWER BYTE OF RANDOM NUMBER
000:114 253              XRA E        EXCLUSIVE-OR WITH LOWER ADDRESS
000:115 117              MOV C,A
000:116 072 160 000      LDA SEED+1  GET UPPER BYTE OF RANDOM NUMBER
000:121 252              XRA D        EXCLUSIVE-OR WITH UPPER ADDRESS
000:122 346 017          ANI 17Q     SAVE ONLY 4 BITS FOR 4K MEMORY
000:124 306 xxx          ADI (page number) ADD IN FIRST PAGE NUMBER OF BOARD
000:126 107              MOV B,A     BEING TESTED
000:127 311              RET        RETURN

```


Fig. 3 (Cont'd.)

```

*      RANDOM NUMBER GENERATOR SUBROUTINE
*      ENTER WITH SEED IN REGISTERS H AND L
*      EXIT WITH NEW RANDOM NUMBER IN H AND L
*      USES 16 BIT FEEDBACK SHIFT REGISTER METHOD
*      DESTROYS REGISTERS A AND B

000:130 006 010      RAND  MVI  B,8          SET COUNTER FOR 8 RANDOM BITS
000:132 174          RAND1 MOV  A,H          EXCLUSIVE-OR BITS 3,12,14, AND 15
000:133 017          RRC                      OF SEED
000:134 254          XRA  H
000:135 017          RRC
000:136 017          RRC
000:137 254          XRA  H
000:140 017          RRC
000:141 255          XRA  L          RESULT IS IN BIT 3 OF A
000:142 017          RRC          SHIFT DOWN TO BIT 0 OF A
000:143 017          RRC
000:144 017          RRC
000:145 346 001     ANI  1          CLEAR OUT ALL OTHER BITS
000:147 051         DAD  H          SHIFT HL LEFT ONE
000:150 205         ADD  L          REPLACE BIT 0 OF HL WITH RESULT
000:151 157         MOV  L,A
000:152 005         DCR  B          TEST IF 8 NEW RANDOM BITS COMPUTED
000:153 302 132 000 JNZ  RAND1       LOOP FOR MORE IF NOT
000:156 311         RET          RETURN

*      STORAGE FOR MEMORY TEST

000:157          SEED  DST  2          RANDOM NUMBER SEED SAVE
000:161          WAS  DST  1          ERROR LOG AREA, ERRONIOUS DATA
000:162          SHLDBE DST  1        CORRECT DATA
000:163          ERADDR DST  2        ADDRESS OF ERROR
000:165          END

```

a revolutionary concept in kit building...

THE PROGRAMMABLE CLOCK KIT! \$29.95



SYSTEM 5000 is the first full-feature timepiece available in programmable form. After the circuit has been assembled and tested, all that is necessary is to add the appropriate switches and jumpers to easily program the system for the desired functions. The system may be expanded or reprogrammed at any time.

This represents a revolutionary concept in adaptability and flexibility. Build an Alarm/Clock/Calendar or a full feature Desk or Radio Station clock. Use the DUPLICATE TIME REGISTER to monitor GMT, another time zone, or as an elapsed timer. Add the optional relay to control AC or DC accessories. The possibilities are limited only by your imagination.

features

TIME OF DAY REGISTER • DUPLICATE TIME REGISTER • FOUR YEAR CALENDAR - month/day or day/month format • ALARM WITH SPEAKER TONE OUTPUT • ADDITIONAL ALARM - for "his and hers" alarm or activate an accessory at preset time • 10 MINUTE SNOOZE & 10 MINUTE REMINDER • 3 FUNCTION ALARM OUTPUT SELECT - tone, relay, or relay then tone • ONE HOUR DOWN COUNTER • BRIGHT FLUORESCENT DISPLAY - .5" easy to read digits with AM/PM • AUTOMATIC DISPLAY DIMMING • POWER FAILURE INDICATION • 12 & 24 HOUR DISPLAY • BLINKING OR STEADY COLON • SIMPLE FORWARD AND REVERSE TIME SETTING •

DIRECT DRIVE ELIMINATES RFI • SINGLE 9 VOLT BATTERY BACKUP • DISPLAY SECONDS CONTROL • HOLD AND RESET CONTROLS • 50/60 HZ • 700 WATT RELAY OPTIONAL

SYSTEM 5000 includes all components, 2 time setting switches, and complete assembly and programming manuals. Switches for additional functions and relay are not included but are available as options.

RELAY OPTION - \$4.00

Includes 700 watt relay and all interface components. Will control appliances, stereos, etc.

SWITCH OPTION - \$3.75

Contains 4 black SPST pushbuttons, 2 black DPDT pushbuttons, and 2 black SPST slide switches. Programs all major features.

CASE OPTION - \$11.00

Hand finished, solid walnut cabinet complete with faceplate and rear panel.

Send your check or money order today for fast delivery. Add \$1.00 per clock to cover shipping and insurance. Money back guarantee on all products if not fully satisfied. N.J. residents add 5% sales tax. Use your Master Charge or BankAmericard. Phone orders accepted.

 digital concepts

DIGITAL CONCEPTS CORPORATION
249 Route 46, Saddle Brook, N.J. 07662
201/845-7101

add a new dimension to time itself with SERIES 2000 Decorator Clocks



A bright Fluorescent display provides easy to read numbers that brighten and dim automatically according to the light. The clear Acrylic tube with Acrylic or Hardwood end blocks gives these clocks a unique look of simple elegance. AM/PM & power failure indication. Seconds display button. 3 1/2" x 3 1/2" x 5 1/2". 50/60 HZ

Specify blue or green display, 12 or 24 hour time, and choice of Hardwood - Walnut, ZebraWood, or Rosewood.

FACTORY ASSEMBLED - 1 YEAR WARRANTY
EC-2001 Solid Acrylic "Time Capsule" \$59.95
EC-2002 Acrylic & Hardwood \$49.95

COMPLETE KITS - 90 DAY WARRANTY
EC-2001-K Solid Acrylic NEW! \$39.95
EC-2002-K Acrylic & Hardwood SPECIAL! \$34.95

be stored into each location. Finally, instead of storing and verifying in an ascending sequence of addresses, a scrambled sequence based on random numbers will be used.

One potential problem with this method is that, with true random numbers, it is not possible to tell during the verification phase what the stored data should be. One solution would be to retain a copy of the correct pattern in known good memory. A better solution is to use a "pseudo random" number generator. Such a generator works by creating a new number from an old one which is

called the "seed." A sequence of random numbers is obtained by repeatedly calling the generator routine giving the last number it produced. If the same initial seed is used, then the sequence of random numbers will be the same. So we have to save only the seed to be able to regenerate the sequence for verification. A scrambled sequence of addresses can be obtained by exclusive OR'ing the lower 12 bits of the memory address with a random number that changes after each "pass" (store and verify phase) through the test routine. Also, after each pass, the data pattern

seed is changed so that each pass is totally different.

Using this method the data lines will be thoroughly tested because after a short time all possible data bytes will have been tried. Addressing will be checked out also since an incorrect address during the data store phase is likely to wipe out data stored elsewhere earlier in the phase. The random address scrambling insures that a variety of pattern store sequences will be tried. After a few dozen passes through the routine, the likelihood is extremely high that every bit of memory has been tried in both one and zero states. Although pattern sensitivity of the memory chips is not specifically tested, a great variety of patterns will be tried.

Figure 3 shows a listing of the improved memory test program in 8080 assembly language. The pseudo-random number generator subroutine simulates a 16-bit shift register with feedback for random bit generation (see the *TTL Cookbook* by Don Lancaster). Eight random bits are generated each call and are put together to make a random byte. The seed that is saved for the verify routine is also used as an address scrambler. The test program runs as an endless loop and will not repeat the sequence of addresses and patterns until 65,535 passes have been completed. Although written for testing a 4k byte memory board, it is readily modified for 8k and 16k boards also. If you are testing a so-called "dynamic" memory board, the computer should be periodically halted from the front panel for a few seconds. This will verify proper operation of the refresh circuitry since normal execution of the test routine would be sufficient to refresh the memory.

If an error is detected during the verify phase, control is passed to an error log routine. This routine stores the address of the error, the correct data byte, and the erroneous data byte in an error log area. (located at the end of the program). At this point, a print routine could take over for a permanent record of all errors. Otherwise, a simple halt could be executed allowing front-panel access to the error log area. By examining a number of error logs, it is usually possible to pinpoint the problem causing errors. For example, if only a single bit is in error and the errors are confined to a 1k block of addresses, then a bad memory chip is the probable cause. If there is a multitude of errors, and the correct data bears no resemblance to the wrong data, there is an addressing problem indicated. ◇

NEW, ANTI-THEFT CB ANTENNA LOCK

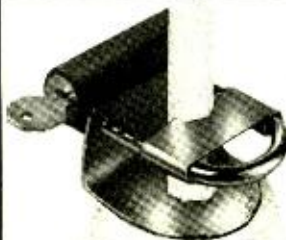


tenna-loc®
MODEL M
Fits most
standard
trunk mount
CB antennas.



tenna-loc®
MODEL H
Fits
'Hustler' type
trunk mount
CB antennas.

\$11.95 ea.
includes shipping



tenna-loc®
MODEL FX
Fits Fibreglass
Hex barrel type
trunk mount
CB antennas.



tenna-loc®
MODEL S
Fits "Signal Kicker"
type trunk and
roof mount
CB antennas.

PROTECT YOUR CB ANTENNA

- Installs in minutes... no special tools, no special skills needed
- Keeps antenna intact and in place year round.
- May be removed for carwash or storage.
- Made of chrome-plated, corrosion resistant materials.
- Made in U.S.A. — World patent applied for.

ORDER NOW!

CHOOSE THE **tenna-loc** MODEL THAT FITS YOUR CB ANTENNA.

Clip and mail today

VERNITRON CORPORATION
CONSUMER PRODUCTS DIVISION Dept. P.E. 3
Lake Success Park, Community Drive, Great Neck, N.Y. 11021

I want tenna-loc! Send me _____ models @ \$11.95 ea. complete (Check models desired)

- Model M — Standard type Model FX — Fibreglass Hex type
 Model H — Hustler type Model S — Signal Kicker type
 check or money order enclosed _____ total amount.

Name _____

Address _____

City _____ State _____ Zip _____

Residents of Calif., Conn., N.Y., N.J. add Sales Tax Approx. two weeks delivery

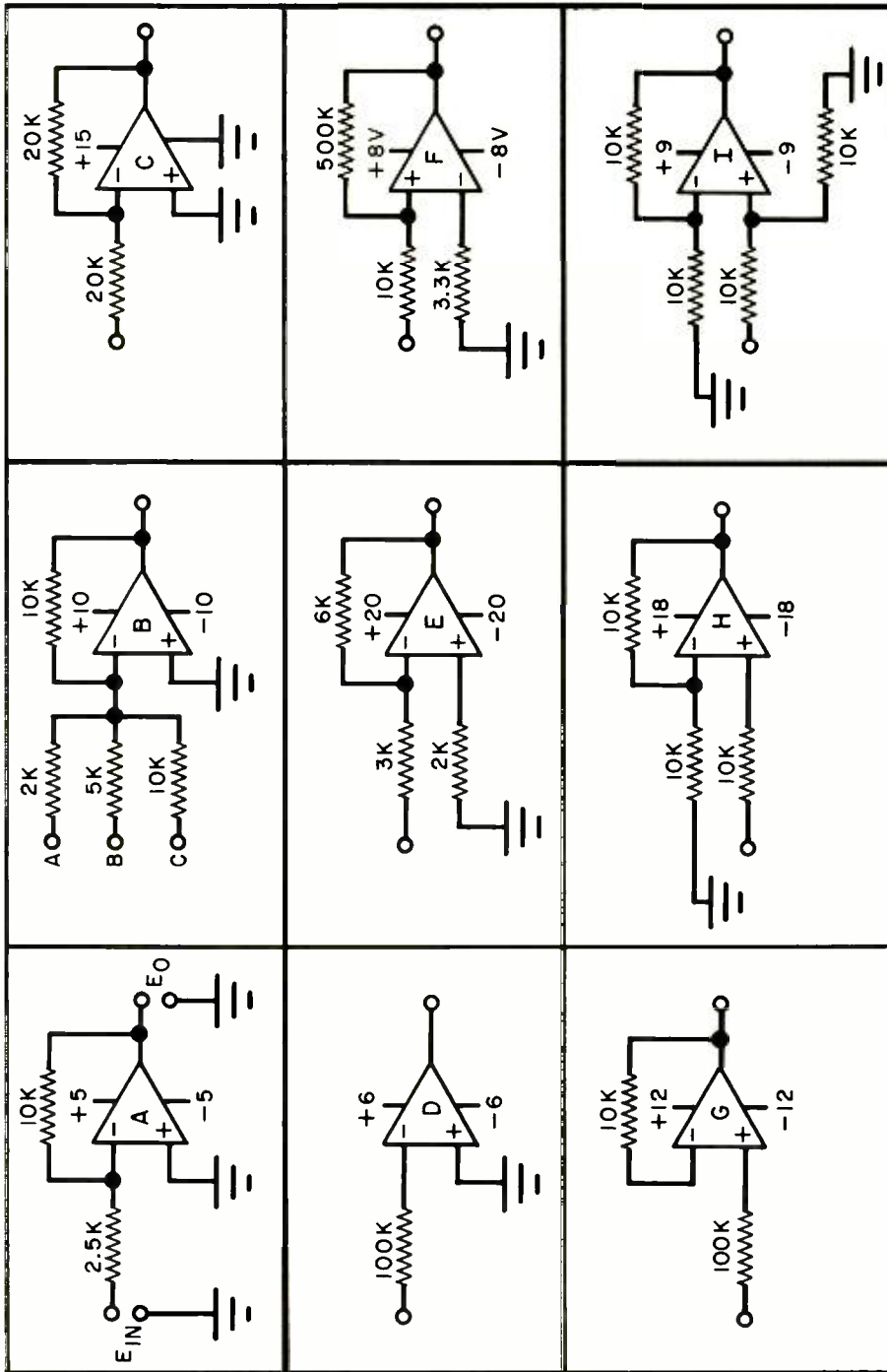
— 10 DAY MONEY BACK GUARANTEE —

A product of
VERNITRON CORPORATION
CONSUMER PRODUCTS DIVISION
Great Neck, N.Y. 11021

OPERATIONAL AMPLIFIER QUIZ

BY WILLIAM E. PARKER

Assume each of these circuits is an ideal op amp and each input is +1.0 volt dc. Determine the output voltages.



Answers A: -4; B: -8; C: 0; D: -6; E: -2; F: +8; G: +1; H: +2; I: +1;

avanti SOLVES TV INTERFERENCE

Interference between television and CB radio is an annoying and not uncommon problem. Avanti solves these problems with 3 line filters...



AV 800 TV interference filter (low pass) installs in CB antenna line and is especially useful for interference on CH2 and 5 of poorly filtered TV receivers.
 impedance = 50 OHMS
 line loss = negligible
 VSWR = 1.1:1
 attenuation on CH2 (54 MHz) = 80db
 1000 watt capacity
 3db cutoff frequency = 43 MHz



AV 811 TV interference filter (hi-pass) installs in TV antenna line and supplements inadequate TV filtering to prevent interference between TV or FM and CB or other high frequency radio services.
 impedance = 300 OHMS
 line loss = negligible
 VSWR = 1.1:1
 cutoff frequency = 54 MHz



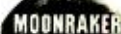
AV 820 A.C. line filter prevents transmission of CB signal through AC power lines. Suitable to contain signal at C.B. transceiver or to prevent outside signal from entering TV through AC line. 1200 watt capacity.

Avanti makes a complete line of high performance mobile and base CB antennas from \$11.95 to \$404.00

Free 24 page color catalog.

avanti
 RESEARCH AND DEVELOPMENT, INC.
 340 Stewart Avenue, Addison, IL 60101

Creators of the famous



PAIA

WE'RE FAMOUS FOR OUR
SYNTHESIZERS



but
did you know
we also have

"OZ"
MINI-
ORGAN,
PHLANGER,
ARTICULATORS
(FOR "TALKING"
GUITAR), COMPUTER
MUSIC INTERFACES,
PROGRAMMABLE RHY-
THM UNITS, ENCEPHALO
GRATIFICATION GENERATOR
(EGG), COMPUTER BASED MUSIC
SYNTHESIS SYSTEMS, PLUS

"POLYPHONY" THE MAGAZINE FOR
THE ELECTRONIC MUSIC ENTHUSIAST.
. . . . AND MORE IN OUR FREE CATALOG

PAIA ELECTRONICS DEPT. 3-P
BOX 14359, OKLAHOMA CITY, OK 73114

CIRCLE NO. 46 ON FREE INFORMATION CARD

CONFUSED BY
ELECTRONIC
IGNITION CLAIMS ?

The
PROOF is in
PERFORMANCE!



Amazing MEGASPARK, the advanced-design Opto-Electronic Breakerless Ignition System, FITS ANY CAR! Replaces points and condenser — gives longer spark plug life. Increases performance, mileage and driving satisfaction while cutting fuel and maintenance costs dramatically. Learn the facts and don't settle for less than the best. Models from \$29.50 to \$64.50

The only unit that gives you all these features:

- LIFETIME WARRANTY
- DIFFERENTIAL AMPLIFIER CIRCUITRY
- FULL INTERNAL VOLTAGE REGULATION
- AUTOMATIC OVERCURRENT PROTECTION

Rush name and address for FREE information package including catalog and discount offer. Or call toll-free 24-hours 800-648-4711 Ext. 22.

MEGASPARK™

by Ignition Systems Inc.
2547 8th Street
Berkeley, CA 94710
(415) 845-3584

CIRCLE NO. 33 ON FREE INFORMATION CARD

Operation Assist

If you need information on outdated or rare equipment—a schematic, parts list etc.—another reader might be able to assist. Simply send a postcard to Operation Assist POPULAR ELECTRONICS 1 Park Ave. New York, NY 10016. For those who can help readers, please respond directly to them. They'll appreciate it. (Only those items regarding equipment not available from normal sources are published.)

Old Tubes W11, UV199, UV99, UV201A, UX201A, 30 and VT-24-864. Needed for old radio collection. Tim Ding, 3752 Orange Ave., Long Beach, CA 90807.

Shaevitz Model S16A oscilloscope. Need manual and schematics. Gerald Kauffman, 99020 Nohua Pl., Aiea, HA 96701.

Tokyo Transistor Model MT-501A candle TV. Schematic, service manual or parts. Bernie J. Workman, 730 Jefferson Ave., Huntington, W. VA 25704.

Electromec Model 1720 oscilloscope. Schematic, operating and maintenance manuals. Perry C. Hutchison, 237 Sheldon, Ames, IA 50010.

Mattes Model SSP-200 stereo power amplifier. Need schematic. G.D.C., Box 824, Huntsville, AL 35804.

Smith Florence Model 810 I-R-E meter. Need manual and schematic. John R. McDaniel, R. R. #1, Box 218, Spencer, IN 47460.

Atwater Kent Model 812 radio. Need schematic and parts list. P. A. Seulerer, 706 New Castle Rd., Marshalltown, IA 50158.

Pentron Model T-90 reel-to-reel tape recorder. Need drive belts and instruction manual. John Whybrew, P. O. Box 387, Upland, IN 46989.

Picture Tube type 13AP4. Need Source. Bob Dvorak, 6244 Colby, Lincoln, NE 68505.

Hammarlund Model HQ 170 ham band receiver. Schematic, calibration and maintenance information needed. Bill Bruyn, 13 Sullivan Ave., Ottawa, ONT, K2G 1S8 Canada.

Hallcrafters Model S-40A shortwave receiver. Schematic and instruction manual. Robert R. Lintner, 102 Cherry St., Gnadenhutten, OH 44629.

Burroughs Model E3500 computer. Operating and programming instructions needed. Frank Hoszu, 725 Wiagara Ln., Wayzata, MN 55391.

Supreme Model 546 oscilloscope. Schematic and manual needed. Peter Pellerzi, 34-45 28th St., Astoria, NY 11106.

Acoustech Model XI stereo power amplifier. Schematic, voltage chart and manual. William Lourie, 2444 White Rd., Cleveland, OH 44118.

Westinghouse Model H-161 AM/FM radio. Schematic and service manual needed. Frank Holland, 17 Hilltop Trailer Ct., Fairfax, VA 22030.

Navy type CCT-46217 radio receiver. Schematic, service information and operating manual needed. Ed Grimes, 569 N. Main Republic, MO 65738.

DeVry transistorized automotive analyzer. Manual or schematic needed. Stanley G. Boler, 116 S Washington St., Knightstown, IN 46148.

Guided Radio Corp. Model M-116A battery powered megaphone set. Need schematic and one 1J6 tube. Dwayne Pantle, Rte. 2, Box 131-C, Woodburn, OR 97071.

Superior Instrument Model TV-50A genometer. Schematic and/or service manual. Dennis Avisais, 71 Plymouth St., New Bedford, MA 02740.

Packard Bell Model 920, "Sync-Lok" TV camera. Schematic and manual needed. Mr. Terry D. Caster, 6515 Hunters Ridge, Holly, MI 48442.

Precision Model 120 V.O.M. Meter movement needed. Gary Lawson, 128 Poulton Ave., Staten Island, NY 10312.

Knight Model C-22 Citizens Band transceiver. Construction and operating manual needed. Robert W. Boehnke, 3011 Antioch Rd., Perry, OH 44081.

McMurdo Model 911 silver sweep generator. Need schematic and maintenance information. John Zettmeier, 29 Coolidge St., Haverstraw, NY 10927.

Hammarlund Model CB214 CB transceiver. Schematic needed. Joe Dura, 2910 Red Fox Run, Warren, OH 44485.

Put Professional Knowledge and a COLLEGE DEGREE in your Electronics Career through HOME STUDY



Earn Your DEGREE

by correspondence, while continuing your present job. No commuting to class. Study at your own pace. Learn from complete and explicit lesson materials, with additional assistance from our home study instructors. Advance as fast as you wish, but take all the time you need to master each topic. Profit from, and enjoy, the advantages of independent study.

The Grantham electronics degree program begins with basics, leads first to the A.S.E.T. degree, and then continues through the B.S.E.E. degree level. Our free bulletin gives complete details of the program itself, the degrees awarded, the requirements for each degree, and how to enroll. Write or phone (no collect calls please) and ask for BULLETIN E-77

Grantham School of Engineering
2000 Stoner Ave., Los Angeles, CA 90025

• Telephone (213) 477-1901 •

Worldwide Career Training thru Home Study

CIRCLE NO. 31 ON FREE INFORMATION CARD

"My father built this Schober Organ for me!"



You'd be proud to buy her an organ this good...but how would you feel if you'd also built it? It's a special kind of satisfaction. The gift of a lifetime of magnificent music, crafted with your own hands!

And you can do it! You need no prior electronic or mechanical abilities. Just the capacity to follow instructions. Every step is clearly detailed, every component is supplied. You'll find the assembly process as enjoyable as the music which follows!

And what music! For this is a truly fine instrument you will build. Far superior to most "ready-made" organs...easily comparable to others at twice the price. Kit costs range from \$650 to \$2850 for all basic components, and you can purchase it in sections to spread costs out...or have two-year time payments.

Just send the coupon for the fascinating Schober color catalog (or enclose \$1 for a record that lets you hear as well as see the quality of Schober).

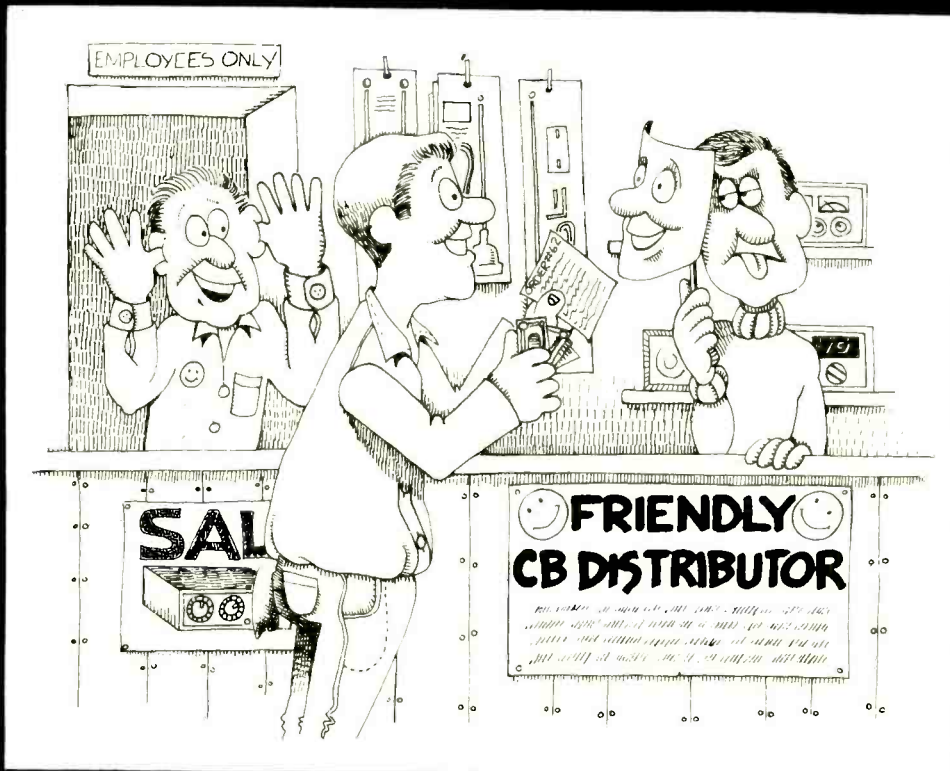
The Schober Organ Corp., Dept. PE-70
43 West 61st Street, New York, N.Y. 10023

Please send me Schober Organ Catalog.
 Enclosed please find \$1.00 for 12-inch L.P. record of Schober Organ music.

NAME _____
ADDRESS _____
CITY _____ STATE _____ ZIP _____

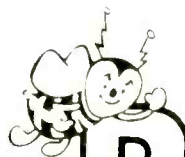
CIRCLE NO. 63 ON FREE INFORMATION CARD

POPULAR ELECTRONICS



DEALERS, DOES YOUR DISTRIBUTOR REALLY CARE?

We really can't say anything about the "other guy," but at **BENNIES**, your business counts. Every dealer we handle gets the best service possible, including a weekly mailer of specially priced items you'll have to see to believe! Send \$5.00 (deductible from your first order if made within 90 days) and your tax number for our giant new 248 page catalog, and see the difference for yourself. **BENNIES**. We're the distributor who cares. Sorry, catalog only available to dealers.



**YOUR ONE STOP DISTRIBUTOR FOR
GEMTRONICS 23 AND 40 CHANNEL
CITIZEN BAND RADIOS.**

BENNIES

**WAREHOUSE DISTRIBUTION CENTER
R.D.1 BERWICK, PA. 18603 717-759-2201**

SAVE!

MONEY • TIME • FREIGHT

QUALITY STEREO EQUIPMENT
AT LOWEST PRICES.

YOUR REQUEST FOR QUOTA-
TION RETURNED SAME DAY.

FACTORY SEALED CARTONS—
GUARANTEED AND INSURED.

SAVE ON NAME BRANDS LIKE:
A.D.C. KLH
A.R. SHURE
DYNACO KOSS
SONY FISHER

PIONEER
AND MORE THAN 50 OTHERS
BUY THE MODERN WAY
BY MAIL—FROM

illinois audio

Department 217S
12 East Delaware
Chicago, Illinois 60611
312-664-0020

CIRCLE NO 34 ON FREE INFORMATION CARD

FREE catalog

over 2000

unique tools,
handy kits,
precision
instruments,
technical
supplies.



Our 23rd year of service to the World's
finest craftsmen and technicians.

A carefully selected and tested assortment of unique, hard-to-find tools, clever gadgets, precision instruments, bargain kits. One-stop shopping for the technician, craftsman, hobbyist, lab specialist, production supervisor. Many tools and measuring instruments available nowhere else. One of the most unusual and complete tool catalogs anywhere. Get your copy of the NC FLASHER today.

National Camera
2000 West Union Ave., Dept. GGA
Englewood, Colorado 80110
(303) 789-1893

CIRCLE NO 41 ON FREE INFORMATION CARD



Electronics Library

DIGITAL TROUBLESHOOTING

by Richard E. Gasperini

The heart of this book is in three chapters. The first covers tools such as logic probes and comparators, and techniques such as piggy-backing IC's, selective shotgunning, toothpicking, and "smoking it out." The chapter on logical troubleshooting examines ways of localizing the problem, including half-splitting and the serial method. The third shows how to remove IC's, with vacuum devices, combination irons, and desoldering wick. The other 15 chapters offer background material (numbering systems, how IC's are manufactured, obtaining parts, logic symbols) or describe various circuits and show how to troubleshoot them (bipolar IC's, MOS, flip-flops, counters, shift registers, displays, memories, etc.). An appendix shows how to decode IC manufacturers' type numbers.

Published by *Movonics Co.*, distributed by *Hayden Book Co.*, 50 Essex St., Rochelle Park, NJ 07662. 180 pages. \$9.95 soft cover.

MICROCOMPUTER DESIGN

by Donald P. Martin

Published by the manufacturers of the Mike 3 and Mike 8 hobby microcomputers, this handbook goes into great detail on the 8008 and 8080 microprocessors. After comparing them with several other popular MPU's, the author examines timing, bus structures, input/output instructions, RAM and ROM, DMA, interrupts, timers, digital displays, interfacing, keyboards, analog I/O, software, and testing. The book concludes with two minimal micros, using 9 and 19 chips, and a thorough discussion of the CPU board for the Mike 3.

Published by *Martin Research*, 3336 Commercial Ave., Northbrook, IL 60062. 416 pages. \$25 soft cover.

THE RADIO AMATEUR'S HANDBOOK

by Robert Hertzberg,

revised by A. Frederick Collins

First published in 1964, this well-known handbook is now in its 13th edition. New chapters have been added on CB radio and 2-meter fm equipment. There are chapters on vacuum tubes and solid-state devices, construction techniques, power supplies, receiver and transmitter theory, amateur licenses, antennas, mobile operation, test equipment, and setting up and operating an amateur station.

Published by *Thomas Y. Crowell Co.*, 666 Fifth Ave., New York, NY 10019. 378 pages. \$8.95 hard cover.

MICROCOMPUTERS/MICROPROCESSORS: HARDWARE, SOFTWARE AND APPLICATIONS

by John L. Hilburn and Paul M. Julich

Part of the extensive Prentice-Hall series on automatic computation, this lean-meat text requires no formal training in digital logic. The first three chapters provide the needed background in basic elements, logic, and number systems. Next discussed are microcomputer hardware (ROM, read/write memory, microprocessors), software (machine, assembly and high-level languages), and interfacing to peripheral devices. Ten microprocessors are discussed in detail (with instruction sets given in the appendixes), and the final chapter is on design and applications.

Published by *Prentice-Hall, Englewood Cliffs NJ 07632*. 372 pages. \$16.50 hard cover.

SOLID-STATE ELECTRONICS

by Frank P. Tedeschi and Margaret R. Taber

Intended for use in junior colleges, technical institutes and industrial training courses, this book is a combination text and lab manual. Prerequisites are a familiarity with algebra and basic electricity. Chapters are included on rectification, power-supply filters, zener diodes, junction transistors, the three configurations (common-base, common-emitter, common-collector), load lines, and biasing for common-emitter circuits.

Published by *Van Nostrand Reinhold Co.*, 450 West 33 St., New York, NY 10001. 202 pages. \$8.95 hard cover.

MODERN GUIDE TO DIGITAL LOGIC: PROCESSORS, MEMORIES & INTERFACES

by United Technical Publications, Inc.

The first four chapters of this guide are on Schottky TTL, ECL and MECL logic gates, at a fairly high technical level. More complex circuits, such as adders and multipliers, accumulators and counters are taken up in the next two chapters, on the MECL 10,000 family, and MSI/LSI Schottky TTL. After a chapter on high-noise-immunity logic gates, and one on using and interfacing CMOS, the book ends with a short chapter on microprocessors and a longer one on bipolar and MOS memory (RAM and ROM). Most of the material in the book is taken from seminars, technical papers and data provided by Motorola, Texas Instruments, Intel, Teledyne Semiconductor, etc.

Published by *Tab Books, Blue Ridge Summit, PA 17214*. 294 pages. \$6.95 soft cover, \$9.95 hard cover.

QUESTIONS AND ANSWERS ABOUT CB INTERFERENCE

by Leo G. Sands

Several hundred short questions and detailed answers are divided into seven parts, on interference types, audio rectification interference, harmonic and overload television interference, interference to radio reception, and auto-engine noise. The questions are explicit, the answers straightforward.

Published by *Howard W. Sams & Co.*, 4300 W. 62nd St., Indianapolis, IN 46206. 80 pages. \$3.95 soft cover.

POPULAR ELECTRONICS

ELECTRONICS MARKET PLACE

REGULAR CLASSIFIED: COMMERCIAL RATE: For firms or individuals offering commercial products or services. \$2.25 per word. Minimum order \$33.75. **EXPAND-AD CLASSIFIED RATE:** \$3.35 per word. Minimum order \$50.25. Frequency discount; 5% for 6 months; 10% for 12 months paid in advance. **READER RATE:** For individuals with a personal item to buy or sell, \$1.35 per word. No minimum! **DISPLAY CLASSIFIED:** 1" by 1 column (2-1/4" wide), \$260.00. 2" by 1 column, \$520.00. 3" by 1 column, \$780.00. Advertiser to supply film positives. For frequency rates, please inquire.

GENERAL INFORMATION: Payment must accompany copy except when ads are placed by accredited advertising agencies. First word in all ads set in caps. All copy subject to publisher's approval. All advertisers using Post Office Boxes in their addresses **MUST** supply publisher with permanent address and telephone number before ad can be run. Advertisements will not be published which advertise or promote the use of devices for the surreptitious interception of communications. Ads are not acknowledged. They will appear in first issue to go to press after closing date. Closing Date: 1st of the 2nd month preceding cover date (for example, March issue closes January 1st. Send order and remittance to **POPULAR ELECTRONICS**, One Park Avenue, New York, New York 10016, Attention: Hal Cymes.

FOR SALE

FREE! Bargain Catalog—I.C.'s, LED's, readouts, fiber optics, calculators parts & kits, semiconductor parts, Poly Paks. Box 942PE, Lynnfield, Mass. 01940.

GOVERNMENT and industrial surplus receivers, transmitters, snooper scopes, electronic parts, Picture Catalog 25 cents. Meshna, Nahant, Mass. 01908.

LOWEST Prices Electronic Parts. Confidential Catalog Free. KNAPP, 3174 8th Ave. S.W., Largo, Fla. 33540.

ELECTRONIC PARTS, semiconductor kits. **FREE FLYER**, Large catalog \$1.00 deposit. **BIGELOW ELECTRONICS**, Bluffton, Ohio 45817.

RADIO—T.V. Tubes—36 cents each. Send for free catalog. Cornell, 4213 University, San Diego, Calif. 92105.

AMATEUR SCIENTISTS, Electronics Experimenters, Science Fair Students... Construction plans—Complete, including drawings, schematics, parts list with prices and sources... Robot Man — Psychedelic shows — Lasers — Emotion/Lie Detector — Touch Tone Dial — Quadraphonic Adapter — Transistorized Ignition — Burglar Alarm — Sound Meter... over 60 items. Send 50 cents coin (no stamps) for complete catalog. Technical Writers Group, Box 5994, University Station, Raleigh, N.C. 27607.

METERS—Surplus, new, used, panel or portable. Send for list. Hanchett, Box 5577, Riverside, CA 92507.

MECHANICAL, ELECTRONIC devices catalog 10 cents. Greatest Values — Lowest Prices. Fertik's, 5249 "D", Philadelphia, Pa. 19120.



ORGAN KITS KEYBOARDS

THE ULTIMATE IN DESIGN
AND SOUND

Demo Record & Brochure \$1.00

Wurlitzer reproductions

DEVTRONIX ORGAN PRODUCTS, Dept. C
5872 Amapola Dr. • San Jose, CA 95129

SOUND SYNTHESIZER KITS—Surf \$12.95. Wind \$12.95. Wind Chimes \$17.95. Electronic Songbird \$6.95. Musical Accessories, many more. Catalog free. **PAIA Electronics**, Box J14359, Oklahoma City, OK 73114.

BUGGED??? New locator finds them fast. Write. Clifton, 11500-L N.W. 7th Avenue, Miami, Florida 33168.

YOU WILL SAVE BIG MONEY! Surplus, Clearouts, Bankruptcy, inventory, Deals. Catalog \$1 (redeemable). **ETCOA Electronics**, Box 741, Montreal, H3C 2V2. U.S. Inquiries.

HEAR POLICE/FIRE Dispatchers! Catalog shows exclusive directories of "confidential" channels, scanners. Send postage stamp. Communications, Box 56-PE, Commack, N.Y. 11725.

JAPANESE TRANSISTORS, all transistors original factory made. Free catalog. West Pacific Electronics, P.O. Box 3879, Torrance, CA 90510.

ELECTRONIC ignition: Capacitor-Discharge, pointless. Auburn Sparkplugs. Wheel Stabilizers. Information 20 cents. Anderson Engineering, Epsom, N.H. 03234.

POLICE, Fire monitors, scanners, crystals, CB Transceivers, New Crystal-less scanners. Discount priced. Box 19224, Denver, CO 80219.

TELETYPE EQUIPMENT for sale for beginners and experienced computer enthusiast. Teletype machines, parts, supplies. Catalogue \$1.00 to: **ATLANTIC SALES**, 3730 Nautilus Ave., Brooklyn, NY 11224. Tel: (212) 372-0349.

CARBON FILM RESISTORS. Brand new as low as 1.7 cents. Discounts of 20%. Prompt delivery. **FREE samples/specifications**. **COMPONENTS CENTER**, Box 134P, N.Y., N.Y. 10038.

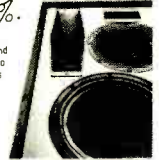
WHOLESALE C.B., Scanners, Antennas, Catalog 25 cents. Crystals: Special cut, \$4.95. Monitor \$3.95. Send make, model, frequency. G. Enterprises, Box 461P, Clearfield, UT 84015.

COMPUTER HOBBYISTS—classified advertising newsletter. \$3.75/year. Free Sample. **ON-LINE**, 24695 Santa Cruz Hwy., Los Gatos, CA 95030.

BUILD YOUR OWN SPEAKERS AND SAVE UP TO 50%.

Send for our free, fact-packed 40 page catalog manual and learn how to assemble your own multielement Stereo Speakers from scratch or from kits. Our catalog includes chapters on design, construction, covers, enclosures, mixtures, woofers, tweeters and horns. Write us today!

SPEAKERLAB
Dept. PE-A, 5500 35th N.E.
Seattle, Washington 98105



Announcing the NEW STANDARD in Stereo Testing!

The All-New Model SR12 STEREO TEST RECORD

The most complete... most sophisticated... most versatile Test Disc available today... For Just \$6.95!

Whether you're an avid audiophile, a casual listener or a professional technician... the new **MODEL SR12** will be the most important disc in your entire collection.

MODEL SR12 has been produced by **Stereo Review Magazine** for music lovers who want immediate answers to questions about the performance of their stereo systems and how to get the best possible sound reproduction.

It is the most complete test record of its kind — containing the widest range of checks ever included on one test disc.

Make these important stereo checks BY EAR... (no test instruments required)

- ▶ Frequency response—a direct warble-tone check of nineteen sections of the frequency spectrum, from 20 to 20,840 Hz, which will pinpoint any frequency response defects in your system.
- ▶ Separation—an ingenious test which indicates whether you have adequate separation for good stereo.
- ▶ Cartridge tracking—the most sophisticated tests ever devised for checking the performance of your cartridge, stylus and tone arm.
- ▶ Channel balance—two broad-band, random-noise signals which permit you to eliminate any imbalances originating in cartridge, amplifier, speakers or room acoustics.
- ▶ Hum and rumble—foolproof tests that help you evaluate the actual audible levels of rumble and hum in your system.
- ▶ Flutter—a sensitive "musical" test to check whether your turntable's flutter is low, moderate, or high.

PLUS! ● Cartridge and Speaker Phasing ● Anti-Skating Adjustment ● "Gun Shot Test" for Stereo Spread ● Multi-purpose Musician's "A" ● Equal-tempered Chromatic Octave ● Guitar-tuning Tones.

Attention Professionals Model SR12 is also designed to be used as a highly efficient design and measurement tool. Tests below have been controlled to laboratory tolerances—affording accurate numerical evaluation when used with oscilloscope, chart recorder, output meter, intermodulation-distortion meter and flutter meter.

- 1,000-Hz square waves to test transient and high-frequency response of phono pickups.
- 500 to 20,000 Hz frequency-response sweep.
- Sine-wave tone-bursts to test transient response of pickup.
- Intermodulation test using simultaneous 400-Hz and 4,000-Hz signals.
- Intermodulation sweep to show distortion caused by excessive resonances in tone arm and cartridge.
- 1,000-Hz reference tones to determine groove velocity.
- 3,000-Hz tone for flutter and speed tests.

Sample waveforms—illustrating both accurate and faulty responses are provided in the Instruction Manual for comparison with the patterns appearing on your own oscilloscope screen.

FREE—An informative manual which includes charts, tables and diagrams.

CHARGE YOUR ORDER TO YOUR AMERICAN EXPRESS, BANKAMERICARD, MASTER CHARGE OR DINERS CLUB ACCOUNT.

Ziff-Davis Service Division, Dept. R, 595 Broadway, N.Y., N.Y. 10012.

Please send the SR12 Stereo Test Record @ \$6.95, postpaid (\$8.95 outside U.S.A.).

Enclosed is \$_____ (Residents of Calif., Col., Fla., Ill., Mich., Mo., N.Y. State, D.C. and Tex. add applicable sales tax.)

CHARGE: BankAmericard Master Charge American Express Diners Club

PE-377

Account # _____ Exp. Date _____

Master Charge Interbank # _____ (4 numbers over your name)

Signature _____

Print Name _____

Address _____

City _____ State _____ Zip _____

SURPRISE! Build inexpensively, the most Unusual Test Instruments, Futuristic Gadgets using Numerical Readouts! Catalogue Free! GBS, Box 100A, Green Bank, West Virginia 24944.

UNSCRAMBLERS: Fits any scanner or monitor, easily adjusts to all scrambled frequencies. Only 4" square \$29.95, fully guaranteed. Dealer inquiries welcomed. PDQ Electronics, Box 841, North Little Rock, Arkansas 72115.

RECONDITIONED Test Equipment \$0.50 for catalog. Walter's Test Equipment, 2697 Nickel, San Pablo, CA 94806.

LEARN Design Techniques. Electronics Design Newsletter, Digital, linear construction projects, design theory and procedures. Annual Subscription \$6.00, sample copy \$1.00. Valley West, Box 2119-B, Sunnyvale, CA 94087.

AUDIO EXPERIMENTERS, Serious Music Synthesizer Stuff: literature, kits, components, circuits and more. Send SASE for FREE INFO. CFR Associates, POB F, Newton, NH 03858.

SURPRISES GALORE! Projects, ham radio, music synthesizers, etc. IC's, pots, hardware, crystals, keyboards, resistors, etc. Send 13 cents stamp for catalogue. UTEP, Box 26231B, Salt Lake City, Utah 84125.

ANYONE CAN SOLDER WITH—



DO-IT-YOURSELFERS!

Let Kester solder aid you in your home repairs or hobbies. A radio, TV, model train, jewelry, plumbing, etc. Save money—repair it yourself. Send self-addressed stamped envelope to Kester for a FREE Copy of "Soldering Simplified".

KESTER SOLDER / 4201 Wrightwood Ave. Chicago, Ill. 60639

CB RADIOS, monitors, crystals, CD ignitions. Southland, Box 3591-B, Baytown, Texas 77520.

FERRIC CHLORIDE ETCHANT. 1/2 gallon \$5.50. Gallon \$9.50. Postpaid. CIRCOLEX, Box 198, Marcy, N.Y. 13403.

NEW ADJUSTABLE THREE OUTPUT REGULATED POWER SUPPLY, plus 900 parts worth \$400.00 list, contained in a solid state CARTRIVISION television recorder electronic unit. Schematics, parts cross reference furnished. Uses: HEATHKIT television transistor substitutions, power CB radios and MICROPROCESSORS, build electronic projects. \$17.95 plus \$3.50 S&H. USA. Free brochure. Master Charge, BankAmericard. Satisfaction Guaranteed. MADISON ELECTRONICS COMPANY, INCORPORATED, Box 369, D55, Madison, Alabama 35758.

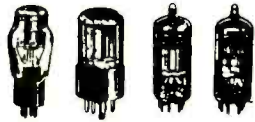
CB CRYSTALS over 20,000 standard and specials in stock from 6.0 MHz to 45.0 MHz. Call or write for information package. Dealer inquiries invited. Roberts Electronics Sales, 73563 29 Palms Highway, 29 Palms, California 92277. (714) 367-6235.

NON SEMI SURPLUS. Monthly picture flyer. Quality. Low prices. Send 25 cents. U.S. only. Startronics, Box 683, McMinnville, OR 97128.

FREE FLYER from Colorado's fastest growing electronic parts distributor. Our second big year with outstanding buys on kits, parts, semi's, scientific items. Visit our retail outlet. J.B. Saunders Company, 3050 Valmont, Boulder, CO 80301.

BUILD AND SAVE. TELEPHONES, TELEVISION, DETECTIVE, BROADCAST Electronics. We sell construction plans with an Engineering Service. Speakerphones, Answering Machines, Carphones, Phonevision, Dialers, Color TV Converters, VTR, Games, \$25 TV Camera, Electron Microscope, Special Effects Generator, Time Base Corrector, Chroma Key, Engineering Courses in Telephone, Integrated Circuits, Detective Electronics, PLUS MUCH MORE. NEW Super Hobby Catalog PLUS year's subscription to Electronic News Letter, \$1.00. Don Britton Enterprises, 6200 Wilshire Blvd., Los Angeles, Calif. 90048.

FREE CATALOG. Unique Components, Kits, Calculators, Digital Thermometers, Ultrasonics, Strobes, Ni-cads, LEDs, Transistors, IC's, Chaney's, Box 27038, Denver, CO 80227.



70% OFF LIST!

1AD2	1.59	6AU8	2.15
1B3GT	1.58	6AV6	1.11
1K3	1.58	6AW8A	1.79
1S2A	2.27	6AX4GTB	1.52
1U4	1.58	6AY3B	1.52
1V2	.96	6AZ8	2.30
1X2B	1.56	6BA6	1.34
2AH2	1.59	6BA11	1.95
2AV2	1.26	6BE6	1.47
2D21	1.95	6BH11	1.77
2GK5	1.58	6B16	1.65
3A3C	1.61	6BK4C6	2.98
3A5	2.50	6BK7B	2.07
3AT2B	1.56	6BL8	1.10
3BS2	1.70	6BM8	1.10
3CU3A	1.95	6BN6	1.97
3CY3	1.76	6BN8	1.56
3DJ3	1.70	6BN11	2.46
3GK5	1.55	6BQ5	1.56
3HA5	1.53	6BQ7A	2.09
3HQ5	2.27	6BR8A	2.12
3JC6A	2.06	6BX6	1.49
3V4	1.83	6BZ6	1.26
4AU6	1.58	6C4	1.58
4BL8	.92	6CA4	1.60
4BZ6	1.41	6CA7	2.04
4CB6	1.10	6CB6A	1.32
4DT6	1.56	6CG3	1.58
4EH7	1.46	6CD6GA	2.83
4EJ7	1.46	6CG7	1.22
4HS8	1.50	6CG8A	1.73
4JC6A	2.04	6CJ3	1.50
4JD6	1.88	6CL3	1.61
4KE8	2.48	6CL6	2.07
4LJ8	1.80	6CL8	1.95
5A04	4.50	6CM7	1.71
5EW6	1.63	6CU5	1.65
5GH8A	1.88	6CW4	3.30
5GJ7	1.11	6CW5	1.02
5GS7	1.17	6DJ8	2.25
5GX7	1.68	6DL4	2.39
5HZ6	1.20	6DQ6	2.15
5JK6	1.47	6DT6A	1.32
5JL6	1.47	6DW4	1.50
5KE8	2.48	6DX8	1.01
5LJ8	1.76	6EA8	1.58
5U4GB	1.23	6EB8	2.40
5Y3GT	1.32	6EH7	1.53
5Y4GT	1.14	6EJ7	1.43
6A8	4.69	6EM7	2.25
6AB4	1.53	6EU7	1.65
6AC7	2.36	6EW6	1.43
6AC10	1.73	6EW7	2.38
6AD10	3.68	6FG7	3.49
6AF4	2.21	6FG6	1.19
6AF9	2.13	6FG7	2.28
6AH6	2.94	6FM7	1.85
6A18	1.74	6GE5	2.16
6AL3	.92	6GF7A	2.12
6AL5	1.31	6GH8A	1.26
6AN8A	1.82	6GJ7	1.86
6AQ5	1.35	6CK5	1.11
6AQ8	.98	6CK6	1.41
6AR5	.81	6CM6	1.68
6AS8	2.48	6GM8	3.30
6AU4GT	1.97	6GS7	1.38
6AU5GT	2.41	6GU7	1.67
6AU6A	1.31	6GW8	.98

EDLIE BARGAIN BONANZA OF HIGHEST QUALITY TUBES

BUY BRAND NEW MANUFACTURER'S BOXED TUBES (Raytheon, Dumont, IEC Mullard, etc.) AT 70% OFF LIST!
HERE IS A BIGGER & BETTER LIST THAN WE EVER OFFERED BEFORE... AND REMEMBER... 70% OFF LIST!

ALL TUBES BRAND NEW MANU. BOXED 70% OFF

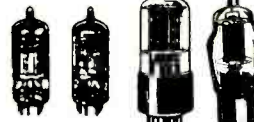
MINIMUM ORDER \$7.50

MONEY BACK GUARANTEE

Terms: Minimum order \$7.50. Include postage. Either full payment with order or 20% deposit, balance C.O.D.

6GX6	1.38	6JH8	2.51
6H6	2.71	6JM6A	2.16
6HA5	1.53	6JN6	2.03
6HB7	1.55	6JR6	3.54
6HE5	1.91	6JSC6	2.95
6HF5	3.78	6J16	2.40
6HF8	2.16	6J18	2.91
6HQ5	2.03	6JU6	1.84
6HS5	2.94	6JU8	1.77
6HS6	1.46	6JW8	1.80
6HS8	1.91	6JW8	1.35
6HV5	3.54	6K6GT	2.64
6HZ6	1.28	6K7GT	1.24
6J5	1.89	6K8	4.69
6J7	2.31	6KA8	1.95
6J10	2.45	6KD6	3.38
6JB6	2.42	6KE8	2.45
6JCGA	1.79	6KM6	3.38
6JD6	1.85	6KT8	2.18
6JEG6	3.35	6KV6A	2.67
6JG6A	2.67	6KZ8	1.64
6JH6	1.43	6L6	4.86

WRITE FOR FREE VALUE PACKED CATALOG



70% OFF LIST!

6L7	2.84	12BH7A	1.58
6LB6	3.23	12BY7	1.43
6LE8	2.27	12DQ6B	2.10
6LF6	3.20	12FX5	1.34
6LF8	2.34	12GN7	2.22
6LJ8	1.76	12HL7	1.95
6LM8	1.95	12JB6A	2.55
6LN8	1.05	12MD8	1.77
6LT8	1.64	12SL7	2.31
6LU8	1.92	13GF7A	2.09
6LX8	1.05	13Z10	2.55
6M11	2.76	14BL11	3.11
6MB8	1.52	15BD11A	2.25
6MD8	2.34	15CW5	.87
6SA7	2.04	15KY8A	2.91
6SG7	2.30	16A8	1.23
6SJ7	2.19	16LU8A	2.97
6SK7	2.03	17AY3A	1.52
6SL7GT	2.30	17BE3	1.52
6SN7GT	1.52	17BF11	2.39
6SQ7	2.01	17BR3	1.23
6T8A	1.92	17BS3	1.52
6T10	2.25	17CK3	1.31
6U8A	1.56	17CU5	1.26
6U10	1.62	17DW4	1.41
6V6	3.57	17JN6	2.16
6X4	1.46	17JQ6	1.85
6X5GT	1.47	17JZ8	1.43
6X9	1.82	19CG3	1.58
7F8	6.00	20A0Q3	1.17
7V7	3.00	21GY5	2.01
8A8	.93	21HB5	1.92
8AC9	1.88	21JS6	4.30
8AR11	2.46	21JZ6	2.10
8B10	1.80	21LR8	1.89
8BA11	2.25	21LJ8	1.86
8BM11	2.30	22JF6	2.66
8BQ11	1.98	22JR6	2.73
8BU11	2.30	22KM6	3.08
8CG7	1.12	22ZN6	1.91
8JH8	1.86	24JE6C	3.20
8L18	1.61	25CG3	1.38
9A08	2.31	29KQ6	3.53
9G8H	1.67	30AE3	1.57
9JW8	1.26	31JS6C	2.89
10CW5	1.02	31LQ6	3.05
10DX8	.98	31LZ6	3.38
10GK6	1.82	33GY7A	2.42
10GN8	1.92	35C5	1.31
10J18	2.06	35W4	.89
10JY8	1.50	35Z5GT	1.41
10KR8	2.04	36KD6	3.36
11AF9	2.13	38HE7	2.92
11AR11	2.46	38HK7	2.86
11BM8	1.86	40K6A	3.26
11F7	1.52	42EC4A	1.59
11KV8	2.20	42KN6	2.75
11MS8	1.53	50B5	1.21
12AB5	1.41	50C5	1.23
12AT6	1.13	50EH5	1.47
12AT7	1.37	50GY7A	3.60
12AU7A	1.23	50L6GT	1.95
12AV6	1.02	80	1.88
12AX7A	1.13	6267	2.10
12AZ7A	1.74	6973	1.85
12B4A	1.77	7025A	1.13
12BA6	1.16	7189A	1.73
12BE6	1.22	7199	2.06

TANK! JUST ONE OF THE 16 GAMES YOU CAN PLAY WITH OUR NEW INCREDIBLE HAND HELD ELECTRONIC GAME. SPECIAL INTRODUCTORY PRICE ONLY: \$8.95 SATISFACTION GUARANTEED INTERFAB, 27963 CABOT RD, LAGUNA NIGUEL, CA 92677

TELEPHONES AND PARTS. Free catalog. Write: Surplus Saving Center, P.O. Box 117, Waymart, PA 18472.

PROFESSIONAL UNSCRABLERS—use with any scanner / monitor. Free information. Capri Electronics, 8753T Windsor, St. Louis, MO 63114.

T.V. COMMERCIAL KILLER. New solid state device will turn off commercials that exceed preset level. Plans \$2.00. Ken's Electronics, Box 23810, Jacksonville, Florida 32217.

NAME BRAND Digital/Analog Test Equipment. Discount prices. Free catalog. Saien Electronics, Box 82, Skokie, Illinois 60076.

CANADA'S electronics bargain centre. Free Catalogue. North American and offshore inquiries welcomed. CANMOS, Box 1690, Peterborough, Canada K9J 7S4.

Tips on top CB/Ham operation

Channel 51 magazine includes tips, articles, and step-by-step guidelines to improve your CB/Ham operation. More meaty editorial per page than leading CB/Ham magazines! Learn to build, repair, and professionally operate your own unit. And more! For your Channel 51, send name, address, and \$1.50 now to:

Hufco Box 357, Dept. C51, Pocatello, Utah 84601 801/375-8566

SURPLUS TEST EQUIPMENT: USM105A 15MHz DT oscilloscope \$315, UPM110 spectrum analyzer \$315, TEK180A \$85, OS8 2MHz oscilloscope \$70, Fluke 803R \$125, HP302AR wave analyzer \$650. All postpaid guaranteed working. Free information. ACS, Box 8104, Athens, GA 30601. (404) 353-1634.

SURPLUS COMPONENTS. Communication and test equipment. Illustrated catalog 25 cents. E. French, P.O. Box 249, Aurora, Illinois 60505.

ALTAIR OWNERS Dress up your Altair 8800 with our front panel, color coded with two shades of blue, black lettering on white background, fully guaranteed. \$24.95 Catalog free. Cycloid, Cherry Drive, Souderton, PA 18964.

MICRO MINI MIKE™ WIRELESS MICROPHONE

World's smallest; solid state, self-contained. Picks up and transmits most sounds without wires up to 300 ft. through FM Radio. Use as mike, ampl., alarm & alert sys. hot line, baby sitter, etc. Money back guar. B/A, M/C cds, COD ok. \$18.95 plus \$1.00 post. & hdg. Calif. res. add tax. Mail orders only. Qty. Disc. Avail. AMC SALES, INC. Dept. M23, Box 928 - Downey, Calif. 90241

SIZE 2 1/4" x 3/4" x 1/2"

MICROPROCESSOR Kit including memory, clock, card reader, controls: \$99.00. Anderson, 2266 Kalmia, Boulder, Colorado 80302.

COMMUNICATIONS Publications and Frequency Lists. Military, Government, Police, Aviation, Maritime and more. Catalog 25 cents. Handler, Box CC, Northfield, Ill. 60093

Poly Pak's EXCLUSIVE Avg. Ship. \$1.98 Wt. 6 ozs.



Every kit carries a money back guarantee!

INCLUDES "100%" MATERIAL TOO!!!

YOUR CHOICE OF ANY KIT

100'S OF BARRELS PURCHASED!

For the first time anywhere, Poly Pak merchandisers introduce a new way in buying the economical way. Raw stock from the "barrel". Remember the "good ole days"? They're back again. The same way merchandisers

throughout the United States buy from various factories... their overruns in barrels. Poly Pak has done the same. Therefore you are getting the same type of material as the RE-TESTERS DO!

TEST 'EM YOURSELF 'N SAVE!

Buy 10 BARREL KITS AND CHOOSE THE 11TH Free

OP AMP SPECIALS

LM301N	5 for \$1.19	LM381N	3 for 4.00
LM301V	5 for 1.19	LM355N	3 for 1.19
LM302V	4 for 1.19	LM555N	3 for 1.50
LM308V	2 for 1.19	LM703N	4 for 1.19
LM309H	3 for 1.19	LM710N	2 for 1.19
LM322N	3 for 3.00	LM723N	2 for 1.19
LM339N	3 for 1.19	LM741H	2 for 1.19
LM370N	3 for 2.50	LM748V	5 for 1.19
LM373N	3 for 4.00	LM1800N	3 for 2.50
LM377N	3 for 4.00	LM2450H	3 for 2.50
LM380V	2 for 1.19	Code H=705 case, V=Mini Dip, N=DIP.	

BARREL KIT #205
MINI BLOCK CAPACITORS
100 for \$1.98

Unbelievable! Worth \$50. High precision submini caps for all applications. Wt. 3 ozs. Cat. No. 3E3528

BARREL KIT #203
CALCULATOR KEYBOARDS
10 for \$1.98

It's true! 20-key, 4 function keyboard at ridiculous give-away. Wt. 12 ozs. Cat. No. 3E3524

BARREL KIT #203
PLUGS, SOCKETS, RECEPTACLES
100 for \$1.98

Includes AC, DC, RF, audio, 4-9 pin, all kinds. Wt. 1 lb. Cat. No. 3E3527

BARREL KIT #201
6V INDICATORS
15 for \$1.98

Test lamp manufacturer dumps inventory! Worth \$6 ea. 1/2" grain-o-wheat. Cat. No. 3E3526

BARREL KIT #200
9 DIT READOUT MODULES
5 for \$1.98

Hard to find, but we got millions. Lo & Hi values. 10% tol. All marked. 100% 3E3534

BARREL KIT #195
400 PARTS
1.98

Includes resistors, caps, transformers, rectifiers, diodes, etc. for p.c. work. Preformed, dumped into barrel by factories. 100% Cat. No. 3E3401

BARREL KIT #188
400 PARTS
1.98

Includes resistors, caps, transformers, rectifiers, diodes, etc. for p.c. work. Preformed, dumped into barrel by factories. 100% Cat. No. 3E3401

BARREL KIT #186
MINI BOARD CHIPS
10 for \$1.98

Truthfully we can't test em, MM6740's, keyboard encoder chips. How good they are we don't know. Cat. No. 3E3414

BARREL KIT #184
1/4-WATT METAL FILM
150 for \$1.98

100% metal film resistors. Look leads. 3E3413

BARREL KIT #182
JUMBO RED LEDS
15 for \$1.98

100% material, user cancellation from factory dumps. 3V 10 mils. For 100's of projects, red lens. Cat. No. 3E3369

BARREL KIT #167
ROMS-RAMS-REGISTERS
1-lb. \$1.98

With approx count of 80 pcs. You get more. Mostly marked mostly National. Some 40 pins. 3E3044

BARREL KIT #166
LONG LEAD DISCS
4 ozs. \$1.98

No counting makes it so you get 150-pec. kit (approx). All marked. 100%. Cat. No. 3E3089

BARREL KIT #163
MINI TRIM POTS
30 for \$1.98

Asst. values 100 to 1 meg. What a buy. Single turn. 1/4 W. Wt. 6 oz. 3E3345

BARREL KIT #161
POP! PLASTIC TRANSISTORS
25 for \$1.98

2N3904's with some 2N3906's of 100% material. 70-92. Preformed. Cat. No. 3E3343 1 oz.

BARREL KIT #160
V. REGULATORS
15 for \$1.98

LM309AC TO-3 V.R.'s barrel dump by the pound. No. 3E3330

BARREL KIT #159
MODULAR SWITCHES
25 for \$1.98

Centralab switches. TV-makers etc. Brand new. Cat. No. 3E3315

BARREL KIT #158
MAGNIFIED MAN-3's
12 for \$1.98

7-sec readout, with built-in magnifier. Factory discount. Continued line. 100% material. Cat. No. 3E3325 1 oz.

BARREL KIT #157
MOLEX CONNECTORS
75 for \$1.98

Nylon, white cable connectors, with wire leads. 3, 4, 5, 6, 8, 10, 12, 15V. Undergrip. NO PICKLE! Mixed in barrels. Cat. No. 3E3324

BARREL KIT #154
CLOCK CHIPS
20 for \$1.98

We gathered an assortment of clock chips, alarm, calendar, beepers, who knows, all mixed. Cat. No. 3E3308

BARREL KIT #149
ROCKER SWITCHES
25 for \$1.98

Barrels 'n barrels, so many, our customer should get the deal. No. 3E3302.

BARREL KIT #145
MINI TRANSFORMER
15 for \$1.98

Miniature transformer back again. Asst. outputs, interstage and audio. Only 1/2 sq. Wt. 2 lbs. 3E3294

BARREL KIT #144
RCA PHONO PLUGS
40 for \$1.98

1,000,000 RCA phono plugs for this one. You hi-fi-ers know what they are. 100% material. 3E3293

BARREL KIT #143
75-PC TRANSISTORS
15 for \$1.98

100% material, TO-92, factory discontinued lines, pop's mixed with upns, 2N4100-1-2-3-4. 3E3290

BARREL KIT #138
PANEL SWITCHES
30 for \$1.98

Did you hear of OAK? Another great barrel! Includes all types of rotary, lever, trip, slides, etc. 3E3268

BARREL KIT #135
MICRO MINI LAMPS
20 for \$1.98

Imagine! Micro size 1/4 x 1/2. 5 VDC. 40 mils. Worth 60¢ ea. Cat. No. 3E3259

BARREL KIT #134
CALCULATOR CHIPS
15 for \$1.98

National type. Cat. No. MM5736, 38, etc. Untested. Cat. No. 3E3258

BARREL KIT #131
TANTALUM ELECTROS
30 for \$1.98

Mixed, marked prime, top grade. Asst. values, voltages. Cat. No. 3E3255

BARREL KIT #128
MINI DIP IC'S
75 for \$1.98

Large mfr dumped 100's of his into barrels. Includes 7414, LM-380-8, 703, 645, 555, 558—but who knows? Wt. 1 lb. 3E3245

BARREL KIT #127
AXIAL ELECTROS
40 for \$1.98

Asst. capacities and voltages. Cat. No. 3E3227

BARREL KIT #126
UPRIGHT ELECTROS
40 for \$1.98

1mf to 300mf in mixture of voltages. 100% marked 'n good. 3E3226

BARREL KIT #118
MINI SCRS
50 for \$1.98

UNBELIEVABLE! TO-92 plastic SCRS in barrels... from factory. Includes all voltages up thru 200 pvt. 3E3135

BARREL KIT #115
MOLEX SOCKETS
200 for \$1.98

Calculator maker dump! We got a million of 'em. Used for IC sockets, etc. Cat. No. 3E3144

BARREL KIT #112
MICRO MINI LEDS
40 for \$1.98

All the tiny leds, axial, upright of Monsanto, Litronic, variety of colors. Yield 50% or better. 3E3138

BARREL KIT #109
TERMINAL STRIPS
150 for \$1.98

Wide ass. of terminal strip connectors, from 1 contact up. Strip manufacturers barrel dump is your gain. Wt. 1 lb. Cat. No. 3E3136

BARREL KIT #104
SLIDE VOLUME CONTROLS
10 for \$1.98

Popular germanium TO-3 case 3E2618 100% good

BARREL KIT #101
RESISTOR SPECIAL
200 for \$1.98

Includes: 1/4, 1/2, 1, 2-watt, carbon, 8 oz. 100% good. 3E3054

BARREL KIT #99
PHOTO ELECTRIC CELLS
15 for \$1.98

Asst. GE types, CDS types, Mixed by factory. Big job for all to separate. 100% good. Cat. No. 3E3052

BARREL KIT #93
HALF WATTERS
200 for \$1.98

Resistor factory tried to fool us by mixing 100's color-coded resistors in barrel. But value is there. 4 oz. 3E3046 Untested

BARREL KIT #92
3 AMP EPOXY RECTIFIERS
100 for \$1.98

Cosmetic rejects, electrical fine business! You check 'em, it's not for us. Asst. voltages. 3E3204

BARREL #91
SILVER MICAS
100 for \$1.98

Axial, red case, variety of physical sizes & values. Cat. No. 3E3018

BARREL KIT #88
LITRONICS LED READOUTS
10 for \$1.98

17's, 22's, singles, triples, etc. 33 to 0.6. Bin from factory, all mixed. Base fun! No. 3E2861

BARREL KIT #87
NATIONAL IC BONANZA
100 for \$1.98

Types 8000, 7400 series, TTLs, ROMs, registers, clock & calc chips, linear, etc. Cat. No. 3E2860 Untested.

BARREL KIT #86
HOBBY LEDS
40 for \$1.98

747's, 727's, singles, triples, etc. 33 to 0.6. Bin from factory, all mixed; have fun! 3E2855

BARREL KIT #83
15 for \$1.98

Factory rejected them for length of leads. May include 5, 6, 8, 12, 15, 18, 24 volt Power Tab. Cat. No. 3E2855

BARREL KIT #81
SILICON RESISTORS
200 for \$1.98

PC, upright type, color coded, 1/4 watt. Asst values. Came to us in a barrel. Cat. No. 3E2746 100% good

BARREL KIT #78
1-WATT ZENERS
100 for \$1.98

Factory same as 400-mw's. Never-to-see-again offer. 6, 8, 10, 12, 15V. Under glass. Double plug. Cat. No. 3E2741 Untested.

BARREL KIT #75
400 MW ZENERS
100 for \$1.98

Factory out of bin! Amazing offer. 6, 8, 10, 12, 15V. Under glass. Double plug. You test. Hermetically sealed glass pak. Double plug. Cat. No. 3E2740

BARREL KIT #73
TRI-MINISTOR ELECTROS
50 for \$1.98

We don't wish to separate wide ass voltages & values up to 300 mf. Cat. 3E2747

BARREL KIT #71
CAPACITOR SPECIAL
100 pcs. \$1.98

micas, mofeds, plastics, ceramics, discs, etc. Nifty 100% good. Cat. No. 3E2738

BARREL KIT #68
2 WATTERS
100 for \$1.98

100% good. Suppliers throw 'em in the barrel. It's a 1/2 good mine! All marked. Cat. No. 3E2735

BARREL KIT #65
MIXED READOUTS
10 for \$1.98

Factory returns—such numbers as MAN-1's, MAN-3's, MAN-3's, 11 barrels & no time to separate. Cat. No. 3E2733 Untested.

BARREL KIT #61
POLYSTYRENE CAPS
100 for \$1.98

Finest caps made. As a gamble we bought 10 barrels from factory, mixed values; all good. Cat. No. 3E2729

BARREL KIT #58
SLIDE SWITCHES
30 for \$1.98

All shapes, sizes, apst, opnt, momentaries, etc. Freshen-up inventory for 100's of switching projects. Cat. No. 3E2726 100% good

BARREL KIT #56
POWERS! POWERS!
100 for \$1.98

Large distributor cleaned house. Barrels of power resistors. 1/2 to 2 watts. Cat. No. 3E2724

BARREL KIT #54
8 DIGIT READOUTS
10 for \$1.98

Bargain of a lifetime! All we got was 1 barrel—the barrel digit! Types, Multi-plexed. Cat. No. 3E2722

BARREL KIT #40
PNP HIGH-POWER TRANSISTORS
20 for \$1.98

Popular germanium TO-3 case 3E2618 100% good

BARREL KIT #39
2N3055 HOBBY TRANSISTORS
15 for \$1.98

Fallouts of the famous 2N3055. 3E2617 100%

BARREL KIT #37
1 AMP "BULLET" RECTIFIERS
100 for \$1.98

Famous style, axial, voltage, silicon, axial includes all types of voltages to JKV. Cat. No. 3E2615

BARREL KIT #36
GERMANIUM DIODES
200 for \$1.98

Famous mfr's, popular item. Never grows old. But this is the way the RE-TESTERS buy 'em from the factories. Cat. No. 3E2614

BARREL KIT #35
NEON LAMPS
30 for \$1.98

Famous N.E.'s. All prime, but factory made millions and barrels. Your ad of vantage. Cat. No. 3E2613

BARREL KIT #31
METALLIC RESISTORS
100 for \$1.98

Made mostly by Corning, the finest resistor made. Mostly 1/2 watters. 1% to 5% tol. & a barrel of values. Cat. No. 3E2608

BARREL KIT #30
PREFORMED RESISTORS
200 for \$1.98

We got barrels of 1/4 and 1/2 watters for a good 100, 100, 200, 100, 1/4, 100 - watters. 100% 3E2608 100% good

BARREL KIT #27
PREFORMED DISCS
100 for \$1.98

H-I-F mfr's shelf inventory but he dumped 'em in barrels. Preformed for PC use. Mixed values too! 3E2605

BARREL KIT #26
PLASTIC TRANSISTORS
100 for \$1.98

Type TO-92 (TO-18), all manufacturers, variety of 2N's. Cat. No. 3E2604

BARREL KIT #25
METAL CAN TRANSISTORS
100 for \$1.98

Includes TO-5, TO-1, TO-18, etc., assorted 2N numbers, unmarked etc. Cat. No. 3E2603 Untested.

Wow! INCREDIBLE PRICES

Poly Paks C-R-A-C-K-S

BUY ANY 10 TAKE 15%

BUY 100 TAKE 25%

TYPE SALE					
SN7400N \$0.16		SN7442N .53	SN7494N .78	SN74160N .88	
SN7401N .16		SN7445N .69	SN7495N .72	SN74161N .88	
SN7402N .16		SN7446N .79	SN7496N .88	SN74162N .88	
SN7403N .16		SN7447N .69	SN74106N .65	SN74173N 1.39	
SN7404N .16		SN7448N .76	SN74107N .63	SN74174N .89	
SN7405N .16		SN7449N .16	SN74113N .35	SN74175N .69	
SN7406N .20		SN7451N .16	SN74114N .65	SN74177N .79	
SN7407N .25		SN7452N .16	SN74121N .38	SN74181N 2.05	
SN7408N .25		SN7453N .34	SN74122N .59	SN74184N 1.75	
SN7409N .18		SN7470N .34	SN74125N .59	SN74185N 1.75	
SN7410N .16		SN7471N .36	SN74126N .59	SN74189N 1.15	
SN7411N .25		SN7472N .36	SN74132N 1.28	SN74191N 1.99	
SN7413N .45		SN7474N .31	SN74132N 1.28	SN74192N .87	
SN7417N .32		SN7475N .49	SN74145N .69	SN74193N .83	
SN7420N .16		SN7476N .79	SN74146N .79	SN74195N .73	
SN7421N .29		SN7478N .79	SN74148N 1.29	SN74198N 1.49	
SN7423N .35		SN7483N .69	SN74150N .99	SN74199N 1.49	
SN7425N .27		SN7485N .95	SN74153N .65	SN74200N 1.99	
SN7430N .16		SN7489N .44	SN74154N 1.03	SN74225N 1.09	
SN7437N .26		SN7490N .73	SN74157N .70	SN74284N 5.95	
SN7438N .26		SN7491N .47	SN74158N .85	SN74285N 5.95	
SN7440N .16					
SN7441N .84					

Cat. No. 3E1981

BARREL KIT #12
POWER TAB TRANS
40 for \$1.98

PNP, plastic TO220 type. Assorted 2N numbers. Cat. No. 3E2426 Untested.

BARREL KIT #11
POWER TAB TRANSISTORS
40 for \$1.98

PNP, plastic TO220 type. Assorted 2N numbers. Cat. No. 3E2425 Untested.

BARREL KIT #10
DIPPED MYLARS
60 for \$1.98

Finest capacitors made, shiny finish. Making factory numbers of raw factory stock. No. 3E3433

BARREL KIT #7
VOLUME CONTROL BONANZA!
30 for \$1.98

Amazing, includes 100's of spec. antenna who knows? From transistor radio manufacturers. 100% 3E2422

BARREL KIT #4
"4000" RECTIFIERS
100 for \$1.98

1N1900 series. May include 2N 4191N, 400, 600, 800 and 1000 volters. 3E2417

BARREL KIT #3
1N4148/914 SWITCHING DIODES
100 for \$1.98

Imagine famous switching diodes at these prices! 400, 600, 800 and 1000 volters. 3E2418

BARREL KIT #2
LINEAR OR AMPS. DIPS/75 for \$1.98

May include 709's, 741's, 703's, 560 series, 555 includes. 3E2416

BARREL KIT #1
75 7400 DIP IC'S.
75 for \$1.98

Marked 14 and/or with 16 pin dips, may include gates, registers, flip flops, counters. 3E2415 Untest.

ARIES brought you the first calculator kit, and the first digital clock kit... and now brings you three of the most innovative electronic kits ever made. The System 300 Electronic Music Synthesizer kit is the most advanced in the world today, regardless of price. The AR-781 is a space-age beauty for any decor. And the wholly solid state AR-830 does the work of a \$400.00 tape memory unit.



WARNING... if you're interested in a music synthesizer, don't make a move until you see our catalog first. It's more like a handbook than a catalog, with hundreds of in-depth photographs and descriptions to explain electronic music principles, and to show equipment to do the job. **ARIES** now offers a complete complement of modules, keyboards, and cases, matched to the most rigorous professional standards. Starter systems priced as low as \$395.00.

A clear, ruby-red cylinder shows off all six digits of this modern calendar clock. Easy-to-read numbers show the hours, minutes, and seconds, as well as the month and day every ten seconds. Red LED 7-segment numerals are 0.33" high, in a sturdy cylinder 2-1/2" in diameter and 4-3/4" long, with finished hardwood ends. Time and calendar are controlled by 60 Hz line frequency, with a 12-month movement. Separate time and calendar adjustments. Includes all the components, PC boards, housing, and instructions. Shipping weight 2 lbs, **AR-781 Clock Kit** \$34.50



Add finger-touch operation to your old-fashioned dial telephone with an **ARIES AR-830 Automatic Digital Telephone Dialer**. This has the same layout and convenience as Ma Bell, plus other features she doesn't offer yet. For instance... AR-830 always remembers the last number you dialed, in case the line was busy and you want to try again later. Not only that, but the Dialer's memory can store as many as ten of your favorite numbers for one-touch dialing. AR-830 uses standard dialing and muting contacts; consult local tariffs before connecting. Sh. wt. 2 lbs. **AR-830 Dialer Kit** \$69.50



ARIES INC.
BOX 808
Peabody, Mass., 01960
(617) 744-2400

CIRCLE NO 8 ON FREE INFORMATION CARD

Mystery Electronic Top Spins For Days!
Spins for days at 2,500 rpm on invisible power. Best new gadget in years. Baffling brain-buster. Bugs the brightest. Perpetual Motion? UFO? Psychic Power? Anti-gravity? Scientific Break Thru From Space? Magic. Mystery. Science combined. Spins without energy loss! Never wears out. Fun at parties, science classes, etc. Complete with secret, scientific explanation. Send \$6.95 each + \$1.00 shipping Johnson Smith Co. Dept. 000, Mt. Clemens, Mich 48043



MARCH GOODIES: 555 - 39 cents, 741 - 29 cents, 747 - 49 cents, Fairchild jumbo LED's red 12/\$1, green 8/\$1, 2x2cm solar cells \$1.50. Free catalog. Our third year. **DIAMONDBACK**, Box 194P, Spring Valley, IL 61362.

ALTAIR 8800: BASIC, 12K, video display, tape interface, keyboard w/enclosure, more. Complete description \$1.00. John Beggs, Box 105, Pasco, WA 99301.

SPECIAL THIS MONTH: IC Sockets, staggered pins, 16 Pin DIP. 10/\$2.00 postpaid. Write for free surplus electronics flyer. R. W. Electronics, 3203 North Western Avenue, Chicago, Illinois 60618.

S-K TOOLS - Wholesale Prices!!! Wrenches, Sockets. Lifetime Guarantee! 48 Page Catalog - 50 cents. Pioneer, Stanwood, Michigan 49346.

C1702A \$7.50; MM5330 \$7.95; 2513 \$9.50; CT7001 \$6.75; XR2240 \$4.20; LM3909 \$0.99; COM2502 \$6.95. Free Catalog. **ELECTRONIC DISCOUNT SALES**, 138 N. 81st Street, Mesa, Arizona 85207.

VOICE SCRAMBLER DECODERS. TR Electronics Model-104C is the finest high quality decoder on the market. Adapts to any monitor, 2-1/2 watts output, 3 integrated circuits, filtering to remove scratchy sound and annoying tone, only 3" X 2" X 4". 1 Year parts & labor warranty! Guaranteed satisfaction. \$45.47. Dealer inquiries welcome. TR Electronics, P.O. Box 527, Mason City, IA 50401. (515) 423-7473.

TELEPHONES UNLIMITED, Equipment, Supplies, All types, Regular, Keyed, Modular. Catalog 50 cents. Box 1147E, San Diego, California 92112.

SIRENS, Flashers, Games, Logic breadboard Kits. Catalog free. Ego, Box 1331-pe, Thousand Oaks, California 91360.

HAMS put your microcomputer on Fastscan ATV for under \$79. Info and catalog for S.A.S.E. W609R, 2522 Paxson, Arcadia, CA 91006.

HIGH CHANNEL crystals available for all synthesizers C.B. sets. Free Catalog. FBC, 2928 14th St., N.W., New Brighton, MN 55112.

CIRCUIT BOARD tungsten carbide drills, good used condition. 12 assorted for \$3.95 ppd. L.R. Design, 515 Birch St., McMinnville, OR 97128.

PANEL FACES made to your specs. Let your project have prize winning professional look. Brochure. PATCO, Box 167, Chalmette, LA 70044.

AM TRANSMITTERS. No license. \$51.95. Hoskins, Box 709, Montclair, N.J. 07042.

T.V. GAMES and other products. Kits, P.C. boards or assembled. Free Catalogue. Galaxy Kits, 108 North Union Ave., Cranford, N.J. 07016.

HYPNOTISM

SLEEP learning. Hypnotic method. 92% effective. Details free. ASR Foundation, Box 23429EG, Fort Lauderdale, Florida 33307.

FREE Hypnotism. Self-Hypnosis. Sleep Learning Catalog! Drawer H400, Ruidoso, New Mexico 88345.

AMAZING self-hypnosis record releases fantastic mental power. Instant results! Free trial. Write: Forum (AA3), 333 North Michigan, Chicago 60601.

TELEPHONE FORMAT KEYBOARD
BY Chometrics
\$4.95 2 1/4" x 3 1/2" thick
6/28 # EF-21360

TRANSISTORS

2N2222 A	TO 18	5 \$1.00
2N2554	TO 18	2 \$1.00
2N2712	TO 98	5 \$1.00
2N3415	TO 98	5 \$1.00
2N3704	TO 92	5 \$1.00
2N4400	TO 92	5 \$1.00
2N4125	TO 92	5 \$1.00
2N4249	TO 92	5 \$1.00
2N4437	TO 92	5 \$1.00
2N6027	PUT	2 \$1.00
2N5457	N J Fer	2 \$1.00

DIODES

IN 4092	1A, 100 PIV	12 \$1.00
IN 4005	1A, 600 PIV	11 \$1.00
IN 4007	1A, 1000 PIV	10 \$1.00
RECTIFIER	2.5A, 1000 PIV	4 \$1.00
IN 914	SIL SIGNAL	20 \$1.00
IN 4148	SIL SIGNAL	20 \$1.00
DYAC	28V	4 \$1.00

LINEAR

555	TIMER	2 \$1.00
556	DUAL TIMER	95
565	PLL	95
566	FUNCTION GEN	1.75
567	TONE DECODER	1.75

MOBILE LED CLOCK
12 OR 24-HOUR OPERATION
12 VOLT AC OR DC POWERED FOR FIXED OR MOBILE OPERATION.
SIX LARGE 4" DIGITS!
Approx. Size: 1 3/4" H x 4" W x 4 1/2" D

MODEL #2001

• 6 JUMBO .4" RED LED'S BEHIND RED FILTER LENS WITH CHROME RIM
• SET TIME FROM FRONT VIA HIDDEN SWITCHES • 12/24-Hr. TIME FORMAT
• STYLISH CHARCOAL GRAY CASE OF MOLDED HIGH TEMP. PLASTIC
• BRIDGE POWER INPUT CIRCUITRY - TWO WIRE NO POLARITY HOOK-UP
• OPTIONAL CONNECTION TO BLANK DISPLAY (Use When Key Off in Car, Etc.)
• TOP QUALITY PC BOARDS & COMPONENTS - EXCELLENT INSTRUCTIONS
• MOUNTING BRACKET INCLUDED

KIT # 2001 COMPLETE KIT (Less 9V Battery) **29⁹⁵ EA** 3 OR MORE **\$27⁹⁵ EA** 115 VAC Power Pack #AC-1 **\$25⁰⁰ EA**

ASSEMBLED UNITS WIRED & TESTED ORDER # 2001 WT (LESS 9V BATTERY) **\$39⁹⁵ EA** 3 OR MORE **\$37⁹⁵ EA** Assembled Units May Be Mixed With Kits for Qty. Price

JUMBO DIGIT CLOCK KIT
A complete Kit (less Cabinet) featuring six 5" digits, MM5314 IC 12/24 Hr. time, 50/60 HZ., Plug-Transformer, Line Cord, Switches, and all Parts. (Ideal Fit in Cabinet II) Kit # 5314-S WITH PC Boards **\$19⁹⁵ ea** **2/38.**

JUMBO DIGIT CONVERSION KIT \$9.95 ea.
Convert small digit LED clock to large 5" displays. Kit includes 6 .5" LED's, Multiplex PC Board & easy hook up info.
Kit # JD 1CC For common Cathode Kit # JD-1CA for common Anode

DISCRETE LED'S
CLEAR/RED
CLEAR/GREEN
CLEAR/BLUE
CLEAR/WHITE

DIGITAL CLOCK IC'S
74121
74122
74123
74124

PC FROM POTS
74121
74122
74123
74124

PLEXIGLAS CABINETS
Great for Clocks or any LED Digital project. Clear-Red Chassis serves as Bezel to increase contrast of digital displays.
CABINET I 3"H, 6"W, 5 1/2"D
CABINET II 2 1/2"H, 5"W, 4"D
ANY SIZE/COLOR **\$6.50 ea.** **2/12.**
RED OR GREY PLEXIGLAS FOR DIGITAL BEZELS
3"x6"x1/8" **95¢ ea.** **4/3**

7-SEG LED
COMMON CATHODE
COLOR: 1 DEC 1 PR EA
FND 359 RED 4' RHDP \$1.95
FND 503 RED 5' RHDP \$1.95
DL 750 RED 6' LHDP \$2.95
XAN 654 GREEN 6' NDP \$1.95
XAN 664 RED 6' NDP \$1.95

COMMON ANODE
DL 747 RED 6' LHDP \$1.95
XAN 72 RED 3' LHDP \$1.25
MAN 72 RED 3' LHDP \$1.25
XAN 81 YELLOW 3' RHDP \$1.75
XAN 351 GREEN 3' RHDP \$1.95
XAN 361 RED 3' RHDP \$1.50
XAN 362 RED 3' LHDP \$1.50
XAN 662 RED 6' NDP \$1.95
XAN 692 RED 6' NDP \$1.95

60 HZ. XTAL TIME BASE
Will enable Digital Clock Kits or Clock-Calendar Kits to operate from 12V DC.
1"x2" PC Board
Power Req. 5-15V (2.5 MA. TYP.)
Easy 3 wire hookup
Accuracy ± 2PPM
#TB-1 (Adjustable)
Complete Kit **\$4.95 ea.**
Wir & Cal **\$9.95**

SEE THE WORKS Clock Kit
Clear Plexiglas Stand
Kit #850-4CP
• 6Big. 4" digits
• 12 or 24 hr. time
• 3 set switches (back)
• Plug transformer
• all parts included
Plexiglas is Pre-cut & drilled
Size 6"H, 4 1/4"W, 3"D
\$23⁵⁰ ea. **2/45.**

Fairchild Super Digit FND-359
4" Char. Ht. 7 segment LED RED Com. Cath. Direct pin replacement for popular FND-70.
95¢ ea. **10/\$8.50**
100/\$79.00

NYLON WIRE TIES
8" TIE WRAP 100 \$1.95
4" TIE WRAP 100 \$1.75

VOLTAGE REGULATORS
LM 309 H TO 5 \$ 95
LM 309 K TO 3 1 25
7805 TAB 95
7812 TAB 1 25
7812 TO 3 1 50

25 AMP BRIDGE \$1.95 ea.
3/\$5.00
100 PIV

IC SOCKETS
PINS 1 24 25 100
8 5 25 5 22 8 20
14 25 22 20
16 28 25 23
18 31 28 26
24 50 45 40
28 80 55 50
40 75 70 65

XTAL
3.759545 MHZ. \$1.95

MEMORY
4096 bits
Fairchild
1K bits
low level
low power
2102L ILC \$1.95 ea
100 150 \$1.75 ea
200 more \$1.45 ea

8080A \$19.95 ea.

ORDER BY PHONE OR MAIL Orders Under \$15 Add \$1.00 Handling
COD ORDERS WELCOME Fla. Res. Please Add 4% Sales Tax.

OPTOELECTRONICS, INC.

BOX 219 • HOLLYWOOD, FLA. 33022 • (305) 921-2056

WE PAY ALL SHIPPING IN CONTINENTAL USA - OTHERS ADD 5% (10% FOR AIRMAIL)

CIRCLE NO. 45 ON FREE INFORMATION CARD

www.americanradiohistory.com

S.D. SALES CO.

P.O. BOX 28810 - D
DALLAS, TEXAS 75228

Z-80 CPU CARD KIT
FOR IMSAI/ALTAIR

\$149.^{KIT}

From the same people who brought you the \$89.95 4K RAM kit. We were not the first to introduce an IMSAI/ALTAIR compatible Z-80 card, but we do feel that ours has the best design and quality at the lowest price.

The advanced features of the Z-80 such as an expanded set of 158 instructions, 8080A software compatibility, and operation from a single 5VDC supply, are all well known. What makes our card different is the extra care we took in the hardware design. The CPU card will always stop on an M1 state. We also generate TRUE SYNC on card, to insure that the rest of your system functions properly. Dynamic memory refresh and NMI are brought out for your use. Believe it or not, not all of our competitors have gone to the extra trouble of doing this.

As always, this kit includes all parts, all sockets, and complete instructions for ease of assembly. Because of our past experience with our 4K kit we suggest that you order early. All orders will be shipped on a strict first come basis. Dealers inquiries welcome on this item.

Kit shipped with 2 MHZ crystals for existing 500NS memory. Easily modified for faster RAM chips when the prices come down.
Z-80 Manual - \$7.50 Separately.

Kit includes Zilog Manual and all parts.

JUMBO
LED
CAR
CLOCK

\$16.95
KIT

You requested it! Our first DC operated clock kit. Professionally engineered from scratch to be a DC operated clock. Not a makeshift kluge as sold by others. Features: Bowmar 4 digit .5 inch LED array, Mostek 50252 super clock chip, on board precision time base, 12 or 24 hour real time format, perfect for cars, boats, vans, etc. Kit contains PC Board and all other parts needed (except case). 50,000 satisfied clock kit customers cannot be wrong!

FOR ALARM OPTION ADD \$1.50
FOR XFMR FOR AC OPERATION ADD \$1.50

60 HZ CRYSTAL TIME BASE FOR DIGITAL CLOCKS
S.D. SALES EXCLUSIVE!

KIT FEATURES:

- A. 60HZ output with accuracy comparable to a digital watch.
- B. Directly interfaces with all MOS Clock Chips. **\$5.95 or**
- C. Super low power consumption. (1.5 ma typ.) **2/\$10.**
- D. Uses latest MOS 17 stage divider IC.
- E. Eliminates forever the problem of AC line glitches.
- F. Perfect for cars, boats, campers, or even for portable clocks at ham field days.
- G. Small size, can be used in existing enclosures.

KIT INCLUDES CRYSTAL, DIVIDER IC, PC BOARD
PLUS ALL OTHER NECESSARY PARTS & SPECS

50HZ CRYSTAL TIME BASE KIT - \$6.95

All the features of our 60HZ kit but has 50HZ output. For use with clock chips like the 50252 that require 50HZ to give 24 hour time format.

THIS MONTH'S SPECIALS!

- 300.00 KHZ CRYSTAL - \$1.50
- 8080A - CPU CHIP by AMD - \$19.95
- 82S129 - 256 x 4 PROM - \$2.50
- N.S. 8865 OCTAL DARLINGTON DRIVERS
3 for \$1.00
- Z-80 - CPU by ZILOG - \$69.95
- MM5204 - 4K EPROM - \$7.95

Prices in effect this month ONLY!

SPECIAL

SPECIAL

4K LOW POWER RAM BOARD KIT
THE WHOLE WORKS - \$89.95

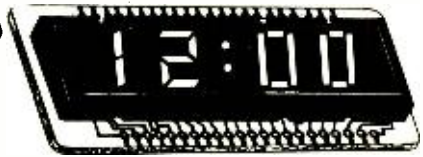
Imsai and Altair 8080 plug in compatible. Uses low power static 21L02-1 500ns. RAM's, which are included. Fully buffered, drastically reduced power consumption, on board regulated, all sockets and parts included. Premium quality plated thru PC Board.

7400-19c	7411-29c	7451-19c	7490-65c	74153-75c
74LS00-49c	7413-50c	7453-19c	74LS90-95c	74154-1.00
7402-19c	7416-69c	7473-39c	7492-75c	74157-75c
74LS02-49c	7420-19c	7474-35c	7493-69c	74161-95c
7404-19c	7430-19c	74LS74-59c	7495-75c	74164-1.10
74L04-29c	7432-34c	7475-69c	7496-89c	74165-1.10
74S04-44c	7437-39c	7476-35c	74121-38c	74174-95c
74LS04-49c	7438-39c	7480-49c	74123-65c	74181-2.50
7406-29c	7440-19c	7483-95c	74132-1.70	74191-1.25
7408-19c	7447-85c	7485-95c	74S138-1.95	74192-1.25
7410-19c	7448-85c	7486-45c	74141-75c	74193-1.00
TTL INTEGRATED CIRCUITS				

STICK IT!
in your clock
in your DVM, etc.!

Huge Special Purchase
Not Factory Seconds
As sold by others!

\$3.95



4 JUMBO 50''
DIGITS ON
ONE STICK!

(with colons and
AM/PM Indicator)

BUY 3 for \$10.

BOWMAR 4 DIGIT LED READOUT ARRAY

The Bowmar Opto-Stick. The best readout bargain we have ever offered. Has four common cathode jumbo digits with all segments and cathodes brought out. Increased versatility since any of the digits may be used independently to fit your applications. Perfect for any clock chip, especially direct drive units like 50380 or 7010. Also use in freq. counters, DVM's, etc. For 12 or 24 hour format.

UP YOUR COMPUTER!
21L02-1 1K LOW POWER 500 NS STATIC RAM
TIME IS OF THE ESSENCE!

And so is power. Not only are our RAM'S faster than a speeding bullet but they are now very low power. We are pleased to offer prime new 21L02-1 low power and super fast RAM's. Allows you to STRETCH your power supply farther and at the same time keep the wait light off. **8 for \$12.95**

\$12.95 S.D. SALES EXCLUSIVE! **\$12.95**
MOS 6 DIGIT UP-DOWN COUNTER

40 PIN DIP. Everything you ever wanted in a counter chip. Features: Direct LED segment drive, single power supply (12 VDC TYP.), six decades up/down, pre-loadable counter, separate pre-loadable compare register with compare output, BCD AND seven segment outputs, internal scan oscillator, CMOS compatible, leading zero blanking. 1MHZ. count input frequency. Very limited qty. WITH DATA SHEET

WESTERN DIGITAL UART

No. TR1602B. 40 pin DIP
This is a very powerful and popular part.

NEW-\$6.95 with data
LIMITED QUANTITY

RESISTOR

ASSORTMENT
¼ W 5% and 10%
PC leads. A good mix
of values. 200/\$2.

1702A 2K ERASEABLE
PROM'S - \$6.95

We tell it like it is. We could have said these were factory new, but here is the straight scoop. We bought a load of new computer gear that contained a quantity of 1702 A's in sockets. We carefully removed the parts, verified their quality, and are offering them on one heck of a deal. First come, first served. Satisfaction guaranteed! U.V. Eraseable. **\$6.95 each** **4 for \$25**

TERMS:
Money Back Guarantee. No COD. Texas Residents add 5% tax. Add 5% of order for postage and handling. Orders under \$10. add 75c. Foreign orders: US Funds ONLY!

SLIDE SWITCH
ASSORTMENT

Our best seller. Includes miniature and standard sizes, single and multi-position units. All new, first quality, name brand. Try one package and you'll reorder more. **SPECIAL 12/\$1.**

MOTOROLA POWER
DARLINGTON
Back in Stock!

Like MJ3001. NPN 80V. 10A. HFE 6000 TYP. TO-3 case. We include a free 723C volt reg. with schematic for power supply. **SPECIAL-\$1.99**

CALL YOUR BANK
AMERICARD OR MASTER
CHARGE ORDER IN ON
OUR CONTINENTAL
UNITED STATES TOLL
FREE WATTS:

1-800-527-3460
Texas Residents Call Collect
214/271-0022

S.D. SALES CO.
P.O. BOX 28810 D
Dallas, Texas 75228

For orders over \$15.00 Choose \$1.00 FREE mdse.

PLANS AND KITS

FREE KIT Catalog contains Test and Experimenter's Equipment. Dage Scientific Instruments, Box 1054P, Livermore, CA 94550.

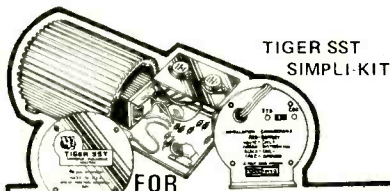
AMAZING ELECTRONIC PRODUCTS

LASERS SUPER POWERED RIFLE, PISTOL, POCKET SEE IN DARK, PYRO TECHNICAL, DE BUGGING, UNCRAMBLERS, GIANT TESLA, STUNWAND, TV DISRUPTER, ENERGY PRODUCING, SCIENTIFIC DETECTION, ELECTRIFYING, CHEMICAL, ULTRASONIC, CB, AERO, AUTO AND MED DEVICES, HUNDREDS MORE. ALL NEW PLUS INFO UNLTD PARTS SERVICE

INFORMATION unlimited

CATALOG 31 Box 626 Lord Jeffrey Pz., Amherst, N. H. 03031

THE "KING OF KITS". Artisan Organ Kits feature all new modular construction, with logic-controlled stops and RAM Preset Memory System. Write for brochure to: A O K Manufacturing, Inc., P.O. Box 445, Kenmore, WA 98028.



TIGER SST SIMPLI-KIT

FOR THE DO-IT-YOURSEFLER NOW! a high quality CD Electronic Ignition System in kit form.

Contains all components and solder to build complete Solid State Electronic CD Ignition System for your car. Assembly requires less than 3 hours.

- Increases MPG 15%
- Increases horsepower 15%
- Plugs and Points last 50,000 miles
- Eliminates 4 of 5 tune-ups
- Instant starting, any weather
- Dual system switch

Fits only 12 volt neg. ground. Only \$21.95 postpaid

Tiger Star Corporation
P.O. Box 1727 Grand Junction, Colorado 81501

VOICE ACTIVATED SWITCH

Activates devices such as lights, tape recorders etc. Comes with 5 leads 3 x 1. Operates on 4.5 VDC Shpg wt. 1/2 lb.

Reg. 1.98 **99c**

XM-556

VC-274

Volume Controls

- 12 Piece Kit
- Less Than 5c Each
- 12 Popular Values
- Various dia. & lengths
- Some Have Switches

Reg. \$1 **49c**

Red LED's

- Large Dome Type
- 10mA +2 Volt

Emits red light. Long life, hi-quality. Shpg wt. 1/4 lb.

5 PAK

PL-233 Reg. 1.19 **59c**

TA-879 Limit 3 Pkgs with this ad

60-Minute Blank Cassettes

180 minutes of recording time for less than 1c per minute. Stock up now! Shpg wt. 1/2 lb.

Each in lots of 3

Reg. 3/1.49 **29c**

HARDWARE AND COMPONENTS

1/4 RPM Timing Motor 115V AC	MO-277	Reg. 89	39
1 RPM Timing Motor 115V AC	MO-289	Reg. 89	39
3-6V DC Hobby Motors Kit of 5	MO-336	Reg. 2.00	1.39
2-Speed Motor 115V AC	MO-361	Reg. 4.98	2.49
3600 RPM Motor 115V AC	MO-361	Reg. 3.00	99
4000 RPM Appliance Motor 115V AC	MO-395	Reg. 2.98	99
6V Panel Lamp 1-Red 1-Green	PL-065	Reg. 1.79	79
6V 30 ma Lamp W/Leads Pkg. 2	PL-270	Reg. 89	59
6V Mini Screw Base Bulb, Pkg. 2	PL-271	Reg. 69	59
12V Mini Screw Base Bulb, Pkg. 2	PL-272	Reg. 89	69
12V Bipin Mini Bulbs, Pkg. 2	PL-273	Reg. 1.19	59
TV Cheater Cord, Pkg. of 2	WW-051	Reg. 1.29	59
Terminal Strips, Pkg. 40 Ass'd.	XM-501	Reg. 1.30	50
25B474 Output Transistor	TR-174	Reg. 3.79	1.19
Fairchild 703 Type IC	TR-293	Reg. 99	39
Fairchild 717 Type IC	TR-294	Reg. 99	39
IC Grab Bag, 10 Ass'd Types	TR-422	Reg. 1.19	50
Calculator Chp. Nortec 4202	TR-224	Reg. 6.00	2.99
SCR Grab Bag, 25 Ass'd Types	TR-446	Reg. 2.59	90
Cadmium Photo Cells, Pkg. of 2	TR-512	Reg. 80	49
Motorola Amplifier IC, 8 Pin O.P.	TR-513	Reg. 1.29	59
Aluminum Heat Sink 1 3/4 x 1/2 x 1/2	XM-027	Reg. 49	29
12 Digit Calculator IC	XM-330	Reg. 6.00	1.49
20 Key Calculator Keyboard	XM-339	Reg. 6.00	1.29
3 7 Seg. L.E.O. Green, Comm. A	XM-341	Reg. 2.69	1.39
3 7 Seg. L.E.O. Yellow, Comm. A	XM-342	Reg. 2.49	1.39
3 7 Seg. L.E.O. Red, Comm. A	XM-370	Reg. 2.00	1.19
Sperry 9 Digit Display	XM-399	Reg. 1.49	79
3 7 Seg. L.E.O. Red, Comm. K	XM-414	Reg. 2.00	99
TI Calculator Keyboard, 20 Key	XM-523	Reg. 5.00	1.00
16 Key Switch Pad, Less Keys	XM-524	Reg. 1.29	59
23 Key Switch Pad, Less Keys	XM-525	Reg. 1.49	69
Calculator Keys, Pkg. of 20 Ass'd.	XM-538	Reg. 1.50	49
455 KHz IF Transformer, Pair	SW-154	Reg. 1.59	1.00
Toggle Switch Kit, Pkg. 3 Ass'd.	SW-406	Reg. 1.79	99
Mini Toggle Switch O.P.O.T. 3A	SW-409	Reg. 1.29	69
See-Saw Rocker Switch O.P.O.T. 3A	SW-423	Reg. 1.89	1.09
Center-Off Mini Toggle S.P.O.T. 3A	SW-460	Reg. 29	19
Three Level Push Switch, 8A	SW-586	Reg. 1.69	49
Mercury Switch, S.P.O.T. 5A	SW-641	Reg. 2.00	69
117 V AC Relay, Mini, S.P.O.T. 2A	SW-773	Reg. 59	49
Mini Rocker Switch S.P.S.T. 1A	SW-814	Reg. 1.59	69
Leaf Switch, S.P.O.T. 5A Pkg. 2	SW-838	Reg. 90	40
Heavy Duty Toggle, 3 P.O.T. 10A	SW-840	Reg. 2.00	69
117 V AC Solenoid, 1" Travel	SW-846	Reg. 1.20	59
Slide Switch, D.P.3 T. Pkg. of 2	SW-850	Reg. 1.29	79
6 & 12V Trans., 117V PRI. 5A SEC.	TF-048	Reg. 3.00	90
12 & 10V Trans., 117V PRI. 2A SEC.	TF-050	Reg. 1.79	60
6.3V Trans., 117V PRI. 1A Sec	TF-076	Reg. 2.00	1.29

INTERNATIONAL ELECTRONICS UNLIMITED

10% OFF WITH \$25 ORDER
15% OFF WITH \$100 ORDER
THESE DISCOUNTS APPLY TO TOTAL OF ORDER - SPECIALS INCLUDED

1702A	2048 bit static PROM elect. prog. - UV eras. 24 pin	\$6.95
2102	1024 BIT STATIC RAM DTL/TTL comp. 16 pin	\$1.49
99c SPECIALS		
KEYBOARD	20 KEYS 2 SLIDE SW 3" x 3 1/2"	99c ea.
5 VOLT REGULATOR	340 T (7805) 10-220	99c
CALCULATOR DISPLAY	9 MAN 3 ON PC BOARD RED 7 SEG 127 LED 17 TERMINAL BOARD 1/2" x 2 1/2"	99c
LARGE RED LED		12/99c
OP AMP	741 mini DIP	5/99c
EDGE CONNECTOR	6/99c ELCO MODULAR UNIT 6 PIN 3 POSITION WIRE WRAP GOLD PLATE, 156"	6/99c

SPECIAL DEVICES

372 AF-IF Strip Detector DIP	2.93
546 AM Radio Receiver Subsystem DIP	2.75
1310 FM Stereo Demodulator DIP	2.90
1496 Balanced Modulator-Demodulator	2.48
1800 Stereo Multiplexer DIP	1.18
ULN2208 FM Gain Block 34db (typ) mDIP	1.35
ULN2209 FM Gain Block 48db (typ) mDIP	10.20
2513 Character Generator 64x85 DIP-24	10.20
3046 Transistor Array DIP-14	.73

CLOCK CHIPS

MM5311 6 digit multiplexed BCD, 7 seg. 12-24 Hr, 50-60 Hz	4.45
MM5312 4 digit multiplexed BCD, 7 seg. lpps. 12-24 Hr, 50-60 Hz	3.95
MM5314 6 digit multiplexed 12-24 Hr, 50-60 Hz 24 pin	4.45
MM5316 4 digit, 12-24 Hr, 50-60 Hz, alarm 40 pin	4.95

SHIFT REGISTERS

MM5011 1024 bit accum. dyn.	1.75
MM5016 500-512 bit dyn.	1.99
515-4025 Quad 25 bit	1.50
7504 1024 bit multiplexed dyn	3.95

IC SOCKETS

Solder Tail - low profile

8 pin	5	17	24 pin	.42
14 pin	.20	28 pin	.59	
16 pin	.22	40 pin	.69	
18 pin	.29			

WIRE WRAP - gold plate

14 pin	.49
--------	-----

MULTIPLE DISPLAYS

MS-11 3 digit 12" red LED	1.79
HP5082 5 digit 11 red LED	3.49
7405	.79
HP5082 4 digit 11 red LED	3.25
7414	
SP-425-09 9 digit 25 gsd dch.	1.79

FREE CATALOG AVAILABLE ON REQUEST

Satisfaction guaranteed. Shipment will be made postage prepaid within 3 days from receipt of order. Payment may be made with personal check, charge card (include number and exp. date), or money order. Phone Orders - BoFA and M/C card or C.O.D.

Add \$1.00 to cover shipping and handling if order is less than \$10.00. California residents add sales tax. Include shipping expense for orders shipped out of U.S. and Canada approx. 10% of order.

INTERNATIONAL ELECTRONICS UNLIMITED
P.O. BOX 3036-R MONTEREY, CA. 93940 USA
PHONE (408) 659-3171

FREE CATALOG



260 SO. FORGE ST.
DEPT. IV, AKRON, OHIO 44327

NAME _____

ADDRESS _____ CITY STATE _____

ZIP _____ Send Olson Catalog

Free PA Catalog Ship The Following

How Many	Stock Number	Description	Price	Total

ENCLOSE POSTAGE AND SALES TAX

7400 SERIES TTL					
7400	.21	7442	1.08	74121	.55
7401	.21	7448	1.15	74122	.49
7402	.21	7450	.26	74123	1.05
7404	.21	7451	.27	74125	.60
7405	.24	7453	.27	74126	.81
7406	.45	7454	.41	74132	3.00
7407	.45	7460	.22	74141	1.15
7408	.25	7472	.39	74150	1.10
7409	.25	7473	.45	74151	1.26
7410	.20	7474	.45	74153	1.35
7411	.30	7475	.80	74154	1.25
7413	.85	7482	1.75	74155	1.21
7416	.43	7483	1.15	74157	1.30
7417	.43	7485	1.12	74161	1.45
7420	.21	7486	.45	74164	1.65
7422	1.50	7489	2.49	74165	1.65
7425	4.3	7490	6.9	74166	1.70
7427	.37	7491	1.20	74174	1.95
7428	.33	7492	.82	74175	1.95
7430	.26	7493	.82	74180	1.05
7432	.31	7494	.91	74181	3.55
7437	.47	7495	.91	74191	1.50
7438	.40	7496	.91	74195	1.00
7440	.21	74100	1.25	74197	1.00
7441	1.10	74107	.49	74298	1.30

5400 SERIES				
5400	1.00	5475	1.50	
5404	1.25	5486	1.90	
5410	1.00	5493	2.00	
5426	1.25	54100	1.80	
5473	1.50	54LS04	1.00	

MOTOROLA CIRCUITS				
MC725P	1.50	MC1804P	.98	
MC740L	1.55	MC1806P	.98	
MC790P	1.50	MC1810P	.98	
MC832P	.48	MC2053L	.45	
MC1004L	1.25	MC3004L	1.32	
MC1008L	1.25	MC3006P	1.44	
MC1010L	1.25	MC3007P	1.32	
MC1011L	1.25	MC3007L	2.15	
MC1036L	12.50	MC3021P	2.15	
MC1037L	12.50	MC3060L	2.65	
MC1352P	1.05	MC3062L	3.00	
MC1406CP	3.95	MC4024P	2.20	
MC1468L	2.90	MC14501CP	.31	
MC1469P	2.50	MC14502CP	1.18	
MC1510G	8.00	MC14507CP	.82	
MC1514L	4.50	MC14510CP	2.40	
MC1550G	1.50	MC14511CP	2.76	
MC1558	4.37	MC14512CP	1.92	
MC1595L	6.25	MC14519CG	.94	
MC1596G	3.31	MC14528CP	1.74	
MC1723CG	1.25	MC4044P	4.80	

JAPANESE CIRCUITS							
AN136	2.90	HA1312	4.05	STK056	11.35	TA7201P	6.40
AN203	3.75	HA1322	5.20	STK415	11.50	TA7203P	7.00
AN208	4.75	HA1339	5.20	TA7045M	3.50	TA7204P	6.50
AN210	3.10	LA1201	4.25	TA7054P	3.05	TA7205P	6.50
AN211	3.30	LA1364	4.70	TA7055P	5.50	TA78005M	2.50
AN214	4.90	LA1366	6.00	TA7060P	1.85	TA78005P	1.95
AN217	3.30	LA1367	5.90	TA7061P	2.25	TA78012M	2.50
AN229	6.35	LA3301	4.85	TA7062P	2.25	TA78012P	1.95
AN234	5.75	LA4030	4.85	TA7063P	2.25	TA78015M	2.50
AN239	6.50	LA4031P	3.50	TA7064P	4.80	TA78015P	1.95
AN241	3.20	LA4051P	4.65	TA7075P	4.90	TC9100P	12.00
AN245	6.50	LD3001	3.35	TA7076P	4.55	UPC16C	2.50
AN274	3.95	LD3080	4.00	TA7092P	6.50	UPC20C	5.00
AN277B	3.40	LD3120	3.10	TA7102	5.15	UPC41C	3.95
AN288	4.80	LD3141	2.40	TA7106P	3.25	UPC48C	3.95
AN328	4.05	M5112	5.40	TA7120P	2.20	UPC554C	3.90
AN343	3.90	M5115PR	4.80	TA7120P-C	2.20	UPC583H2	6.00
BA511	3.50	M5155	2.85	TA7122AP	2.30	UPC586H	2.25
BA521	3.95	SG613	5.40	TA7124P	1.85	UPC575C	4.10
HA1158	6.30	STK011	10.50	TA7146P	1.10	UPC1001H2	5.15
HA1159	6.60	STK015	6.50	TA7150P	4.55	UPC1020H	5.50
HA1202	3.10	STK025	12.50	TA7153P	6.90	UPC1025	5.50
HA1306W	5.20	STK032	14.20	TA7200P	6.25		

74L SERIES TTL					
74L00	33	74LS04	.45	74LS113	.98
74L10	33	74LS10	.39	74LS138	1.89
74L30	33	74LS20	.39	74LS174	2.50
74L42	1.50	74LS51	.39	74LS386	5.50
74LS60	69	74LS74	.65	74S153	2.25
74L80	39	74LS112	.65	74S387	1.95

MISC CIRCUITS					
BC184L	.60	LM309K	1.95	SN15844N	.55
CA3001	.75	LM351AN	.70	SN15946	.55
CA3005	.80	LM741CP	.40	SN158097N	.60
CA3006	1.10	LM1458M	.65	SN72560P	4.50
CA3018	1.60	MFC9020	1.15	SN727410N	.85
CA3018A	1.60	MR995A	1.05	SN727410L	.45
CA3026	2.15	MSC9967P1	.50	SN72748P	.49
CA3035	2.45	N5556	.55	UA703C	.45
CA3039	1.35	N8590	5.00	UA709C	.40
CA3058	1.90	NE555V	.45	USF7733393	2.40
CK707P	.45	PA771131	.45	995879	6.50
C5134J	1.15	PL994551	.45	996079	12.50
C5135J	1.20	RC14370B	.35	998979	9.00
C5136	1.25	SC9926P	.70	936-5D	1.10
IC3(GE)	1.50	SC9966P	1.25	9313DC	1.20
LM301AN	.35	SN15830N	.50	93L28DC	2.75

POSITIVE VOLTAGE REGULATORS				
LM340K-5	1.95			
LM340K-6	1.95			
LM340K-8	1.95			
LM340K-12	1.95			
LM340K-15	1.95			
LM340K-18	1.95			
LM340T-5	1.75			
LM340T-6	1.75			
LM340T-8	1.75			
LM340T-12	1.75			
LM340T-15	1.75			
LM340T-18	1.75			
LM340T-24	1.75			

IC'S ON THE MOVE					
BBD: BUCKET BRIGADE DEVICE					
MM3001	19.50	MM3002	11.70	MM3003	9.45
HALL IC: DN834	1.25	DN837	1.50		
	DN835	1.35	DN838(NEW)		
SN76001	1.75	SN76002	1.95		
PL02A	MIDLAND PHASE LOCK LOOP			12.00	

74H00 TTL					
74H00	33	74H11	.33	74H53	.39
74H01	33	74H20	.33	74H55	.39
74H04	33	74H21	.33	74H73	.59
74H05	33	74H30	.33	74H74	.59
74H10	33	74H40	.33	74H76	.60

ELECTROLYTIC CAPACITORS				
2.2MF50	AXIAL LEADS	.15		
3.3MF10	AXIAL LEADS	.15		
3.3MF10	NO POLARITY	.15		
10MF25	AXIAL LEADS	.15		
10MF150	AXIAL LEADS	.15		
25MF35	AXIAL LEADS	.20		
30MF25	AXIAL LEADS	.15		
47MF25	RADIAL LEADS	.15		
47MF50	RADIAL LEADS	.20		
100MF16	RADIAL LEADS	.15		
100MF25	RADIAL LEADS	.20		
500MF50	AXIAL LEADS	.60		
1000MF35	AXIAL LEADS	.65		

HOBBY SPECIALS				
Power Pac	100 Asst. (includes Case T03, T066 T0220, T0202)		\$2.99	
Transistor/ Diode Pac	100 Asst. (includes Case T05, T039, T018, D07, 0041)		\$1.99	
IC Pac	100 Asst. (includes 14 & 16 Pin)		\$3.50	
Resistor Pac	50 Asst. (Assorted values)		\$1.50	
Mos Fet Pac	10 Asst. (many top #s Case T072)		\$0.99	
SCR Pac	100 Asst. (similar to C103 Series) Case to 92. VR-10-100V, I-400MA, IGT:200MA		\$4.00	

MICROPROCESSOR CHIPS					
1404A	3.25	2102	2.50	MM5013	3.25
C1702A	19.95	C2708	95.00	6008	19.95
2101	6.95	CA702A	19.95	8080A	29.95
MK4200 P-11	4096x1 Bit Dynamic Ram				9.95
KS101-3	1024 Bit (256x4) Static C-Mos Ram				4.50
MC14514	4 Bit Latch 4 to 16 Line Decoder				4.25

PACE/PATHCOM PART #'S					
130078	4.00	IP20-0123	2.75		
1300821	65	IP20-0131	2.50		
13-0122	1.75	IP20-0141	3.00		
83-0005	2.00	IP20-0142	3.00		
83-0007	2.50	IP20-0139	.43		
83-0008	2.00	IP20-0154	6.00		
83-0015	3.00	IP20-0155	2.50		
IP20-0005	3.00	IP20-0161	4.00		
IP20-0018	4.00	IP20-0177	2.75		
IP20-0034	.85	IP20-0176	2.85		
IP20-0037	.85	IP20-0191	.72		
IP20-0045	2.00				
IP20-0073	2.75				
IP20-0093	2.50				

JAPANESE TRANSISTORS * CB, AUDIO, INDUSTRIAL									
2SA52	.60	2SC206	1.00	2SC774	1.75	2SC1173	95	2SD77	1.00
2SA316	.75	2SC240	1.10	2SC775	2.75	2SC1175	65	2SD81	3.25
2SA473	.75	2SC291	65	2SC776	3.00	2SC1209	55	2SD88	1.50
2SA483	1.95	2SC292	3.00	2SC777	4.00	2SC1213	75	2SD118	3.25
2SA489	.80	2SC320	75	2SC778	4.00	2SC1226A	1.25	2SD130	1.25
2SA490	.70	2SC352	75	2SC781	3.00	2SC1237	4.50	2SD141	2.25
2SA505	.95	2SC495	1.10	2SC803	4.00	2SC1239	4.00	2SD151	2.25
2SA564	.50	2SC371	75	2SC784	70	2SC1243	1.50	2SD170	2.00
2SA628	.65	2SC372	70	2SC785	1.00	2SC1293	85	2SD180	2.75
2SA643	.85	2SC394	70	2SC789	1.00	2SC1306	4.75	2SD201	1.95
2SA647	2.75	2SC458	70	2SC793	2.50	2SC1307	5.75	2SD218	4.75
2SA673	.85	2SC460	70	2SC796	3.15	2SC1308	4.75	2SD235	1.00
2SA679	3.75	2SC478	80	2SC797	2.50	2SC1317	.60	2SD300	2.50
2SA682	.85	2SC481	1.85	2SC798	3.10	2SC1318	70	2SD313	1.10
2SA699	1.30	2SC482	1.75	2SC799	4.25	2SC1325	4.95	2SD315	.75
2SA699A	1.45	2SC491	2.50	2SC802	3.75	2SC1327	.70	2SD316	2.50
2SA705	.95	2SC495	1.10	2SC803	4.00	2SC1338	1.75	2SD317	1.25
2SA815	.85	2SC497	1.60	2SC815	.75	2SC1346	80	2SD318	.95
2SA816	.85	2SC502	1.50	2SC828	.75	2SC1347	80	2SD325	1.25
		2SC515	.80	2SC829	.75	2SC1364	1.50	2SD341	.95
2SB22	.85	2SC517	4.25	2SC830	1.60	2SC1377	5.50	2SD350	3.25
2SB54	.70	2SC535	.75	2SC838	70	2SC1383	.75	2SD352	.80
2SB56	.70	2SC536	.65	2SC839	85	2SC1384	85	2SD380	5.70
2SB77	.70	2SC537	.70	2SC922	.55	2SC1409	1.25	2SD389	.75
2SB128	2.25	2SC563	2.50	2SC929	70	2SC1410	1.25	2SD390	

7400N TTL

SN7400N	16	SN7459A	25	SN74154N	1.00
SN7401N	16	SN7460N	22	SN74155N	99
SN7402N	21	SN7470N	45	SN74156N	99
SN7403N	16	SN7472N	37	SN74157N	99
SN7404N	16	SN7473N	32	SN74158N	1.25
SN7405N	24	SN7474N	39	SN74161N	99
SN7406N	20	SN7475N	50	SN74163N	99
SN7407N	29	SN7476N	32	SN74164N	1.10
SN7408N	25	SN7479N	5.00	SN74165N	1.10
SN7409N	25	SN7480N	50	SN74166N	1.25
SN7410N	18	SN7482N	30	SN74167N	5.50
SN7411N	30	SN7483N	70	SN74170N	2.10
SN7412N	33	SN7485N	89	SN74172N	8.95
SN7413N	45	SN7486N	50	SN74173N	1.00
SN7414N	70	SN7488N	3.50	SN74174N	1.25
SN7416N	35	SN7489N	2.49	SN74175N	99
SN7417N	35	SN7490N	45	SN74176N	90
SN7421N	33	SN7492N	49	SN74177N	1.00
SN7422N	49	SN7493N	49	SN74180N	99
SN7423N	37	SN7494N	79	SN74181N	2.49
SN7425N	29	SN7495N	79	SN74182N	95
SN7426N	29	SN7496N	89	SN74184N	7.95
SN7427N	37	SN7497N	4.00	SN74185N	2.20
SN7429N	42	SN74100N	1.00	SN74186N	15.00
SN7430N	26	SN74107N	39	SN74187N	6.00
SN7432N	31	SN74121N	39	SN74189N	3.95
SN7437N	27	SN74122N	39	SN74190N	1.00
SN7438N	27	SN74123N	50	SN74191N	1.25
SN7439N	25	SN74125N	60	SN74192N	89
SN7440N	15	SN74126N	60	SN74193N	89
SN7441N	80	SN74132N	1.00	SN74194N	1.25
SN7442N	58	SN74136N	95	SN74195N	1.25
SN7443N	75	SN74141N	1.15	SN74196N	1.25
SN7444N	75	SN74142N	4.00	SN74197N	75
SN7445N	75	SN74143N	4.50	SN74199N	1.75
SN7446N	81	SN74144N	4.50	SN74200N	5.58
SN7447N	69	SN74145N	1.15	SN74209N	5.58
SN7448N	79	SN74173N	2.35	SN74290N	1.79
SN7450N	26	SN74148N	2.00	SN74291N	1.79
SN7451N	27	SN74151N	7.99	SN74295N	6.00
SN7452N	20	SN74153N	89	SN74367N	75

MANY OTHERS AVAILABLE ON REQUEST
20% Discount for 100 Combined 7400's

CMOS

CD4000	25	74C04N	75
CD4001	25	74C05	65
CD4002	25	74C02N	65
CD4003	2.50	74C03N	65
CD4007	25	74C04	2.15
CD4009	59	74C04A	1.50
CD4010	59	74C04B	1.15
CD4011	25	74C04C	1.00
CD4012	59	74C04D	2.75
CD4013	47	74C05	1.25
CD4016	56	74C05	2.90
CD4017	56	74C05A	2.90
CD4018	56	74C05B	2.90
CD4019	56	74C05C	2.90
CD4020	1.35	74C06	4.00
CD4021	55	74C06	4.00
CD4022	1.25	74C06	3.25
CD4023	25	74C06	3.25
CD4024	1.50	74C06	2.25
CD4025	25	74C06	2.25
CD4027	69	74C06	2.75
CD4028	1.65	74C06	4.50
CD4029	7.00	74C06	4.50
CD4030	65	74C06	4.50

LINEAR

LM3004	80	LM3100N	2.95
LM3005	35	LM3101N	1.65
LM3010CN	75	LM3141N	1.75
LM302H	35	LM3158CN	1.00
LM304H	100	LM3159N	1.95
LM305H	95	LM3160N	1.85
LM307CN	35	LM3177N	1.00
LM308H	100	LM3201N	2.95
LM308CN	1.00	LM3085N	6.00
LM309H	110	LM3300N	3.25
LM309CN	99	LM3301N	50.00
LM310CN	1.15	NE501K	8.00
LM311H	90	NE501A	6.00
LM311CN	90	NE531H	3.00
LM318CN	1.50	NE561K	6.00
LM319N	1.30	NE540L	6.00
LM320A-5	1.35	NE501K	8.00
LM320K-5	1.35	NE555V	5.00
LM320K-12	1.35	NE560E	5.00
LM320K-15	1.35	NE561E	5.00
LM320T-5	1.75	NE562B	5.00
LM320T-5.2	1.75	NE565H	1.25
LM320T-8	1.75	NE565N	1.75
LM320T-12	1.75	NE566N	1.75
LM320T-15	1.75	NE567H	1.95
LM320T-18	1.75	NE567V	1.50
LM320T-24	1.75	LM730CN	45
LM323H-5	9.95	LM730N	39
LM324N	1.80	LM709N	29
LM339N	1.70	LM710N	79
LM340K-5	1.95	LM711N	39
LM340K-6	1.95	LM723H	35
LM340K-8	1.95	LM730N	39
LM340K-12	1.95	LM733N	1.00
LM340K-15	1.95	LM739N	1.00
LM340K-18	1.95	LM741CN	35
LM340K-24	1.95	LM741N	35
LM340T-5	1.75	LM747H	79
LM340T-6	1.75	LM747N	79
LM340T-12	1.75	LM748H	39
LM340T-15	1.75	LM748N	39
LM340T-18	1.75	LM1303N	90
LM340T-24	1.75	LM1304N	119
LM350N	1.00	LM1305N	1.40
LM351CN	65	LM1307N	85

74LS00 TTL

74LS00	29	74LS139	3.95
74LS02	29	74LS151	1.95
74LS03	29	74LS153	1.89
74LS04	35	74LS157	1.55
74LS05	35	74LS162	2.75
74LS08	29	74LS163	2.75
74LS10	29	74LS164	1.95
74LS13	69	74LS175	1.95
74LS14	75	74LS190	3.09
74LS20	29	74LS192	2.85
74LS28	39	74LS193	2.85
74LS27	39	74LS194	2.85
74LS28	39	74LS195	2.85
74LS30	29	74LS199	1.89
74LS32	39	74LS201	1.89
74LS40	29	74LS217	1.75
74LS51	29	74LS132	1.25
74LS55	29	74LS136	39
74LS73	49	74LS138	1.89

CLOCK CHIPS

MM5309	6 Digit. BCD Outputs. 16 Pin	\$9.95
MM5311	6 Digit. BCD Outputs. 12 or 24 Hour	4.95
MM5312	4 Digit. BCD Outputs. 1 PPS Output	4.95
MM5314	6 Digit. 12 or 24 Hour. 50 or 60 Hz	4.95
MM5315	4 Digit. Alarm. PPS Output	4.95
MM5318	Video Clock Chip. For Use With MM5841	9.95
CT1901	6 Digit. Calendar. Alarm. 12 or 24 Hour	5.95

DATA HANDBOOKS

7400	Pin out & Description of 5400/7400 ICs	\$2.95
CMOS	Pin out & Description of 4000 Series ICs	\$2.95
Linear	Pin out & Functional Description of Linear	\$2.95

FAIRCHILD TECHNOLOGY KITS FAIRCHILD

• Complete Specifications on back of each kit
• Packaged for WALL DISPLAY APPEARANCE
• Dealer's Inquires Invited — Price List Available

7205 - Stop Watch Chip \$19.95

DIGITS		PHOTO ARRAYS			
FTK0001	0.5" High Common Anode Digit	\$1.00	FTK0040	9 Element Tape Reader Array	16.00
FTK0002	0.5" High Common Anode Digit	1.00	FTK0041	12 Element Card Reader Array	24.00
FTK0003	3.5" High Common Cathode Digit	7.00	FTK0042	Reflective Opto Coupler	4.00
FTK0004	0.8" High Common Anode Digit	2.00			
FTK0005	0.8" High Common Anode Digit	2.00			
0.8" HIGH DISPLAY ARRAYS					
FTK0010	12 Hour, 3 1/2 Digit Clock Display	7.00			
FTK0011	24 Hour, 4 Digit Clock Display	8.00			
LED LAMPS					
FTK0020	10 Red LED Lamps	1.00			
FTK0021	5 Mixed Colored LED Lamps	1.00			
FTK0022	10 LED Mounting Clips	1.00			
FTK0023	5 Three Piece LED Mounting Adapters	1.00			
PHOTO TRANSISTORS					
FTK0030	5 Flat Lens Photo Transistors	1.00			
FTK0031	5 Round Lens Photo Transistors	1.00			
FTK0032	3 Flat Lens Photo Darlington	1.00			
FTK0033	3 Round Lens Photo Darlington	1.00			
COUPLERS					
FTK0050	3 General Purpose Opto Couplers	1.00			
FTK0051	Darlington Opto Coupler	1.00			
MOS CLOCK CIRCUITS					
FTK0400	Digital Clock Calendar Circuit (FCM7001)	7.00			
FTK0401	Digital Clock Calendar with BCD Outputs (FCM7002)	7.00			
FTK0402	Direct Drive Digital Clock Circuit with AC Output (FCM3817A)	5.00			
FTK0403	Direct Drive Digital Clock Circuit with DC Output (FCM3817D)	5.00			
FTK0405	Direct Drive Digital Clock Calendar Circuit (FCM7015)	6.00			
KITS					
FTK1016	Automobile Clock Kit	40.00			

DISCRETE LEDES

175" dia	200" dia	185" dia	200" dia	185" dia	200" dia	085" dia
XC209 Red 10/S1	XC22 Red 4/S1	XC22 Green 4/S1	XC22 Yellow 4/S1	XC22 Orange 4/S1	XC22 Blue 4/S1	XC111 Red 10/S1
XC209 Green 4/S1	XC22 Yellow 4/S1	XC22 Orange 4/S1	XC22 Blue 4/S1	XC22 Clear 4/S1	XC111 Green 4/S1	
XC209 Orange 4/S1	XC22 Blue 4/S1	XC22 Clear 4/S1	XC22 Red 4/S1	XC22 Yellow 4/S1	XC111 Yellow 4/S1	
					XC111 Orange 4/S1	

SPECIAL — XC556 Red 100/\$8.00 1000/\$60.00 — SPECIAL*

DISPLAY LEDES

TYPE	POLARITY	HT	TYPE	POLARITY	HT
MAN 1	Common Anode	270 2 95	MAN 3620	Common Anode-orange	300 1 75
MAN 2	5 x 1 Dot Matrix	300 4 95	MAN 3640	Common Cathode-orange	300 1 75
MAN 3	Common Cathode	125 39	MAN 3710	Common Anode-Red	400 1 95
MAN 4	Common Cathode	168 1 95	DL 101	Common Anode-red	300 1 75
MAN 7	Common Anode	300 1 25	DL 104	Common Cathode	300 1 75
MAN 7G	Common Anode-green	300 1 95	DL 107	Common Anode	300 1 95
MAN 7Y	Common Anode-yellow	300 1 95	DL 128	Common Cathode	500 1 75
MAN 52	Common Anode green	300 1 75	DL 147	Common Anode	600 2 25
MAN 64	Common Anode red	400 1 75	DL 150	Common Cathode	600 2 49
MAN 72	Common Anode	300 1 25	DL 338	Common Cathode	100 5 00
MAN 74	Common Cathode	300 1 50	FND70	Common Cathode	750 7 50
MAN 82	Common Anode yellow	300 1 75	FND503	Common Cathode	500 1 00
MAN 84	Common Cathode yellow	300 1 75	FND507	Common Cathode	500 1 00

IC SOLDERTAIL — LOW PROFILE (TIN) SOCKETS

Pin	1-24	25-49	50-100	101-24	25-49	50-100
8 pin	1.24	16	15	24 pin	1.24	37
14 pin	20	19	18	28 pin	3.48	44
16 pin	22	21	20	36 pin	6.00	59
18 pin	29	28	27	40 pin	6.3	67
22 pin	37	36	35			

SOLDERTAIL STANDARD (TIN)

Pin	1-24	25-49	50-100	101-24	25-49	50-100
8 pin	1.24	16	15	24 pin	3.48	37
14 pin	20	19	18	28 pin	6.00	44
16 pin	22	21	20	36 pin	6.00	59
18 pin	29	28	27	40 pin	6.3	67
22 pin	37	36	35			

SOLDERTAIL STANDARD (GOLD)

Pin	1-24	25-49	50-100	101-24	25-49	50-100
8 pin	3.20	27	24	24 pin	7.70	63
14 pin	35	32	32	28 pin	1.10	1.00
16 pin	38	35	32	36 pin	1.75	1.40
18 pin	42	41	41	40 pin	1.75	1.59

WIRE WRAP SOCKETS (GOLD) LEVEL #3

Pin	1-24	25-49	50-100	101-24	25-49	50-100
10 pin	5.45	41	37	24 pin	1.05	95
14 pin	39	38	37	28 pin	1.40	1.25
16 pin	43	42	41	36 pin	1.59	1.45
18 pin	45	44	42	40 pin	1.75	1.55

Plastic Push Button Switch MINATURE TOGGLE SWITCH

• 18 AWG Solid Wire • 5" Long
• 50 (wide) X 50 (high) %27 Thread
• 8 AMP @ 14 Volt • 1 AMP @ 110 Volt

J-188-1	Push On-Push Off	59 48	JMT-221	DPDT on/off/on	\$1.95
J-188-2	Normally Open	59 49	JMT-223	DPDT on/none/on	\$1

Same day shipment. First line parts only. Factory tested. Guaranteed money back. Quality IC's and other components at factory prices.

INTEGRATED CIRCUITS

7400TTL	SN74157AN	59	NE540L	3.90	CD4044	2.00	8730	4.00
SN74100N	SN74158A	75	NE540L	3.90	CD4049	4.00	8725	3.20
SN74102N	SN74159N	110	NE553V	1.00	CD4066	65	8728	2.75
SN74103N	SN74159N	110	NE553V	1.00	CD4066	75	8727	2.45
SN74104N	SN74159N	110	NE553V	1.00	CD4066	40	8728	2.45
SN74105N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74106N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74107N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74108N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74109N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74110N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74111N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74112N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74113N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74114N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74115N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74116N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74117N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74118N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74119N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74120N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74121N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74122N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74123N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74124N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74125N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74126N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74127N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74128N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74129N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74130N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74131N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74132N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74133N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74134N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74135N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74136N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74137N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74138N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74139N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74140N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74141N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74142N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74143N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74144N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74145N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74146N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74147N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74148N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74149N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74150N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74151N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74152N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74153N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74154N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74155N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74156N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74157N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74158N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74159N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74160N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74161N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74162N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74163N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74164N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74165N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74166N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74167N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74168N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74169N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74170N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74171N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74172N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74173N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74174N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74175N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74176N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74177N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74178N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74179N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74180N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74181N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74182N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74183N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74184N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74185N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74186N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74187N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74188N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74189N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74190N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74191N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74192N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74193N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74194N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74195N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74196N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74197N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74198N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74199N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45
SN74200N	SN74159N	110	NE553V	1.00	CD4071	40	8728	2.45

ELECTRONICS

4 digit, 7 function hop-w/hold time extnd	UART#1#10	CA	270	2.90
new National MM5865	AVS-1013	CA	125	3.90
\$2.00 Board available	3341	CA	300	3.50
10 page spec only, \$1.00	MAN14	CA	300	3.50
	MAN15	CA	300	3.50
	MAN16	CA	300	3.50
	MAN17	CA	300	3.50
	MAN18	CA	300	3.50
	MAN19	CA	300	3.50
	MAN20	CA	300	3.50
	MAN21	CA	300	3.50
	MAN22	CA	300	3.50
	MAN23	CA	300	3.50
	MAN24	CA	300	3.50
	MAN25	CA	300	3.50
	MAN26	CA	300	3.50
	MAN27	CA	300	3.50
	MAN28	CA	300	3.50
	MAN29	CA	300	3.50
	MAN30	CA	300	3.50
	MAN31	CA	300	3.50
	MAN32	CA	300	3.50
	MAN33	CA	300	3.50
	MAN34	CA	300	3.50
	MAN35	CA	300	3.50
	MAN36	CA	300	3.50
	MAN37	CA	300	3.50
	MAN38	CA	300	3.50
	MAN39	CA	300	3.50
	MAN40	CA	300	3.50

VOLUME SPECIALS

MM5262	2K RAM	1.00
MM5359	Driver	2.10
710211	500 NS 1K RAM	1.30
MM5375AA	Alarm Clock	3.75
FD503	50" Display	1.20
EM72	Clock	2.90
PD4114		

CLIPLITE

4 for \$1.00

NEW LED MOUNTING SYSTEM

- CLIPLITE mounts from the front of the panel in a .250 hole on 3/8" centers. Panel thickness from 1/16" to 1/8".
- CLIPLITE equalizes and increases the brightness of commonly used wide beam LEDs.
- CLIPLITE is to be used with 200" dia. LEDs.
- Specify colors—red, green, amber, or yellow when ordering.

TTL 7400N

SN7400N 13	SN7472N 26	SN74154N 98
SN7401N 14	SN7473N 30	SN74155N 77
SN7402N 14	SN7474N 30	SN74156N 68
SN7403N 14	SN7475N 47	SN74157N 63
SN7404N 17	SN7476N 33	SN74158N 94
SN7405N 17	SN7477N 33	SN74159N 94
SN7406N 17	SN7478N 33	SN74160N 88
SN7407N 28	SN7479N 33	SN74161N 88
SN7408N 17	SN7480N 33	SN74162N 88
SN7409N 17	SN7481N 99	SN74163N 88
SN7410N 14	SN7482N 58	SN74164N 1.09
SN7411N 20	SN7483N 68	SN74165N 98
SN7412N 27	SN7484N 68	SN74166N 1.18
SN7413N 40	SN7485N 68	SN74167N 2.97
SN7414N 69	SN7486N 44	SN74170N 1.74
SN7415N 25	SN7487N 63	SN74171N 2.97
SN7416N 25	SN7488N 45	SN74172N 98
SN7417N 30	SN7489N 45	SN74173N 98
SN7420N 14	SN7490N 73	SN74174N 98
SN7421N 17	SN7491N 73	SN74175N 88
SN7422N 20	SN7492N 73	SN74176N 78
SN7423N 26	SN7493N 68	SN74177N 77
SN7424N 26	SN7494N 68	SN74178N 1.24
SN7425N 26	SN7495N 68	SN74179N 1.24
SN7426N 26	SN7496N 68	SN74180N 68
SN7427N 26	SN7497N 2.84	SN74181N 1.98
SN7428N 34	SN74100N 98	SN74182N 68
SN7429N 23	SN74101N 42	SN74183N 1.88
SN7430N 14	SN74102N 28	SN74184N 1.88
SN7431N 23	SN74103N 48	SN74185N 1.84
SN7432N 23	SN74104N 53	SN74186N 3.49
SN7433N 24	SN74105N 53	SN74187N 3.49
SN7434N 24	SN74106N 53	SN74188N 3.49
SN7435N 24	SN74107N 53	SN74189N 3.49
SN7436N 24	SN74108N 53	SN74190N 3.49
SN7437N 22	SN74109N 53	SN74191N 3.49
SN7438N 22	SN74110N 53	SN74192N 87
SN7439N 24	SN74111N 53	SN74193N 87
SN7440N 14	SN74112N 35	SN74194N 93
SN7441N 87	SN74113N 38	SN74195N 93
SN7442N 37	SN74114N 38	SN74196N 92
SN7443N 37	SN74115N 44	SN74197N 92
SN7444N 37	SN74116N 44	SN74198N 1.68
SN7445N 37	SN74117N 44	SN74199N 1.68
SN7446N 37	SN74118N 44	SN74200N 5.58
SN7447N 68	SN74119N 92	SN74201N 1.19
SN7448N 73	SN74120N 92	SN74202N 1.84
SN7449N 14	SN74121N 92	SN74203N 1.84
SN7450N 14	SN74122N 92	SN74204N 1.84
SN7451N 14	SN74123N 92	SN74205N 1.84
SN7452N 14	SN74124N 92	SN74206N 1.84
SN7453N 14	SN74125N 92	SN74207N 1.84
SN7454N 14	SN74126N 92	SN74208N 1.84
SN7455N 14	SN74127N 92	SN74209N 1.84
SN7456N 14	SN74128N 92	SN74210N 1.84
SN7457N 14	SN74129N 92	SN74211N 1.84
SN7458N 14	SN74130N 92	SN74212N 1.84
SN7459N 14	SN74131N 92	SN74213N 1.84
SN7460N 14	SN74132N 92	SN74214N 1.84
SN7461N 14	SN74133N 92	SN74215N 1.84
SN7462N 14	SN74134N 92	SN74216N 1.84
SN7463N 14	SN74135N 92	SN74217N 1.84
SN7464N 14	SN74136N 92	SN74218N 1.84
SN7465N 14	SN74137N 92	SN74219N 1.84
SN7466N 14	SN74138N 92	SN74220N 1.84
SN7467N 14	SN74139N 92	SN74221N 1.84
SN7468N 14	SN74140N 92	SN74222N 1.84
SN7469N 14	SN74141N 92	SN74223N 1.84
SN7470N 27	SN74142N 92	SN74224N 1.84
SN7471N 27	SN74143N 92	SN74225N 1.84
SN7472N 27	SN74144N 92	SN74226N 1.84
SN7473N 27	SN74145N 92	SN74227N 1.84
SN7474N 27	SN74146N 92	SN74228N 1.84
SN7475N 27	SN74147N 92	SN74229N 1.84
SN7476N 27	SN74148N 92	SN74230N 1.84
SN7477N 27	SN74149N 92	SN74231N 1.84
SN7478N 27	SN74150N 98	SN74232N 1.84
SN7479N 27	SN74151N 62	SN74233N 1.84
SN7480N 27	SN74152N 62	SN74234N 1.84
SN7481N 27	SN74153N 62	SN74235N 1.84
SN7482N 27	SN74154N 62	SN74236N 1.84
SN7483N 27	SN74155N 62	SN74237N 1.84
SN7484N 27	SN74156N 62	SN74238N 1.84
SN7485N 27	SN74157N 62	SN74239N 1.84
SN7486N 27	SN74158N 62	SN74240N 1.84
SN7487N 27	SN74159N 62	SN74241N 1.84
SN7488N 27	SN74160N 62	SN74242N 1.84
SN7489N 27	SN74161N 62	SN74243N 1.84
SN7490N 27	SN74162N 62	SN74244N 1.84
SN7491N 27	SN74163N 62	SN74245N 1.84
SN7492N 27	SN74164N 62	SN74246N 1.84
SN7493N 27	SN74165N 62	SN74247N 1.84
SN7494N 27	SN74166N 62	SN74248N 1.84
SN7495N 27	SN74167N 62	SN74249N 1.84
SN7496N 27	SN74168N 62	SN74250N 1.84
SN7497N 27	SN74169N 62	SN74251N 1.84
SN7498N 27	SN74170N 62	SN74252N 1.84
SN7499N 27	SN74171N 62	SN74253N 1.84
SN7500N 27	SN74172N 62	SN74254N 1.84

TTL 74LS00N

SN74LS00 24	SN74LS578 4.48	SN74LS164 2.94
SN74LS01 24	SN74LS579 4.48	SN74LS170 2.79
SN74LS02 24	SN74LS580 4.48	SN74LS174 1.39
SN74LS03 24	SN74LS581 4.48	SN74LS175 1.39
SN74LS04 29	SN74LS582 4.48	SN74LS176 3.49
SN74LS05 24	SN74LS583 4.48	SN74LS177 3.49
SN74LS06 24	SN74LS584 4.48	SN74LS178 1.94
SN74LS07 24	SN74LS585 4.48	SN74LS179 1.94
SN74LS08 24	SN74LS586 4.48	SN74LS180 1.94
SN74LS09 24	SN74LS587 4.48	SN74LS181 1.94
SN74LS10 24	SN74LS588 4.48	SN74LS182 1.94
SN74LS11 24	SN74LS589 4.48	SN74LS183 1.94
SN74LS12 24	SN74LS590 4.48	SN74LS184 1.94
SN74LS13 24	SN74LS591 4.48	SN74LS185 1.94
SN74LS14 24	SN74LS592 4.48	SN74LS186 1.94
SN74LS15 24	SN74LS593 4.48	SN74LS187 1.94
SN74LS16 24	SN74LS594 4.48	SN74LS188 1.94
SN74LS17 24	SN74LS595 4.48	SN74LS189 1.94
SN74LS18 24	SN74LS596 4.48	SN74LS190 1.94
SN74LS19 24	SN74LS597 4.48	SN74LS191 1.94
SN74LS20 24	SN74LS598 4.48	SN74LS192 1.94
SN74LS21 24	SN74LS599 4.48	SN74LS193 1.94
SN74LS22 24	SN74LS600 4.48	SN74LS194 1.94
SN74LS23 24	SN74LS601 4.48	SN74LS195 1.94
SN74LS24 24	SN74LS602 4.48	SN74LS196 1.94
SN74LS25 24	SN74LS603 4.48	SN74LS197 1.94
SN74LS26 24	SN74LS604 4.48	SN74LS198 1.94
SN74LS27 24	SN74LS605 4.48	SN74LS199 1.94
SN74LS28 24	SN74LS606 4.48	SN74LS200 1.94
SN74LS29 24	SN74LS607 4.48	SN74LS201 1.94
SN74LS30 24	SN74LS608 4.48	SN74LS202 1.94
SN74LS31 24	SN74LS609 4.48	SN74LS203 1.94
SN74LS32 24	SN74LS610 4.48	SN74LS204 1.94
SN74LS33 24	SN74LS611 4.48	SN74LS205 1.94
SN74LS34 24	SN74LS612 4.48	SN74LS206 1.94
SN74LS35 24	SN74LS613 4.48	SN74LS207 1.94
SN74LS36 24	SN74LS614 4.48	SN74LS208 1.94
SN74LS37 24	SN74LS615 4.48	SN74LS209 1.94
SN74LS38 24	SN74LS616 4.48	SN74LS210 1.94
SN74LS39 24	SN74LS617 4.48	SN74LS211 1.94
SN74LS40 24	SN74LS618 4.48	SN74LS212 1.94
SN74LS41 24	SN74LS619 4.48	SN74LS213 1.94
SN74LS42 24	SN74LS620 4.48	SN74LS214 1.94
SN74LS43 24	SN74LS621 4.48	SN74LS215 1.94
SN74LS44 24	SN74LS622 4.48	SN74LS216 1.94
SN74LS45 24	SN74LS623 4.48	SN74LS217 1.94
SN74LS46 24	SN74LS624 4.48	SN74LS218 1.94
SN74LS47 24	SN74LS625 4.48	SN74LS219 1.94
SN74LS48 24	SN74LS626 4.48	SN74LS220 1.94
SN74LS49 24	SN74LS627 4.48	SN74LS221 1.94
SN74LS50 24	SN74LS628 4.48	SN74LS222 1.94
SN74LS51 24	SN74LS629 4.48	SN74LS223 1.94
SN74LS52 24	SN74LS630 4.48	SN74LS224 1.94
SN74LS53 24	SN74LS631 4.48	SN74LS225 1.94
SN74LS54 24	SN74LS632 4.48	SN74LS226 1.94
SN74LS55 24	SN74LS633 4.48	SN74LS227 1.94
SN74LS56 24	SN74LS634 4.48	SN74LS228 1.94
SN74LS57 24	SN74LS635 4.48	SN74LS229 1.94
SN74LS58 24	SN74LS636 4.48	SN74LS230 1.94
SN74LS59 24	SN74LS637 4.48	SN74LS231 1.94
SN74LS60 24	SN74LS638 4.48	SN74LS232 1.94
SN74LS61 24	SN74LS639 4.48	SN74LS233 1.94
SN74LS62 24	SN74LS640 4.48	SN74LS234 1.94
SN74LS63 24	SN74LS641 4.48	SN74LS235 1.94
SN74LS64 24	SN74LS642 4.48	SN74LS236 1.94
SN74LS65 24	SN74LS643 4.48	SN74LS237 1.94
SN74LS66 24	SN74LS644 4.48	SN74LS238 1.94
SN74LS67 24	SN74LS645 4.48	SN74LS239 1.94
SN74LS68 24	SN74LS646 4.48	SN74LS240 1.94
SN74LS69 24	SN74LS647 4.48	SN74LS241 1.94
SN74LS70 24	SN74LS648 4.48	SN74LS242 1.94
SN74LS71 24	SN74LS649 4.48	SN74LS243 1.94
SN74LS72 24	SN74LS650 4.48	SN74LS244 1.94
SN74LS73 24	SN74LS651 4.48	SN74LS245 1.94
SN74LS74 24	SN74LS652 4.48	SN74LS246 1.94
SN74LS75 24	SN74LS653 4.48	SN74LS247 1.94
SN74LS76 24	SN74LS654 4.48	SN74LS248 1.94
SN74LS77 24	SN74LS655 4.48	SN74LS249 1.94
SN74LS78 24	SN74LS656 4.48	SN74LS250 1.94
SN74LS79 24	SN74LS657 4.48	SN74LS251 1.94
SN74LS80 24	SN74LS658 4.48	SN74LS252 1.94
SN74LS81 24	SN74LS659 4.48	SN74LS253 1.94
SN74LS82 24	SN74LS660 4.48	SN74LS254 1.94
SN74LS83 24	SN74LS661 4.48	SN74LS255 1.94
SN74LS84 24	SN74LS662 4.48	SN74LS256 1.94
SN74LS85 24	SN74LS663 4.48	SN74LS257 1.94
SN74LS86 24	SN74LS664 4.48	SN74LS258 1.94
SN74LS87 24	SN74LS665 4.48	SN74LS259 1.94
SN74LS88 24	SN74LS666 4.48	SN74LS260 1.94
SN74LS89 24	SN74LS667 4.48	SN74LS261 1.94
SN74LS90 24	SN74LS668 4.48	SN74LS262 1.94
SN74LS91 24	SN74LS669 4.48	SN74LS263 1.94
SN74LS92 24	SN74LS670 4.48	SN74LS264 1.94
SN74LS93 24	SN74LS671 4.48	SN74LS265 1.94
SN74LS94 24	SN74LS672 4.48	SN74LS266 1.94
SN74LS95 24	SN74LS673 4.48	SN74LS267 1.94
SN74LS96 24	SN74LS674 4.48	SN74LS268 1.94
SN74LS97 24	SN74LS675 4.48	SN74LS269 1.94
SN74LS98 24	SN74LS676 4.48	SN74LS270 1.94
SN74LS99 24	SN74LS677 4.48	SN74LS271 1.94
SN7500N 24	SN74LS678 4.48	SN74LS272 1.94

CMOS

CD4000 09	CD4042 64	CD4518 94
CD4001 18	CD4043 64	CD4519 88
CD4002 18	CD4044 64	CD4520 94
CD4006 1.18	CD4046 2.50	CD4528 1.24
CD4007 1.17	CD4047 2.74	CD4530 1.38
CD4008 85	CD4049 3.8	CD4531 1.38
CD4009 3.8	CD4050 3.8	CD4532 1.38
CD4010 2.1	CD4051 1.19	CD4533 1.38
CD4011 1.8	CD4052 1.19	CD4534 1.38
CD4012 1.7	CD4053 1.24	CD4535 1.38
CD4013 3.8	CD4054 1.34	CD4536 1.38
CD4014 94	CD4055 1.49	CD4537 1.38
CD4015 94	CD4056 1.49	CD4538 1.38
CD4016 3.8	CD4057 1.49	CD4539 1.38
CD4017 98	CD4058 2.4	CD4540 1.38
CD4018 1.08	CD4059 2.4	CD4541 1.38
CD4019 4.3	CD4060 2.4	CD4542 1.38
CD4020 1.08	CD4071 2.4	CD4543 1.38
CD4021 1.14	CD4072 2.4	CD4544 1.38
CD4022 94	CD4073 2.4	CD4545 1.38
CD4023 1.8	CD4074 2.4	CD4546 1.38
CD4024 6.8	CD4075 2.4	CD4547 1.38
CD4025 1.7	CD4076 2.4	CD4548 1.38
CD4026 1.44	CD4077 2.4	CD4549 1.38
CD4027 4.3	CD4078 2.4	CD4550 1.38
CD4028 7.8	CD4079 2.4	CD4551 1.38
CD4029 8.8	CD4080 2.4	CD4552 1.38
CD4030 3.8	CD4081 2.4	CD4553 1.38
CD4031 1.6	CD4082 2.4	CD4554 1.38
CD4032 1.6	CD4083 2.4	CD4555 1.38
CD4033 1.6	CD4084 2.4	CD4556 1.38
CD4034 1.6	CD4085 2.4	CD4557 1.38
CD4035 1.6	CD4086 2.4	CD4558 1.38
CD4036 1.6	CD4087 2.4	CD4559 1.38
CD4037 1.6	CD4088 2.4	CD4560 1.38
CD4038 1.6	CD4089 2.4	

BOOK

The Adam Osborne & Associates books on microcomputers are recognized as tops in their field. Lucid and complete, these are now available from us p/d in the USA, or buy all 3 books for \$25 p/d.

"AN INTRODUCTION TO MICROCOMPUTERS, VOL. 1" book #2001. Clearly covers all the basics.....\$7.50

"VOLUME 2" book #3001. Covers latest u/ps and support ICs, replacing 100s of pages of data...\$12.50

"8080 PROGRAMMING FOR LOGIC DESIGN" book #4001. Demystifies the art of programming.....\$7.50

an OFFER YOU CAN'T REFUSE

We wanted to put together an exceptional offer on memories for our customers...so we're selling new full spec 2102LIs (super low power version of the 2102), guaranteed 450 ns or faster over the full temp range...at 10/315! ALL ORDERS MUST BE POST-MARKED BEFORE 3/31/77 TO TAKE ADVANTAGE OF THIS SPECIAL OFFER.

CRYSTALS \$4.95

STATEK 3-lead xtal's give .01% accuracy in a TC-5 cal; use for fixed freq oscillators or with binary dividers to generate other freqs. Choose from (all freqs in KHz) 10,000 12,800 15,360 16,000 16,384 18,641 19,200 20,480 30,720 31,500 32,768 38,400 40,960 60,000 76,800 100.00 153.60 240.00

These SENTRY crystals are series mode, fundamental, with wire leads...for hams and computer bugs. Choose from 4, 5, 8, 9, 10, 12, 15, 18, and 20 MHz!

SEND FOR OUR FLYER

CIRCLE NO. 30 ON FREE INFORMATION CARD

GODBOUT

BILL GODBOUT ELECTRONICS
BOX 2355, OAKLAND AIRPORT, CA 94614

TERMS: Add 50c orders under \$10; over \$10 add 5%. No COD. Cal res add tax. MasterCard* and BankAmericard* orders: call 415-562-0636. 24 hrs.

SPECIALS

The following are ltd qty, subject to prior sale:
DISCRETE RED. 2" LEDs.....\$12/\$1.00
14511 CMOS BCD-to-7-segment decoder/latch/driver, no extra transistors needed.....\$2.00 each
MC4024 bipolar dual VCO (TTL compat.).....\$2.00 each

74 LS TTL

1/5	THE POWER OF TTL BUT NO SPEED PENALTY
00	\$0.36 22 50.38 124 \$2.50 168 \$1.87
01	0.36 27 0.38 132 1.50 169 1.87
02	0.36 30 0.36 138 1.38 175 1.35
04	0.42 32 0.38 139 1.38 221 1.38
08	0.38 37 0.53 155 1.38 258 1.38
10	0.36 38 0.53 157 1.25 273 2.25
11	0.38 42 1.25 160 1.85 367 1.00
20	0.36 74 0.56 162 1.85 368 1.00
21	0.38 75 0.85 163 1.85 377 1.88

JUST IN! 74LS14.....\$1.38

HIGH FIDELITY

DIAMOND NEEDLES and Stereo Cartridges at Discount prices for Shure, Pickering, Stanton, Empire, Grado and ADC. Send for free catalog. LYLE CARTRIDGES, Dept. P, Box 69, Kensington Station, Brooklyn, New York 11218.

SAVE 50% build your own speaker system write: McGee Radio Electronics, 1901 McGee Street, Kansas City, Missouri 64108.

BURGLAR ALARMS

DIALING UNIT automatically calls police \$29.95. Free security equipment catalog. S&S Systems, 5619-C St. John, Kansas City, MO 64123. (816) 483-4612.

Burglar-Smoke Fire Alarm Catalog

• Billions of dollars lost annually due to lack of protective warning alarms.

FREE CATALOG Shows you how to protect your home, business and person. Wholesale prices. Do-it-yourself. Free engineering service.



Burdex Security Co.

Box 82209 Dept. PE Lincoln, Ne. 68501

GOVERNMENT SURPLUS

MANUALS for Govt Surplus radios, test sets, scopes. List 50 cents (coin). Books, 7218 Roanne Drive, Washington, D.C. 20021.

GOVERNMENT SURPLUS. How and where to Buy in your area. send \$2.00. Surplus, 30177-PE Headquarters Building, Washington, D.C. 20014.

For faster service

USE ZIP CODE

on all mail

2708-PROM	\$55.00
2522 STATIC SHIFT REG	\$1.95
2518 HEX 32 BIT SR	\$3.50
2102-1 1024 BIT RAM	\$1.80
5780 4K DYNAMIC RAM	\$10.50
5202A UV PROM	\$10.50
M55203 UV PROM	\$10.50
1702A UV PROM	\$10.75
5204-4K PROM	\$18.95
MINIATURE MULTI-TURN TRIM POTS	
100, 50K, 20K, 10K, 100K, 200K, 1 Meg	\$1.75 each
MULTI-TURN TRIM POTS Similar to Bourns	\$2.00
3010 style 3/16" x 5/8" x 1 1/4", 50, 100, 1K, 10K, 50K ohms	\$1.50 ea
LIGHT ACTIVATED SCR's	\$3.50/DOZ
TO-18, 200V 1A	\$ 1.75
TRANSISTOR SPECIALS	
2N3585 NPN Si TO 66	\$.95
2N3772 NPN Si TO-3	\$ 1.60
2N4908 PNP Si TO-3	\$ 1.00
2N6095 NPN Si TO-3 Darlington	\$ 1.70
2N5086 PNP Si TO-92	4/5 1.00
2N4898 PNP TO-66	\$.60
2N4043 PNP GE TO 5	5/5 1.00
2N3919 NPN Si TO-3 RF	\$ 1.50
MPSA 13 NPN Si TO-92	3/1 1.00
2N3767 NPN Si TO-66	\$.70
2N2222 NPN Si TO-18	5/5 1.00
2N3055 NPN Si TO-3	\$.80
2N3904 NPN Si TO-92	5/5 1.00
2N5296 NPN Si TO-220	\$.50
2N6109 PNP Si TO-220	\$.55
2N3638 PNP Si TO-5	5/5 1.00
2N651 / NPN TO 92 Si	3/5 1.00
CMOS (DIODE CLAMPED)	
74C02 - 22 4015 95 4035 - 1 10	
74C10 - 22 4016 40 4042 - 7 80	
74C193 1 50 4017 1 05 4047 2 00	
4001 - 22 4018 - 100 4049 - 40	
4002 - 22 4019 - 25 4050 - 40	
4006 1 20 4022 95 4055 1 50	
4007 - 22 4024 - 75 4066 80	
4009 - 42 4027 - 40 4071 - 22	
4010 - 42 4028 88 4076 70	
4011 - 22 4029 1 10 4081 - 22	
4012 - 22 4030 - 12 4520 - 1 15	
4013 - 40	
MCA 81 OPTICAL LIMIT SWITCH \$1.50	
LED READOUTS	
FND 500 5" CC	\$1.75
HP 7740 3" CC	\$1.40
MAN 7 3" C.A.	\$1.25
NS 33-3 dig. array	\$1.35
DL 747	\$2.50
Send 25c for our catalog featuring Transistors and Rectifiers	
145 Hampshire St., Cambridge, Mass.	

PRINTED CIRCUIT BOARD

4.1 1/2" x 6.1 1/2" SINGLE SIDED EPOXY BOARD 1/16" thick, unetched \$3.50 ea. 5/52.20

7 WATT LD-65 LASER DIODE IR \$8.95

2N 3820 P FET	\$.45
2N 5457 N FET	\$.45
T1S 43 UJT	\$.35
ER 900 TRIGGER DIODES	4 \$1.00
2N 6028 PROG UJT	\$.65
8 PIN DIP SOCKETS	\$.24
14 PIN DIP SOCKETS	\$.25
16 PIN DIP SOCKETS	\$.28
18 PIN DIP SOCKETS	\$.30
24 PIN DIP SOCKETS	\$.40
40 PIN DIP SOCKETS	\$.60

VERIPAX PC BOARD

This board is a 1/16" single sided paper epoxy board, 4" x 6", DRILLED and ETCHED which will hold up to 21 single 14 pin IC's or 8, 16, or LSI DIP IC's with buses for power supply Connector. \$4.00

MY 5681 YEL LOW GREEN	\$1.25
FP 100 PHOTO TRANS	\$ 5.50
RED, YELLOW, GREEN OR AMBER LARGE LED's	ea. \$.20
MOLEX PINS	1000/5 1.00
10 WATT ZENERS 3.9, 4.7, 5.6, 8.2, 12, 15, 18, 22, 100, 150 or 200V	ea. \$ 6.00
1 WATT ZENERS 4.7, 5.6, 10, 12, 15, 18 OR 22V	ea. \$.25
MC6860 MODEM CHIP	\$13.00

Silicon Power Rectifiers

PRV 1A 3A 12A 50A 125A	
100 06 .14 30 80 3 70	
200 07 .20 35 1.15 4.25	
400 09 .25 50 1.40 6.50	
600 11 .30 70 1.80 8.50	
800 15 .35 90 2.30 10.50	
1000 20 .45 110 2.75 12.50	

SILICON SOLAR CELLS

2 1/4" diameter
4V at 500 ma. . . . \$4.00 ea., 6/\$22.50

REGULATED MODULAR POWER SUPPLIES

+ - 15 VDC AT 100ma	\$27.95
115VAC INPUT	
5VDC AT 1A 115VAC INPUT	\$24.95
12 VDC AT 5 AMP	\$24.95
LN 4148 (IN914)	15/\$1.00

TANTULUM CAPACITORS

22UF 35V 5 \$1.00	4 7UF 35V 4 \$1.00
47UF 35V 5 \$1.00	6 8UF 35V 3 \$1.00
68UF 35V 5 \$1.00	22UF 35V \$.40
11UF 35V 5 \$1.00	33UF 35V \$.40
2 2UF 20V 5 \$1.00	10UF 5V \$ 5.10
3 3UF 35V 4 \$1.00	100UF 35V \$.50
	150UF 15V \$.50
M/7001 ALARM CLOCK CHIP	\$5.75

NATIONAL MOS DEVICES

MM1402 1.75	MM5057 2.25
MM1403 1.75	MM5058 2.75
MM1404 1.75	MM5060 2.75
MM5013 2.50	MM5061 2.50
MM5016 2.50	MM5555 4.75
MM5017 2.70	MM5556 4.75
MM5055 2.25	MM5210 1.95
MM5056 2.25	MM5260 1.75

TTL IC SERIES

7400 - 15 7442 52 74126 - 40	
7401 - 15 7445 70 74151 - 70	
7402 - 15 7446 70 74153 - 65	
7403 - 15 7447 70 74154 - 110	
7404 - 20 7448 70 74155 70	
7405 - 20 7450 20 74157 70	
7406 - 25 7472 33 74161 85	
7407 25 7473 35 74164 95	
7408 25 7474 35 74165 105	
7409 21 7475 49 74173 140	
7410 15 7476 35 74174 95	
7411 20 7480 35 74175 92	
7412 20 7483 70 74177 79	
7413 45 7485 88 74180 70	
7414 70 7486 30 74181 - 210	
7415 25 7489 1.85 74190 1.20	
7417 25 7490 45 74191 1.20	
7420 20 7491 70 74192 85	
7425 28 7492 50 74193 95	
7426 25 7493 45 74194 85	
7427 30 7494 70 74195 75	
7430 20 7495 70 74196 88	
7432 25 7496 70 74257 1.25	
7437 25 74107 32 74279 90	
7438 25 74121 38 75324 1.75	
7440 16 74123 65 75401 65	
7441 85 74125 40 75492 65	

MINIATURE DIP SWITCHES

CTS 206 4 Four SPST switches in one minidip package	\$1.75
CTS-206 8 Eight SPST switches in a 16 pin D P package	\$1.95

AY-5-1013 A30K ser./par., par./ser., universal UART \$6.95

ALCO MINIATURE TOGGLE SWITCHES	
MTA 106 SPDT	\$1.20
MTA 206 DPDT	\$1.70

Full Wave Bridges

PRV 2A 6A 25A	
200 75 1.25 2.00	
400 95 1.50 3.00	
600 1 20 1.75 4 00	

SANKEN AUDIO POWER AMPS

Si 1010 G 10 WATTS	\$ 7.95
Si 1020 G 20 WATTS	\$15.95
Si 1050 G 50 WATTS	\$27.95

CCD 110 LINEAR 256 X1 BIT SELF SCANNING CHARGED COUPLED DEVICE \$99.00

CCD 201 100 x 100 CHARGE COUPLED DEVICE \$135.00

LINEAR CIRCUITS

LM 307 Op Amp	\$.30
LM 309K 5V 1A REGULATOR	\$.95
723 40 + 40VV REGULATOR	\$.50
301/748-Hi Per. Op. Amp	\$.31
3201 5, 12, 15, or 24V NEG REG	\$1.25
709C Op Amp	\$.31
741A or 741C OP AMP.	\$.31
710 COMPARATOR	\$.35
CA 3047 Hi Per. Op Amp	\$.95
3401 5, 6, 8, 12, 15, 18, 24V POS REG. TO 220	\$1.10
101 OPER. AMP. HI PERFORM	\$.75
LM 308 Oper. Amp., Low Power	\$.95
747 DUAL 741	\$.65
556 DUAL TIMER	\$1.00
537 - PRECISION OP. AMP	\$1.70
LM 3900 QUAD OP. AMP	\$.49
LM 324 QUAD 741	\$1.50
560 - PHASE LOCK LOOP	\$2.00
561 - PHASE LOCK LOOP	\$2.00
566 FUNCTION GEN.	\$1.65
567 - TONE DECODER	\$1.50
LM 1310M FM STEREO DEMOD	\$2.75
8038 IC VOLTAGE CONT. OSC	\$3.90
LM 370 - AGC SQUELCH AMP.	\$1.15
555 250 2 HR TIMER	\$.45
553 QUAD TIMER	\$2.50
FCD 810 OPTO-ISOLATOR	\$.80
1458 DUAL OP AMP	\$.60
LM 380 2W AUDIO AMP	\$.95
LM 377 - 2W Stereo Audio Amp.	\$2.50
LM 381 - STEREO PREAMP.	\$1.50
LM 392 DUAL AUDIO PREAMP	\$1.50
LM 311 HI PER. COMPARATOR	\$.90
LM 319 Dual Hi Speed Comp	\$1.25
LM 339 - QUAD COMPARATOR	\$1.50

TRIACS SCR'S

PRV 1A 10A 25A 1.5A 6A 35A	
100 40 70 1.30 40 50 1.20	
200 70 1.10 1.75 .60 70 1.60	
400 1.10 1.60 2.60 1.00 1.20 2.20	
600 1.70 2.30 3.60 1.50 3.00	

Terms: FOB Cambridge, Mass.
Send Check or Money Order.
Include Postage. Minimum Order \$5.00, COD'S \$20.00



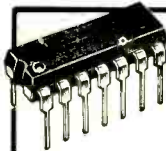
SOLID STATE SALES

P.O. BOX 74A
SOMERVILLE, MASS. 02143 TEL. (617) 547-4005

WE SHIP OVER 95% OF OUR ORDERS THE DAY WE RECEIVE THEM

CIRCLE NO 56 ON FREE INFORMATION CARD

www.americanradiohistory.com



DIGI-KEY CORPORATION
Quality Electronic Components
Double-Digit Discounts
Save You Even More

2102-1 \$1.99 **8080A \$24.95** **LM3909 69¢**

MA1002A 12 Hour (AM-PM) Version \$10.50
MA1002C 24 Hour Version \$10.50



0.5" High LED Digits

Special transformer and 6 switches, when ordered with module add \$3.45.

NATIONAL SEMICONDUCTOR CLOCK MODULES

MA1010A 12 Hour (AM-PM) Version . . . \$13.00
MA1010C 24 Hour Version \$13.00

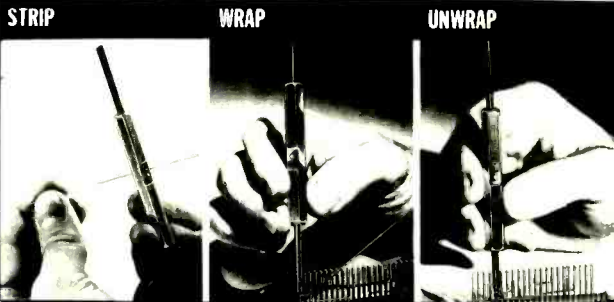
0.84" High LED Digits



Special transformer and 6 switches when ordered with module add \$3.45

Hobby-Wrap-30 \$5.95

Strips, Wraps and Unwraps 30 ga. wire on standard wire wrapping pins



STRIP

WRAP

UNWRAP



MA1002 & MA1010 Series Electronic Clock Modules

The MA1002 & MA1010 Series Electronic Clock Modules are assembled and pretested modules which combine a monolithic MOS-LSI integrated clock circuit, 4-digit LED display, power supply and other associated discrete components on a single printed circuit board to form a complete electronic clock movement. The user need add only a transformer and switches to construct a digital clock for application in clock radios, alarm or instrument panel clocks. Time-keeping may be from 50 or 60 Hz inputs and 12 or 24 hour display formats may be chosen. Direct LED drive eliminates RF interference. Time setting is made easy through use of "Fast" and "Slow" scanning controls.

The MA1002A and MA1010A have a 12 hour display with an AM and PM indicator. The MA1002C and MA1010C have a 24 hour display.

Features include alarm "on" and "PM" indicators, "sleep" and "snoot" timers and variable brightness control capability. The modules are extremely compact, the MA1002 measuring 1.375" by 3.05", the MA1010 measuring 1.75" by 3.75". This small size is achieved by bonding the I.C. to the back of the circuit board.

It is highly recommended that the transformer be obtained with the clock module as it is a special dual secondary type not otherwise readily available.

Double Digit Discounts Save You Even More!

ACE201-K \$24.95

1,032 SOLDERLESS PLUG-IN THE POINTS
CAPACITY: UP TO 12 14-PIN DIP'S
TWO 5-way binding posts
Size: 4-9/16" x 7-1/2"
Kit form



ENTIRE ROCKWELL CALCULATOR LINE ON DISCOUNT IN OUR LATEST CATALOG



SLIDE SWITCHES

Single Pole Single Throw
15 1.20/10 10.00/C
Double Pole Double Throw
.23 2.00/10 19.00/C

BATTERY HOLDERS

1-AA 26c
2-AA 42c
1-C 35c
2-C 42c
1-D 35c
2-D 42c

BISHOP GRAPHICS Printed Circuit Drafting Aids are now available from Digi-Key

RADIAL ELECTROLYTICS

47/50V .08	65/10	22/50V .12	1.00/10	330/25V .23	1.86/10
1/50V .08	65/10	100/6.3V .09	.75/10	470/10R .21	1.71/10
2/250V .08	65/10	100/10V .10	.77/10	470/16V .23	1.81/10
3/350V .08	65/10	100/16V .11	.85/10	470/25V .29	2.35/10
4/735V .08	65/10	100/25V .13	1.10/10	1000/16V .24	1.96/10
4/750V .08	68/10	100/50V .21	1.71/10	1000/16V .29	2.35/10
10/16V .08	65/10	220/10V .13	1.08/10	1000/25V .42	3.33/10
10/25V .08	65/10	220/16V .15	1.16/10	2200/10V .42	3.33/10
10/50V .10	75/10	220/25V .21	1.71/10	2200/16V .54	4.30/10
22/16V .08	67/10	220/50V .29	2.35/10	2200/25V .58	4.67/10
22/25V .09	70/10	330/10V .15	1.16/10	3300/16V .89	7.14/10
		330/16V .21	1.66/10		

AXIAL ELECTROLYTICS

47/10V .11	90/10	33/25V .14	1.15/10	330/16V .29	2.35/10
1/30V .11	90/10	33/50V .19	1.52/10	330/25V .32	2.54/10
3/335V .12	95/10	47/16V .14	1.15/10	470/16V .32	2.55/10
3/350V .12	1.00/10	47/25V .17	1.30/10	470/25V .37	3.00/10
4/725V .11	90/10	47/50V .21	1.71/10	1000/10V .33	2.65/10
4/735V .12	95/10	100/10V .10	1.00/10	1000/16V .33	2.65/10
4/750V .12	1.00/10	100/16V .11	1.10/10	1000/25V .42	3.33/10
10/25V .12	1.00/10	100/16V .11	1.10/10	1000/50V .56	4.50/10
10/50V .14	1.15/10	100/20V .12	1.55/10	2200/10V .50	3.96/10
22/16V .12	1.00/10	100/50V .29	2.30/10	2200/16V .62	4.95/10
22/25V .13	1.05/10	220/10V .18	1.47/10	2200/25V .79	6.36/10
22/50V .17	1.32/10	220/16V .20	1.55/10	3300/16V .95	7.63/10
33/16V .12	1.00/10	220/25V .29	2.35/10	4700/16V .109	8.70/10
		330/10V .14	1.16/10	1000/10V .115	9.19/10

INTEGRATED CIRCUITS — TTL, CMOS, LINEAR & MOS

7400 .21	7476 .32	74181 .215	4012 .23	4520 .114	
7401 .21	7480 .70	74182 .79	4013 .40	4527 .168	
7402 .21	7482 .70	74184 .219	4014 .96	4528 .180	
7403 .21	7483 .70	74185 .219	4015 .96	4585 .128	
7404 .21	7485 .89	74188 .350	4016 .40	2102-1 .199	
7405 .21	7486 .28	74189 .350	4017 1.05	8080A .24.95	
7406 .25	7489 .219	74190 .23	4018 1.05	CA3046 .75	
7407 .25	7490 .44	74191 1.23	4019 .23	LM211N .125	
7408 .21	7491 .70	74192 .88	4020 1.14	LM309K .180	
7409 .21	7492 .44	74193 .88	4021 1.14	LM324A .128	
7410 .21	7493 .44	74194 .88	4022 .96	LM3401-5 .125	
7411 .21	7494 .70	74195 .88	4023 .23	LM3401-6 .125	
7412 .21	7495 .70	74196 .88	4024 .84	LM3401-8 .125	
7413 .25	7496 .70	74197 .88	4025 .23	LM3401-12 .125	
7414 .89	74100 .28	74198 .49	4026 1.68	LM3401-15 .125	
7416 .25	74109 .33	74199 1.49	4027 .40	LM3401-18 .125	
7417 .25	74109 .33	74201 .09	4028 .89	LM3401-24 .125	
7420 .21	74121 .35	74275 .55	4029 1.14	LM3900M .88	
7421 .25	74122 .44	74365 .67	4030 .23	LM3909M .69	
7423 .35	74123 .61	74366 .67	4033 1.51	MC1456V .100	
7425 .35	74125 .40	74367 .67	4034 3.50	MC1458V .53	
7426 .25	74126 .40	74368 .67	4035 1.14	MC2302P .115	
7427 .33	74132 .70	8093 .40	4040 1.14	NE531 .324	
7428 .78	74141 .88	8094 .40	4041 .79	NE540L .204	
7430 .21	74145 .70	8095 .67	4042 .79	NE555V .48	
7432 .75	74147 .63	8096 .67	4043 .70	NE560A .86	
7433 .30	74148 .30	8097 .67	4044 .70	NE560B .383	
7437 .25	74150 .16	8098 .67	4046 1.86	NE561B .383	
7438 .25	74151 .70	75150 .116	4049 .40	NE562B .383	
7440 .21	74153 .88	75151 .61	4050 .40	NE565A .125	
7442 .53	74154 .03	75451 .61	4051 1.26	NE566V .28	
7443 .63	74155 .70	75452 .61	4052 1.26	NE567V .136	
7445 .70	74156 .70	75453 .61	4053 1.26	uA709CV .44	
7446 .70	74157 .70	75454 .61	4056 1.58	uA710CA .44	
7447 .70	74160 .88	75491 .81	4064 .79	uA711CA .53	
7448 .70	74161 .88	75492 .84	4071 .23	uA723CA .64	
7450 .21	74162 .88	75493 1.09	4072 .23	uA733CA .75	
7451 .21	74163 .88	75494 1.19	4073 .23	uA741CV .44	
7452 .21	74164 .96	82525 2.19	4075 .23	uA747CA .75	
7454 .21	74165 .115	4000 .23	4081 .23	uA748CV .125	
7459 .21	74166 1.26	4001 .23	4082 .23	uA7805CU .125	
7460 .21	74170 2.64	4002 .23	4502 .79	uA7806CU .125	
7470 .30	74173 1.42	4006 1.23	4510 1.14	uA7808CU .125	
7472 .30	74174 .98	4007 .23	4511 1.05	uA7812CU .125	
7473 .30	74175 .92	4008 .79	4514 2.80	uA7815CU .125	
7474 .30	74176 .78	4009 .44	4515 2.80	uA7818CU .125	
7475 .49	74177 .99	4010 .44	4516 1.23	uA7819CU .125	
		4011 .23	4518 1.14	uA7824CU .125	

NEW



Battery wire wrapping tool
\$34.95
ONLY \$34.95
COMPLETE WITH BIT AND SLEEVE

WIRE WRAPPING WIRE IN BULK

Red or Black 30 ga. Kynar
100' \$2.00 500' \$8.50 1000' \$15.00

SILICON DIODES

1N4001	.64/10	5.50/C	\$49/M
1N4002	.66/10	5.60/C	\$51/M
1N4003	.68/10	5.80/C	\$52/M
1N4004	.70/10	5.95/C	\$54/M
1N4005	.82/10	7.05/C	\$63/M
1N4006	.90/10	7.75/C	\$69/M
1N4007	.99/10	8.60/C	\$77/M
1N4148	.40/10	3.50/C	\$29/M

Double Digit Discounts Save You Even More!

1/2 WATT ZENER DIODES

1N5268	3.3v	15 111/C	1N5236B	7.5v	15 111/C
1N5271B	3.6v	15 111/C	1N5237B	8.2v	15 111/C
1N5278B	3.9v	15 111/C	1N5238B	8.7v	15 111/C
1N5298B	4.3v	15 111/C	1N5239B	9.1v	15 111/C
1N5230B	4.7v	15 111/C	1N5240B	10v	15 111/C
1N5231B	5.1v	15 111/C	1N5241B	11v	15 111/C
1N5232B	5.5v	15 111/C	1N5242B	12v	15 111/C
1N5233B	6.0v	15 111/C	1N5243B	13v	15 111/C
1N5234B	6.2v	15 111/C	1N5244B	14v	15 111/C
1N5235B	6.8v	15 111/C	1N5245B	15v	15 111/C

PERF BOARD

0.1" spacing between holes
4 1/2" x 6" \$1.71
4 1/2" x 17" \$4.25

TERMINALS

for above perf board
\$1.50/C

LED LAMPS

NSLS503 T-1 3/4 .18 \$15/C
NSLS506 T-1 3/4 .18 \$15/C

LED DISPLAYS

FND357 CC .375" \$1.35
FND500 CC .500" \$1.35
FND .507 CA .500" \$1.35
FND800 CC .800" \$2.50

DATA BOOKS



DATA BOOKS

TTL IC's 595 p. \$4.00
Linear IC's 957 p. \$5.00
CMOS IC's 286 p. \$3.00
Transistors 258 p. \$3.00
Memory IC's 592 p. \$4.00
Interface IC's 464 p. \$3.00
Volt. Regs. 128 p. \$3.00
Linear Appl. 1 432 p. \$4.00
Linear Appl. 2 246 p. \$3.00
Audio 196 p. \$3.00

WIRE-WRAPPING TOOL

\$5.95
Wraps, Unwraps & Strips 30 ga. Wire

1/4 & 1/2 WATT 5% CARBON FILM RESISTORS

See each in multiples of 5 per value
\$1.70/100 & \$12.00/1000 of same value
1 ohm thru 1.0 megohm

HARDWARE

2-56 1/4 Screw	99/C	7.20/M
2-56 1/2 Screw	99/C	7.65/M
4-40 1/4 Screw	55/C	3.60/M
4-40 1/2 Screw	60/C	4.05/M
6-32 1/4 Screw	65/C	4.40/M
6-32 1/2 Screw	75/C	4.85/M
8-32 3/8 Screw	90/C	5.85/M
8-32 5/8 Screw	99/C	7.00/M
2-56 Hex Nut	55/C	3.90/M
4-40 Hex Nut	55/C	3.75/M
6-32 Hex Nut	60/C	4.00/M
8-32 Hex Nut	60/C	4.15/M
No. 2 Lockwasher	85/C	5.75/M
No. 4 Lockwasher	45/C	3.00/M
No. 6 Lockwasher	45/C	3.00/M
No. 8 Lockwasher	45/C	3.00/M

I.C. SOCKETS

8 Pin Solder	17	1.60/10
14 Pin Solder	20	1.90/10
18 Pin Solder	22	2.10/10
18 Pin Solder	29	2.75/10
24 Pin Solder	38	3.60/10
28 Pin Solder	45	4.25/10
40 Pin Solder	63	6.00/10
8 Pin W-W	24	2.30/10
14 Pin W-W	26	2

INSTRUCTION

LEARN ELECTRONIC ORGAN SERVICE at home all makes including transistor. Experimental kit—troubleshooting. Accredited NHSC. Free Booklet. NILES BRYANT SCHOOL, 3631 Stockton, Dept. A, Sacramento, Calif. 95820.

EARN ELECTRONICS DEGREE by correspondence. Free information bulletin. Grantham, 2000 Stoner Avenue, Los Angeles, California 90025

F.C.C. EXAM MANUAL

TESTS ANSWERS FOR FCC FIRST AND 2ND CLASS RADIO TELEPHONE LICENSES

NEW! REVISED MULTIPLE-CHOICE QUESTIONS AND DIAGRAMS COVER ALL AREAS TESTED IN FCC EXAMS PLUS "Self-Study Ability Test" \$3.95 POSTPAID. MONEYBACK GUARANTEE

COMMAND PRODUCTIONS P.O. BOX 26348-P
RADIO ELECTRONICS DIVISION SAN FRANCISCO, CALIF. 94126

BELL & HOWELL Television Electronics Course. Best Offer. P.S.B., 49 Derby Ave., Orange, CT 06477.

SCORE high on F.C.C. Exams... Over 300 questions and answers. Covers 3rd, 2nd, 1st and even Radar. Third and Second Test, \$14.50; First Class Test, \$15.00. All tests, \$26.50. R.E.I., Inc., Box 806, Sarasota, Fla. 33577.

UNIVERSITY DEGREES BY MAIL! Bachelors. Masters. Ph.D's. Free revealing information. Counseling. Box 389-PE03, Tustin, California 92680.

SELF-STUDY CB RADIO REPAIR COURSE. THERE'S MONEY TO BE MADE REPAIRING CB RADIOS. This easy-to-learn course can prepare you for a career in electronics enabling you to earn as much as \$16.00 an hour in your spare time. For more information write: CB RADIO REPAIR COURSE, Dept. PE037, 531 N. Ann Arbor, Oklahoma City, Okla. 73127.

LEARN WHILE ASLEEP! HYPNOTIZE! Astonishing details, strange catalog free! Autosuggestion, Box 24-ZD, Olympia, Washington 98507.

GRANTHAM'S FCC LICENSE STUDY GUIDE — 377 pages, 1465 questions with answers/discussions — covering third, second, first radiotelephone examinations. \$10.70 postpaid. GSE, 2000 Stoner, Los Angeles, California 90025.

FREE Educational Electronics Catalog. Home study courses. Write to: Edukits Workshop, Department 722D, Hewlett, N.Y. 11557.

INTENSIVE 5 week course for Broadcast Engineers. FCC First Class license. Student rooms at the school. Radio Engineering Inc., 61 N. Pineapple Ave., Sarasota, FL 33577 and 2402 Tidewater Trail, Fredericksburg, VA 22401.

PRACTICAL Electronic training. FCC license. Free home study catalog. Genn Tech., 5540 Hollywood Blvd., Los Angeles, CA 90028. Or, Ra-Tel Electronics, P.O. Box 167, "P" Toronto, Ont., Canada. U.S. Inquiries.

LEARN BASIC Digital Troubleshooting by correspondence. Course includes text and demonstration modules. Educational Technologies, Box 224, Reynoldsburg, Ohio 43068.

BREAK INTO TV/RADIO Broadcasting. Disc Recording career. Expert reveals secret avoiding disappointment, wasted time/money. Free information. Box 921, Beverly Hills, Calif. 90213.

HIGHLY EFFECTIVE Degree Program in Electronics Engineering. Advance rapidly! Our 31st Year. Free literature. Cook's Institute, Box 20345, Jackson, Miss. 39209.

FCC EXAMINATIONS? Go First Class! Complete First — Third Questions - Answers plus "topical study" guide. \$8.00. "Guaranteed Exams". Box 5516-AC, Walnut Creek, CA 94596.

HIGHLY EFFECTIVE Degree Program in Electronics Engineering. Advance rapidly! Our 31st Year. Free literature. Cook's Institute, Box 20345, Jackson, Miss. 39209.

BECOME TELEVISION REPORTER without previous experience! New book by acclaimed newsmen reveals shortcuts to rewarding career. \$6.00 postpaid. Free brochure. Station Break, Box 550, Bentonville, Arkansas 72712.

PERSONALS

MAKE FRIENDS WORLDWIDE through international correspondence. Illustrated brochure free. Hermes-Verlag, Box 110660/Z, D-1000 Berlin 11, Germany.

WARTS. Vergo® Cream is painless, safe, easy, gentle. Buy Vergo® at better pharmacies.

INVENTIONS WANTED

INVENTORS: Manufacturers Need New Products. Free "Recommended Procedure," by a creative fee-based invention service company. Washington Inventors Service, 422-T Washington Building, Washington, D. C. 20005.

★ MICROPROCESSOR PRODUCTS

★ MICROCOMPUTER PRODUCTS

BUILD YOUR OWN COMPLETE COMPUTER SYSTEM

★ AMI EVK 99 6800 BASED MICROCOMPUTER

Photo of expanded EVK 99

\$159.95

★ UNIVERSAL KLUGE BOARD \$98.00

★ 16K BYTE RAM BOARD \$77.95

★ 4 SLOT MOTHER BOARD \$29.95

★ EXTENDER BOARD \$46.50

★ TV GAME KITS

BUY 10 OF THE FOLLOWING AND YOUR PRICE IS

AMD 8080A \$19.95

AMD 9111 \$4.10

AMD 9112 \$7.30

RF MODULATOR MODULE \$8.95

★ SPECIALS

75452	10/2/50
81268	2/5/00
74151/138	8097
74166	80
74161	45
7414C	10/2/50
MHD26CN	3.95
1489	1.29

★ NEW PRODUCTS

NEW FROM NEC Microcomputer! FIRST TIME OFFERED

D372 Floppy Disc Controller Chip \$75.00

D371 Map Cassette Controller Chip \$65.00

Application Notes (26 pages) 6.95

GI AY3550 4 1/2 Digit DVM Chip 29.95

GI AY3600 Keyboard Encoder 9.95

Internal 80386C 4.95

AY3507 4.95

RO 32513 Char Gen 9.95

★ IC MARKET PLACE ★

★ LINEAR

LM108	3.50	LM2006	5.2	1.45	LM339N	1.75
LM109	2.50	LM2006	12	1.45	LM339N	1.75
LM300A	80	LM2006	15	1.45	LM567CN	58
LM301A	45	LM2006	17	1.75	LM567CN	58
LM301CN	45	LM2006	17	1.75	LM567CN	58
LM302H	1.25	LM2006	17	1.75	LM567CN	58
LM300A	40	LM2006	17	1.75	LM567CN	58
LM305H	85	LM2006	17	1.75	LM567CN	58
LM305AH	1.25	LM2006	17	1.75	LM567CN	58
LM309A	95	LM2006	17	1.75	LM567CN	58
LM307CN	35	LM2006	17	1.75	LM567CN	58
LM307A	35	LM2006	17	1.75	LM567CN	58
LM308H	100	LM2006	17	1.75	LM567CN	58
LM308CN	100	LM2006	17	1.75	LM567CN	58
LM309H	110	LM2006	17	1.75	LM567CN	58
LM309E	125	LM2006	17	1.75	LM567CN	58
LM310CN	115	LM2006	17	1.75	LM567CN	58
LM310H	115	LM2006	17	1.75	LM567CN	58
LM311H	90	LM2006	17	1.75	LM567CN	58
LM311CN	49	LM2006	17	1.75	LM567CN	58
LM312H	1.95	LM2006	17	1.75	LM567CN	58
LM318H	50	LM2006	17	1.75	LM567CN	58
LM318CN	1.50	LM2006	17	1.75	LM567CN	58
LM319H	110	LM2006	17	1.75	LM567CN	58
LM320H	1.45	LM2006	17	1.75	LM567CN	58

★ 7400 TTL

7400N	18	7445A	99	74122N	44	74185A	\$2.10
74101N	18	7446A	99	74123N	80	74186A	30
74020N	18	7447A	99	74124N	78	74187A	\$1.30
74040A	18	7448A	99	74125N	78	74188A	\$1.10
74060A	20	7449A	28	74126N	78	74189A	95
74080A	28	7450A	28	74127N	78	74190A	95
74100A	25	7451A	28	74128N	78	74191A	95
74120A	21	7452A	46	74129N	78	74192A	95
74140A	21	7453A	46	74130N	78	74193A	95
74160A	21	7454A	46	74131N	78	74194A	95
74180A	21	7455A	46	74132N	78	74195A	95
74200A	21	7456A	46	74133N	78	74196A	95
74220A	21	7457A	46	74134N	78	74197A	95
74240A	21	7458A	46	74135N	78	74198A	95
74260A	21	7459A	46	74136N	78	74199A	95
74280A	21	7460A	46	74137N	78	74200A	95
74300A	21	7461A	46	74138N	78	74201A	95
74320A	21	7462A	46	74139N	78	74202A	95
74340A	21	7463A	46	74140N	78	74203A	95
74360A	21	7464A	46	74141N	78	74204A	95
74380A	21	7465A	46	74142N	78	74205A	95
74400A	21	7466A	46	74143N	78	74206A	95
74420A	21	7467A	46	74144N	78	74207A	95
74440A	21	7468A	46	74145N	78	74208A	95
74460A	21	7469A	46	74146N	78	74209A	95
74480A	21	7470A	46	74147N	78	74210A	95
74500A	21	7471A	46	74148N	78	74211A	95
74520A	21	7472A	46	74149N	78	74212A	95
74540A	21	7473A	46	74150N	78	74213A	95
74560A	21	7474A	46	74151N	78	74214A	95
74580A	21	7475A	46	74152N	78	74215A	95
74600A	21	7476A	46	74153N	78	74216A	95
74620A	21	7477A	46	74154N	78	74217A	95
74640A	21	7478A	46	74155N	78	74218A	95
74660A	21	7479A	46	74156N	78	74219A	95
74680A	21	7480A	46	74157N	78	74220A	95
74700A	21	7481A	46	74158N	78	74221A	95
74720A	21	7482A	46	74159N	78	74222A	95
74740A	21	7483A	46	74160N	78	74223A	95
74760A	21	7484A	46	74161N	78	74224A	95
74780A	21	7485A	46	74162N	78	74225A	95
74800A	21	7486A	46	74163N	78	74226A	95
74820A	21	7487A	46	74164N	78	74227A	95
74840A	21	7488A	46	74165N	78	74228A	95
74860A	21	7489A	46	74166N	78	74229A	95
74880A	21	7490A	46	74167N	78	74230A	95
74900A	21	7491A	46	74168N	78	74231A	95
74920A	21	7492A	46	74169N	78	74232A	95
74940A	21	7493A	46	74170N	78	74233A	95
74960A	21	7494A	46	74171N	78	74234A	95
74980A	21	7495A	46	74172N	78	74235A	95
75000A	21	7496A	46	74173N	78	74236A	95

★ PLASSEY SEMICONDUCTORS

★ RADIO COMMUNICATION

SL810C	1.95	SL824C	2.75
SL811C	1.95	SL830C	1.95
SL812C	1.95	SL840C	1.95
SL813C	2.40	SL841C	6.95
SL820C	2.55	SL850C	7.55
SL821C	4.95	SL851C	4.95
SL822C	2.95	SL860C	3.75

★ DIVIDERS

SP8600B	8.95	SP8610B	11.50	SP8620B	8.70
SP8610B	4.25	SP8620B	8.50	SP8630B	7.50
SP8620B	16.00	SP8630B	21.00	SP8640B	12.50
SP8630B	14.50	SP8640B	17.00	SP8650B	10.00
SP8640B	8.25	SP8650B	12.00	SP8660B	8.00
SP8650B	12.00	SP8660B	10.00	SP8670B	8.00
SP8660B	17.50	SP8670B	10.00	SP8680B	8.00
SP8670B	18.00	SP8680B	10.00	SP8690B	8.00
SP8680B	22.00	SP8690B	10.00	SP8700B	8.00
SP8690B	22.00	SP8700B	10.00	SP8710B	8.00

INVENTORS

RECOGNITION...FINANCIAL REWARD...OR CREDIT FOR "INVENTING IT FIRST" MAY BE YOURS!

If you have an idea for a new product, or a way to make an old product better, contact us, "the idea people" We'll develop your idea, introduce it to industry, negotiate for cash sale or royalty licensing. Write now without cost or obligation for free information. Fees are charged only for contracted services. So send for your FREE "Inventor's Kit." It has important Marketing Information, a special "Invention Record Form" and a Directory of 500 Corporations Seeking New Products.

RAYMOND LEE ORGANIZATION
230 Park Avenue North, New York, NY 10017

At no cost or obligation, please rush my FREE "Inventor's Kit No. A-112".

Name Please Print

Address

City State Zip

TAPE AND RECORDERS

RENT 4-Track open reel tapes—free brochure. Stereo-Parti, P.O. Box 7, Fulton, CA 95401.

RECORDS—TAPES! Discounts to 73%; all labels; no purchase obligations; newsletter; discount dividend certificates; 100% guarantees. Free details. Discount Music Club, 650 Main St., Dept 5-0377, New Rochelle, New York, N.Y. 10801.

WANTED

GOLD, Silver, Platinum, Mercury wanted. Highest prices paid by refinery. Ore assayed. Free circular. Mercury Terminal, Norwood, MA 02062.

SOLVE YOUR TEST CONNECTION PROBLEMS WITH EZ-HOOK

E-Z Hooks have been designed and field tested throughout the industry to save time and money in commercial electronic production and servicing. The spring-loaded hook attaches firmly, yet so gently it will not damage component - frees hands while testing. Durably constructed and fully insulated to a single contact point assuring true readings. Meets exacting laboratory and space age computer technology requirements. AVAILABLE IN 10 RETMA COLORS: Red, black, blue, green, orange, yellow, white, violet, brown or gray.

 <p>Jumper with X-100W Mini Hooks Order No. Length Price 204-12W* 12" \$1.60 204-24W* 24" 1.60</p> <p>Specify color</p>	 <p>Jumper with XM Micro Hooks Order No. Length Price 204XM-12* 12" \$1.70 204XM-24* 24" 1.70</p> <p>Specify color</p>	<p>EXTRA LONG MINI HOOK XL-1 Mini Hook (5.0" long) combines all the proven features of the X100W with an extra long body. It will make safe, short-free test connections in card racks and through deep wiring nest up to 4" \$1.25 ea</p> <p>ORDER Pin XL 1</p>
 <p>Jumper with X-100W Mini Hook to Stacking Banana Plug Order No. Length Price 201XM* 32" \$1.40</p>	 <p>MICRO HOOK XM Micro Hook (1.75" long < 1 gram) for difficult IC Testing. Permits hooks to delicate wires where weight and leverage may damage component. \$.80 ea.</p> <p>Specify color. ORDER P/N XM</p>	 <p>JUMPER WITH XL-1 MINI HOOKS Order No. Length Price 204XL1-12 12" \$2.80 204XL1-24 24" 2.80</p> <p>Specify Color</p>
 <p>Jumper X-100W Mini Hook** to Stacking Banana Plug Order No. Length Price 201V* 32" \$1.35</p>	 <p>MINI HOOK X100W Mini Hook (2.25" long) combines rugged construction, miniature size and Finger-size Hypo Action for all the best test connections. Hook is large enough for component leads, yet small enough to get into tight places. \$.75 ea.</p> <p>Specify color. ORDER P/N X100W</p>	 <p>JUMPER, XL-1 MINI HOOK TO STACKING BANANA PLUG Order No. Length Price 201XL-1* 32" \$1.95</p> <p>Specify color</p> <p>*Specify color **Square hole tip for hooking laterally to leads or vertically over square wire-wrap pins.</p>

SOCKETS

LOW PROFILE, SOLDER, TIN				STANDARD, SOLDER, TIN				STANDARD, SOLDER, GOLD				WIREWRAP GOLD (Level No.3)			
8 Pin	0.16	0.15	0.14	18 Pin	0.28	0.27	0.26	8 Pin	0.20	0.27	0.24	10 Pin	0.25	0.41	0.37
14 Pin	0.19	0.18	0.17	20 Pin	0.34	0.33	0.32	14 Pin	0.35	0.32	0.29	14 Pin	0.39	0.38	0.37
16 Pin	0.21	0.20	0.19	22 Pin	0.36	0.35	0.34	16 Pin	0.38	0.35	0.32	16 Pin	0.43	0.42	0.41
				24 Pin	0.37	0.36	0.35	18 Pin	0.52	0.47	0.43	18 Pin	0.75	0.68	0.62
								22 Pin	0.70	0.63	0.57	24 Pin	1.05	0.95	0.85
								24 Pin	0.70	0.63	0.57	28 Pin	1.40	1.25	1.10
								28 Pin	0.99	0.90	0.81	36 Pin	1.59	1.45	1.30
								36 Pin	1.39	1.26	1.12	40 Pin	1.75	1.55	1.40
								40 Pin	1.59	1.45	1.30				

SAM'S BOOKS

TTL Cookbook/No. 21035/336 pgs. \$8.95
IC OP-AMP Cookbook/20969/592 pgs. \$12.95
Second Class Radiotelephone License Handbook, 5th Ed./21111/448 pgs. \$7.50
Transistor Substitution Handbook, 16th Ed. 21333/384 pgs. \$4.95
Reference Data for Radio Engineers, 6th Ed. 21219/1344 pgs. \$30.00
Basic Electricity/Electronics Series, Vol. 1, Basic Principles and Applications/20167/320 pgs. \$5.50
TV Typewriter Cookbook/21313/256 pgs. \$9.95
Transistor Specifications Manual, 8th Ed. 21335/224 pgs. \$6.95
First Class Radio Telephone License Handbook, 4th Ed./21144/416 pgs. \$7.50
Semiconductor Replacement Guide/21092/256 pgs. \$3.95

Building & Installing Electronic Intrusion Alarms 20929/136 pgs. \$4.50
Understanding IC Operational Amplifiers 20855/128 pgs. \$3.95
How To Use IC Logic Elements, 2nd Ed. 21081/160 pgs. \$4.50
Understanding CMOS Integrated Circuits 21129/144 pgs. \$4.95



1" (26mm) GaAsP LED NUMERIC DISPLAY EP1000 (Common Anode)

1 Pcs - \$4.90 3 Pcs - \$13.00 5 Pcs - \$19.00

Our Quality Is Best!

OK WIRE-WRAP TOOL & WIRE

WSU 30 Wire-wrap tool \$5.95
R-30W-0050 50ft. roll, blue wire 30AWG. \$1.98
R-30Y-0050 50ft. roll, yellow wire 30AWG. \$1.98
R-30W-0050 50ft. roll, white wire 30AWG. \$1.98
R-30R-0050 50ft. roll, red wire 30AWG. \$1.98

NEW 74C00 SERIES CMOS

74C00N 38	74C74N 90	74C157N 340	74C195N 1.80
74C02N 40	74C76N 100	74C160N 2.10	74C221N 2.10
74C04N 60	74C83N 2.75	74C161N 2.10	74C901N 1.00
74C08N 40	74C85N 2.75	74C162N 2.10	74C902N 1.00
74C10N 50	74C86N 1.00	74C163N 2.10	74C903N 1.00
74C14N 2.20	74C89N 14.00	74C164N 1.80	74C904N 1.00
74C20N 50	74C90N 2.70	74C165N 1.80	74C906N 1.00
74C30N 50	74C93N 2.70	74C173N 1.80	74C907N 1.00
74C32N 50	74C95N 1.80	74C174N 1.70	74C914N 2.70
74C42N 2.10	74C107N 1.90	74C175N 1.70	80C95 1.00
74C47N 3.30	74C151N 3.80	74C192N 2.10	80C97 1.00
74C73N 1.20	74C154N 5.70	74C193N 2.10	

CMOS

4000AE 20	4023AE 24	4051AE 1.70	4093AE 1.65
4001AE 24	4024AE 95	4052AE 1.40	4095BE 1.95
4002AE 24	4025AE 24	4053AE 1.70	4098AE 2.50
4006AE 1.30	4026AE 2.50	4055AE 1.95	4099AE 2.90
4007AE 24	4027AE 55	4056AE 1.98	4502AE 1.50
4008AE 1.40	4028AE 1.00	4058AE 50	4507BE 50
4009AE 50	4029AE 1.20	4063AE 2.50	4508BE 2.20
4010AE 50	4030AE 48	4066AE 90	4510AE 1.40
4011AE 24	4032AE 2.00	4068AE 44	4511BE 1.30
4012AE 24	4035AE 1.30	4069AE 44	4512BE 1.30
4013AE 40	4040AE 1.20	4070BE 60	4514AE 5.00
4014AE 1.20	4041AE 1.25	4071AE 45	4515AE 5.00
4015AE 1.30	4042AE 1.20	4072AE 34	4516AE 1.75
4016AE 80	4043AE 95	4073AE 40	4518AE 1.50
4017AE 1.05	4044AE 1.10	4074AE 1.10	4520AE 1.28
4018AE 1.24	4046AE 3.10	4076AE 1.24	4528AE 2.20
4019AE 54	4047AE 1.50	4077AE 40	4585AE 2.05
4020AE 1.45	4048AE 2.40	4078AE 40	4901AE 3.20
4021AE 1.30	4049AE 58	4081BE 40	4911AE 32
4022AE 1.05	4050AE 58	4082AE 39	


POWER SUPPLIES-ADTECH

Model No.	Vdc	Amps	
APSS 3	5	3.0	
APSS 12 1.6	12	1.6	
APSS 15 1.5	15	1.5	30.95
APSS 24 1	24	0	
APSS 28 0.8	28	0.8	
APSS 5 6	5	6	50.40
APSS 12 4	12	4	
APSS 15 3	15	3	
APSS 24 2.2	24	2.2	
APSS 28 2	28	2	
APSS 10 10	10	10	
APSS 12 7	12	7	
APSS 15 6	15	6	71.20
APSS 24 5	24	5	
APSS 28 4	28	4	
DAPS 12 7.5 1.2	12	7.5	41.50
DAPS 12 6.0 1.5	12	6.0	
DAPS 12 1.5 2.12	1.5	2.12	
DAPS 15 1.3 2.15	1.3	2.15	55.10

XR FUNCTION GENERATOR

XR-2206KA SPECIAL \$16.95
Includes monolithic function generator IC, PC board, and assembly instruction manual.

XR-2206KB SPECIAL \$26.95
Same as XR-2206KA and includes external components for PCB board.



SANKEN HYBRID AUDIO POWER AMPLIFIERS

SI-1010G (10W output) ... \$ 6.90
SI-1020G (20W output) ... \$13.95
SI-1050G (50W output) ... \$24.95

Multi-purpose linear amplifiers for commercial and industrial applications. • Less than 0.5% harmonic distortion at full power level. • 1/2 db response from 20 to 100,000 Hz. • Built-in current limiting (for SI-1050G) and efficient heat radiating construction. • Single or split (dual) power supply. • Rugged, compact and light weight packages.

SANKEN Series SI-1000G amplifiers are self-contained power hybrid amplifiers designed for Hi-Fi, stereo, musical instruments, public address systems and other audio applications. The amplifiers have quasi-complementary class B output. The circuit employs flip-chip transistors with high reliability and passivated chip power transistors with excellent secondary breakdown strength.

114 PAGE APPLICATIONS MANUAL

Contains Circuit Data, System Design and Technical Data for SL 1600 series integrated circuits. ... \$1.95

RESISTOR ASSORTMENTS

Each assortment contains 5 pcs each of 10 different values. Values included are shown in (Ohms)

• 1/4W (50 pcs total) ... \$1.75 / 1/2W (50 pcs total) ... \$1.85

Asst.1: 10, 12, 15, 18, 22, 27, 33, 39, 47, 56 ohm
Asst.2: 68, 82, 100, 120, 150, 180, 220, 270, 330, 390 ohm
Asst.3: 470, 560, 680, 820 ohm, 1K, 1.2K, 1.5K, 1.8K, 2.2K, 2.7K
Asst.4: 3.3K, 3.9K, 4.7K, 5.6K, 6.8K, 8.2K, 10K, 12K, 15K, 18K
Asst.5: 22K, 27K, 33K, 39K, 47K, 56K, 68K, 82K, 100K, 120K
Asst.6: 150K, 180K, 220K, 270K, 330K, 390K, 470K, 560K, 680K, 820K
Asst.7: 1M, 1.2M, 1.5M, 1.8M, 2.2M, 2.7M, 3.3M, 3.9M, 4.7M, 5.6M, 6.8M, 8.2M, 10K, 12K, 15K, 18K, 22K, 27K, 33K, 39K, 47K, 56K, 68K, 82K, 100K, 120K
Asst.8R: (All seven assortments above)

• 1/4W 5% 350 pcs total \$10.95 • 1/2W 5% 350 pcs total \$11.55

MATSUO DIPPED TANTALUM CAPACITORS

MF	V	\$	MF	V	\$
1.35	33	6.8	16	40	
15.35	33	6.8	35	45	
22.35	33	10.0	16	42	
33.35	33	10.0	25	45	
47.35	33	10.0	35	90	
68.35	33	15.0	20	45	
1.0	35	33	15.0	35	1.32
1.5	35	40	22.0	16	45
2.2	20	33	33.0	20	12
2.2	35	40	47.0	20	15.3
3.3	35	42	68.0	16	1.62
4.7	35	45			

PLESSEY POLYESTER (CAPACITOR) MINI BOX

MF	V	\$	MF	V	\$
001	1000	14	039	250	15
0012	1000	14	047	250	15
0015	1000	14	056	250	15
0018	1000	14	068	250	15
0022	1000	14	082	250	17
0027	1000	14	1	100	17
0033	1000	14	12	100	18
0039	630	14	15	100	20
0047	630	14	18	100	21
0056	630	14	22	100	23
0068	630	14	27	100	26
0082	630	14	33	100	30
01	630	14	39	100	30
012	630	14	47	100	33
015	630	14	56	100	44
018	630	14	68	100	47
022	400	15	82	100	54
027	400	15	100	100	60

MARCH SPECIAL R-OHM RESISTOR KITS 5% CARBON FILM RESISTORS

1/4 WATT KIT
42 Different Values (68Ω to 4.7 MΩ)
20 Each Value

1/2 WATT KIT
42 Different Values (68Ω to 4.7 MΩ)
20 Each Value

\$23.40 PER KIT
COMPLETE WITH CONVENIENT PARTITIONED STORAGE BIN

PLESSEY SAMPLER

300 METALIZED CAPACITORS 18 DIFFERENT STD. VALUES \$26.00

L 15 PULSE/SWEEP FUNCTION GENERATOR KIT

FEATURES: 1 HZ to 100 KHz in 5 ranges, at constant amplitude • Sine and triangle adjustable to 20vpp into 600 ohms • Sine distortion is .5% typical • Voltage controlled sweep of sine and triangle waves • TTL square wave has a fully adjustable pulse and drives 600 ohms • Frequencies of lower than 1 Hz and greater than 100 kHz are obtainable • short proof • Complete with power supply and metal case. ... \$55.00

new ANCRONA

Minimum order \$10.00. Add \$1.00 to cover postage and handling. California Residents add 6% sales tax. Mail order - Send check or money order to: P.O. BOX 2208P, Culver City, CA 90230. COD, Master Charge and BankAmericard welcomed. (Stores do not accept mail or phone orders.) Books will be shipped by 4th class rate.

• Phone Order - Call: (213) 641-4064

<p>No. 101 250 page INFORMATION BOOKLET Only \$4.95</p>	<p>CALIFORNIA ANCRONA 11080 Jefferson Blvd. Culver City, CA 90230 (213) 390-3595</p>	<p>CALIFORNIA ANCRONA 1300 E. Edinger Ave. Santa Ana, CA 92705 (714) 547-8424</p>	<p>ARIZONA ANCRONA 4518 E. Broadway Tucson, AZ 85711 (602) 881-2348</p>	<p>OREGON ANCRONA 1125 N.E. 82nd Ave. Portland, OR 97220 (503) 254-5541</p>	<p>GEORGIA ANCRONA 3330 Piedmont Rd., NE Atlanta, GA 30305 (404) 261-7100</p>	<p>CANADA, B.C. ANCRONA 5656 Fraser St. Vancouver, BC V5W 2Z4 (423) 324-0707</p>
---	--	---	---	---	---	--

SUPER VALUE!

- ICS Socketed
- Push button Switches on Main PC Board
- Open chassis for Easy Assembly

2 IN 1 DMM-COUNTER



**FCM-8
8 DIGIT
250 MHz KIT**
\$219.95

Size 10W x 3-1/2H x 9D

Meter: Auto polarity and overrange indicator. 11 Meg. Ohm input impedance. Four overlapping ranges on AC-DC volts and current to 1KV and 1 AMP and five ranges on ohms to 1 Meg. Ohm. 500% overrange capability, except current. Accuracy: $\pm 1\%$, ± 1 count DC, $\pm 1.5\%$, ± 1 count AC and Ohms. Counter: Same as FCC-8.

CAPACITANCE COUNTER



**NOW, IT IS
A DREAM TO
MEASURE
YOUR
CAPACITORS.**
**\$89.95
KIT**

Size 7W x 3H x 8D

$\pm 1\%$ ± 1 count (± 1 pfd. below 100 pfd.) Four ranges from pico farads to several thousand microfarads. Features crystal timebase reference for stability. Auto-cycling.

LIN CORP. 15311 S. Broadway, Gardena, California 90248 (213) 532-8809

- Deluxe Metal Cabinet
- Complete Step-by-step Instruction & Diagrams
- .3 in. 7-Seg. LED Readouts

FREQUENCY COUNTER



**FC-6
30 MHz KIT**
\$89.95

Size 7W x 3H x 8D

Perfect for CBers, hams, hobbyists, technicians. Hi Z input, 50MV sensitivity. Frequency 10 Hz to over 30 Mhz. (FC-6) and 100 Hz to over 250 Mhz. (FC-6H). Crystal timebase. 5 ppm.



**FCC-8
8 DIGIT
250 MHz KIT**
\$149.95

Size 10W x 3-1/2H x 9D

Hi Z input. Sensitivity 50 millivolts at 250 Mhz. Readout Hz., Khz., or Mhz. Resolution 1 Hz. to 10 Mhz. and 10 Hz above Crystal time base — 5 ppm.

Add \$2.50 Shipping/Handling Each
California Residents Add 6% Sales Tax



OVERSEAS JOBS — NOW HIRING! High Pay! All Occupations. Transportation. Computerized Reports — \$2.00. TRANSWORLD, International Airport, 3623-N, Los Angeles, Calif. 90009.

AUSTRALIA — NEW ZEALAND. WANT YOU!!! 50,000 Jobs! Transportation! Latest information. \$2.00. AUSTCO, Box 8489-N, Long Beach, Calif. 90803.

DO-IT-YOURSELF

MODULAR TELEPHONES now available. Sets and components, compatible with Western Electric concept. Catalog 50 cents. Box 1147W, San Diego, California 92112.

TREASURE FINDERS

TREASURE may lie beneath your feet! Discover gold, silver, coins, rings, artifacts and more with world-famous, deeper-detecting White's metal detectors. From \$59.95. Dealers world-wide. Free literature! White's Electronics, Dept. PD7-C, 1011 Pleasant Valley Rd., Sweet Home, OR 97386.

SERIOUS COIN SHOOTERS — Semtech's solid-state METL-SENSOR pin-points ALL metal objects, yet defines the target before you dig. FOR FREE literature write: Semtech Corporation, 652 Mitchell Rd., Newbury Park, California 91320

HOME ENTERTAINMENT FILMS

MAKE '77 A LUCKY YEAR — SPEND A FEW \$\$\$\$ & ENJOY LIFE! Order Super Bowl X (Steelers/Cowboys) Super 8 Color, \$19.95 delivered (you save \$0.75); B&W \$7.95 del. (you save \$1.95). Operation Tall Ships — America's Bicentennial Celebration, 200' reel of beautiful Eastman color, \$19.95 + \$0.75 shipping, or Super 8 mag color sound at \$29.95 + \$0.75 shipping. Ali/Frazier I, Murder in Venezuela. Standard 8 Eastman Color, 200' reel, \$18.95 PPD — can be shown on standard or dual 8 projector (you save \$1.75). Hitchcock's Psycho or Frenzy, thrillers for all times, home movie adaptation of feature films, \$9.95 ea + \$0.75 for Super 8 B&W or \$19.95 ea PPD Super 8 mag sound B&W. Or make your own selection from new 54-pg Columbia glossy catalog, \$1.00 refundable with order; Castle catalog \$0.50 incl. order form; Sportlite forms \$0.35. SPORTLITE, Elect-3, 20 N. Wacker, Chicago, IL 60606.

CIRCLE NO. 37 ON FREE INFORMATION CARD

PLANNING TO MOVE?

Let us know 8 weeks in advance so that you won't miss a single issue of **POPULAR ELECTRONICS**.

Attach old label where indicated and print new address in space provided. Also include your mailing label whenever you write concerning your subscription. It helps us serve you promptly.

Write to: P.O. Box 2772, Boulder, CO 80323, giving the following information:

- Change address only Extend my subscription

ENTER NEW SUBSCRIPTION

- 1 year \$9.98 Payment enclosed
Allow 30-60 days for delivery. (1 extra BONUS issue)
 Bill me later

NEW ADDRESS HERE 0204

Name _____ please print

Address _____

City _____

State _____ Zip _____

Additional postage per year: For Canada add \$3. For countries outside U.S. and Canada add \$5 — cash in U.S. Currency only

AFFIX OLD LABEL

If you have no label handy, print OLD address here.

Name _____ please print

Address _____

City _____

State _____ Zip _____

EMPLOYMENT OPPORTUNITIES

ELECTRONICS/AVIONICS EMPLOYMENT OPPORTUNITIES. Report on jobs now open. Details FREE. Aviation Employment Information Service, Box 240E, Northport, New York 11768.

MAGNETS

MAGNETS. All types Specials-20 disc or 10 bar, or 2 stick or 8 assorted magnets. \$1.00. Magnets, Box 192-H Randallstown, Maryland 21133.

CLASSIFIED ADVERTISING ORDER FORM

Please refer to heading on first page of this section for complete data concerning terms, frequency discounts, closing dates, etc

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25
26	27	28	29	30
31	32	33	34	35

WORD COUNT: 15 WORD MINIMUM Include name and address. Name of city (Des Moines) or of state (New York) counts as one word each. Zip Code numbers not counted. (Publisher reserves right to omit Zip Code if space does not permit.) Count each abbreviation, initial, single figure or group of figures or letters as a word. Symbols such as 35mm, COD, P.O., AC, etc., count as one word. Hyphenated words count as two words. Telephone numbers count as one word

_____ Words **\$2.25 (Commercial Rate)** **\$1.35 (Reader Rate)**

Payment of \$ _____ enclosed for _____ insertion(s)

CHARGE: American Express BankAmericard Master Charge Diners Club

for _____ insertion(s). You will be billed monthly.

Account # _____ Expiration Date _____

Master Charge Interbank # (4 digits above name) _____

SIGNATURE MUST BE PROVIDED BELOW

PRINT NAME _____

ADDRESS _____

CITY _____ STATE _____ ZIP _____

SIGNATURE _____

PE-377

MARCH 1977 ADVERTISERS INDEX

READER SERVICE NO.	ADVERTISER	PAGE NO.
1	A P Products, Inc.	12
2	Adva Electronics	133
3	Advanced IC Electronics	127
11	Advanced Microcomputer Products	130
12	Allison Automotive	16
6	Ancrona Corp.	131
7	Antenna Specialist Inc.	97
8	Aries Inc.	120
9	Associated Electronics	87
10	Avanti Research & Development Co.	111
13	B&F Enterprises	126
14	B&K Precision, Dynascan Corporation	103
18	Bennies Warehouse Distribution Center	113
16	Bullet Electronics	126
CREI Capitol Radio Engineering Institute90, 91, 92, 93		
Cleveland Institute of Electronics, Inc.70, 71, 72, 73		
15	Cobra, Product of Dynascan	SECOND COVER
19	Continental Specialties Corporation	1
20	Crown	9
21	Delta Products, Inc.	31
	Digital Concepts	109
22	Digital Group, The	13
23	Digi-Key Corporation	129
24	EICO	105
17	E&L Instruments, Inc.	106
25	Edlie Electronics	116
26	Edmund Scientific Co.	134
27	Edmund Scientific Co.	134
28	Electronic Book Club	5
29	Empire Scientific Co.	6
30	Godbout Elecs., Bill	128
31	Grantham School of Engineering	112
5	Heath Company	61, 62
	Heath Company	80, 81, 82, 83
33	Ignition Systems	112
34	Illinois Audio	114
35	International Electronics Unlimited	122
36	James Electronics	124, 125
37	Lin Corporation	132
38	McIntosh Laboratory Inc.	12
39	Midland	14, 15
40	Motorola	21
NRI Schools34, 35, 36, 37		
41	National Camera Supply	114
42	New-Tone	123
43	OK Machine & Tool Corporation	27
44	Olson Electronics	122
45	Optoelectronics	120
46	PAIA Electronics	112
47	Pickering & Co.	THIRD COVER
48	Poly Paks	119
49	Quest Electronics	126
Radio Shack25		
50	S A E	104
51	SBE, Inc.	2
52	S.D. Sales Co.	121
63	Schober Organ Corp., The	112
53	Sencore	88, 89
54	Shakespeare Company	33
55	Shure Brothers Inc.	7
56	Solid State Sales	128
57	Sonaguard	98
58	Southwest Technical Products Corporation	38
	Speakerlab	102
59	Technology Trends	85
60	U.S. Pioneer	10, 11
4	United Audio Products, Inc.	FOURTH COVER
61	Vernitron	110
62	Western Auto	85

CLASSIFIED ADVERTISING
115, 116, 120, 122, 126, 128, 130, 132, 133

BUSINESS OPPORTUNITIES

I MADE \$40,000.00 Year by Mailorder! Helped others make money! Free Proof. Torrey, Box 318-NN, Ypsilanti, Michigan 48197.

FREE CATALOGS. Repair air conditioning, refrigeration. Tools, supplies, full instructions. Doolin, 2016 Canton, Dallas, Texas 75201.

MAILORDER MILLIONAIRE helps beginners make \$500 weekly. Free report reveals secret plan! Executive (1K3), 333 North Michigan, Chicago 60601.

GET RICH with Secret Law that smashes debts and brings you \$500 to \$5 Million cash. Free report! Credit 4K3, 333 North Michigan, Chicago 60601.

HIGHLY PROFITABLE ONE-MAN ELECTRONIC FACTORY

Investment unnecessary, knowledge not required, sales handled by professionals. Postcard brings facts about this unusual opportunity. Write today! Barta- DP, Box 248, Walnut Creek, CA 94597.

FREE SECRET BOOK "2042 UNIQUE, Proven Enterprises" Fabulous "Little Knowns". Work home! Haylings-B, Carlsbad, Calif. 92008.

\$193.00 WEEKLY. GUARANTEED! Your home. One hour daily. Free details — Professional, Box 24543-X, Saint Louis, Missouri 63141.

HOW TO MAKE \$2,000 WEEKLY at home using other people's money. Guaranteed. Free Details. Richlieu, Box 25357, Dept. F3, Houston 77005.

GUARANTEED \$1,000 monthly. Work one hour daily. "FREE DETAILS!" Unicorn. ZD 1.7350 Nugel, Colorado Springs, CO 80911.

SOLICIT TECHNOLOGY. Mexican engineer wishes to have relations with fabricators of semiconductors or digital electronics products, to establish a new small industry. Write to: Jose Luis Garza, Apartado Postal No. 299 Col. del Valle, Nuevo Leon, Mexico.

NEW LUXURY Car Without Cost. Free Details! Codex-ZZ, Box 6073, Toledo, Ohio 43614.

BROADCAST STATION — FM or CABLE: Start your own! Excellent income, plus free tapes and records. Free details. "Broadcasting", Box 5516-AC, Walnut Creek, CA 94596.

STUFF ENVELOPES \$250+/Thousand, supplies. Enclose stamped, addressed envelope. Enterprises, Route One, Box 263-E3, Paula Valley, OK 73075.

MUSICAL INSTRUMENTS

UP TO 60% DISCOUNT. Name brand instruments catalog. Freeport Music, 114 G. Mahan St., W. Babylon, N.Y. 11704.

REAL ESTATE

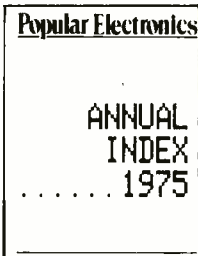
BIG...FREE...CATALOG! Over 2,600 top values coast to coast! UNITED FARM AGENCY, 612-EP, West 47th, Kansas City, MO 64112.

BOOKS AND MAGAZINES

FREE book prophet Elijah coming before Christ. Wonderful bible evidence. Megiddo Mission, Dept. 64, 481 Thurston Rd., Rochester, N.Y. 14619.

POPULAR ELECTRONICS INDEX for 1975 now available. Prepared in cooperation with the Editors of "P/E," this index contains hundreds of references to product tests, construction projects, circuit tips and theory and is an essential companion to your magazine collection. 1975 Edition, \$1.50 per copy. 1972, 73, and 74 editions also still available at \$1.50 each, or \$5.50 for the set of four (1972, thru 1975). Add \$.25 per order for postage and handling.

INDEX, Box 2228, Falls Church, Va., 22042



1977 PHOTOGRAPHY DIRECTORY & BUYING GUIDE



The Directory lists over 3000 products—still cameras, lenses, electronic flash, close-up equipment, slide projectors, darkroom equipment, movie cameras and projectors, film, and more—with complete facts and features, specs, prices, and exclusive "Buypoints". PLUS—A SPECIAL 16-PAGE SUPPLEMENT: Complete optical

tests on 32 normal lenses—four each from eight major camera manufacturers—from the Popular Photography Test Lab.

Order your copy from the Ziff-Davis Consumer Service Division, 595 Broadway, New York, N.Y. 10012. Enclose \$2.25 (\$1.95 plus 30c postage and handling). Outside U.S.A. \$3.00, postpaid.

Residents of Calif., Colo., Fla., Ill., Mich., Mo., N.Y. State, D.C. and Tex. add applicable sales tax (postage and handling charges are non-taxable).

MIND-ABSORBING PROJECTS FOR ELECTRONIC EXPERIMENTERS AND HOBBYISTS



1977 ELECTRONIC EXPERIMENTER'S HANDBOOK

Helps you get it together with a score of build-it-yourself projects.

This latest edition includes a host of exciting construction projects for audio buffs—Audio-Controlled Detailed Power Shut Off; 9-Channel Stereo Equalizer . . . For fun and games—FLIP, a CMOS Logic Game; Sound Effects with the 555 IC Timer . . . for experimenter's—ESP Testing Machine; How to Make Double-Sided PC Boards; IC Digital Logic Memory Probe . . . for computer/calculator enthusiasts—An Under-\$30 Scientific Calculator; Microcomputer Primer; Bits-to-Dots Computer Video. There's a host of other projects including The Executive Digital Temper Countdowner • Versatile Nickel-Cadmium Battery Charger • Shirt-Pocket Metronome • Hall Effect Magnetometer • Low-Cost Metal Locator • 3-Way Photo Flash Tripper • The 99-cent Wonder IC • High-Value Electrolytic Capacitor Meter • Guitar Sound Intensifier • IC Photo Tachometer • R-F Transistor Tester • And more! PLUS: Microcomputer product buying guide and a basic digital logic course. All with complete construction plans, parts lists and printed-circuit board patterns. Many projects are unique designs not available elsewhere. Only \$1.85!

Ziff-Davis Publishing Co. PE-377
Consumer Service Division
595 Broadway, New York, N.Y. 10012

Please send the 1977 ELECTRONIC EXPERIMENTER'S HANDBOOK. I'm enclosing \$1.85 (\$1.50 plus 35c for postage and handling). Outside U.S.A. \$3.00, postpaid.

Residents of Calif., Col., Fla., Ill., Mich., Mo., N.Y. State, D.C. and Tex. add applicable sales tax (postage and handling charges non-taxable).

print name _____
address _____
city _____ state _____ zip _____

THE AUDIO AMATEUR—A quarterly publication for the serious audio constructor. Free prospectus. The Audio Amateur, Box 176Z, Peterborough, N.H. 03458.

BACK ISSUE MAGAZINES. 1890 to 1976. Free list. Send stamped envelope to Everybody's Bookshelf, Dept. PE, 317 West 6th, Los Angeles, CA 90014.

RADIO ASTRONOMY—The Radio Observer magazine. Sample \$1.00. The Peterson Press, 657PM Circle, Drive, Santa Barbara, CA 93108.

RUBBER STAMPS

RUBBER STAMPS, BUSINESS CARDS. Many new products. Catalog. Jackson's, Dept. K, Brownsville Rd., Mt. Vernon, Ill. 62864.

MISCELLANEOUS

WINEMAKERS: Free illustrated catalog yeasts, equipment. Semplex, Box 12276P, Minneapolis, Minn. 55412.

**AMAZING & HARD-TO-FIND
SCIENCE BUYS!
ALTERNATE ENERGY
SPACE AGE • HOBBIES**

SUPER POWER FOR ANY AM RADIO

Antenna assist has pulled in stations 1000 miles off! No wires, clips, grounding. Solid state—no elec., balls, tubes.
No. 72,095AVB \$19.95 Ppd.
ULTRA SELECT-A-TENNA (OVER 1000 MILES)
No. 72,147AVB.....\$24.95



SOLAR ENERGY CUBE

Demonstration of sunlight converting to kinetic energy! Clear plastic cube in sun with its 3 silicon solar cells powers motor to whirl the propeller. Actually produces 1.5v DC. 825 ma.
No. 42,287AVB (4x4x4).....\$23.95



SAVE 50%! 8 x 20 MONOCULAR

Top quality Spy Scope, a \$30 value, now \$14.95! Special purchase saves you 50%. 100% coated optics. 393 ft. field of view. Only 2 oz.—stores in pocket, purse, glove box.
No. 1568AVB \$14.95 Ppd.



NASA-CHOSEN FOR APOLLO/SOYUZ

The Astronauts used this super 20x60 binocular (modified) to view Earth! Big 60 mm objective lenses. 173-ft. field of view at 1000 yds. Relative brightness, 9.0. Fully coated optics. more!
No. 1558AVB(9 1/2 x 8 1/2 : 47.5 oz) \$99.95 Ppd.



ELECTRONIC SOUND COLLECTOR

Tune in a whisper at 20 ft., normal conversations up to 100 ft., birdcalls & high freq. sounds at almost 200 ft. Nearly twice as far over water! Check on baby birds! 18" refl. disc. mike, etc.
No. 80,176AVB \$32.25 Ppd.



LOW COST PORT. INFRA-RED EYE

Self-cont. scope (90 nite vision) has 6032 IR converter tube, f/3.5 telephoto lens, adjust triplet eyepiece. 1.6X Not avail. to Cal. res. except spec. auth'd.
No. 1683AVB (6,12v DC).....\$299.95 Ppd.
No. 1685AVB (SUPER 2.5X BINOC.) \$329.95 Ppd.



MEASURE WIND SPEED ANYWHERE

Hold handy (16 oz.) low cost Anemometer into the wind, quickly read wind speed on its big dial—from 5 to 70mph. Acc to -3% of full scale (2.1 mph), no batts., adjustments, recalibration req.
No. 42,428AVB (7 1/2" HIGH).....\$19.95 Ppd.



OUR MYSTICAL MUSICAL MACHINE

... gets it on! Automatic 256-note pseudo-random tone pattern. Adjust beat, vol., pitch, finger 3 photocells to creatively vary tone of continuous "music." Output jack for patching, recorder! 1.3 lb.
No. 72,208AVB (INCL. 9v BATT.)....\$59.95 Ppd.



110V FUEL MISER RECLAIMS HEAT

Save your 40% wasted heat to warm a basement, garage, room at no extra cost! Direct it your way instead of up the chimney! Fan-forced clean hot air via easy ducting!
No. 19,194AVB (5 DIA.) Shpg. 17 lb. ...\$121.50 FOB



QUALITY DETECTOR UNDER \$40

Our fully transistorized BFO unit can locate a quarter at 18". Powerful 6 trans-oscillator-amplifier circuit. Comp. to others priced 50% more! Aluminum, just 2 lb.
No. 80,222AVB \$39.95 Ppd.



Patent Pending

**THERE IS NO OTHER TELESCOPE LIKE IT!
THE NEW EDMUND 4 1/4", f/4
NEWTONIAN WIDE FIELD
REFLECTOR TELESCOPE**

Clear, bright, spectacular wide angle views of stars, moon, comets... easy to use... portable!

IN SECONDS YOU'RE SCANNING THE ASTOUNDING UNIVERSE. able to see and study the breath-taking cosmos as perhaps you never have before. awesome vastness, unbelievable orderliness, stark silent beauty. All the fascinating heavenly mysteries are yours to enter and explore. This new reflector telescope makes it easy for everyone to span a thousand light-years to space-age enjoyment of the heavens and outdoors. No complicated set up! Just insert the eyepiece, focus, and its big 3 1/2" field of view gives you more stars in a single view than any other type of telescope. Bright, crisp, finely resolved images to capture your interest and imagination. It's probably the easiest to use telescope ever—over your shoulder, in your lap, on a tripod. Or just rotate the spherical base on its own mount for use on a table, car hood. Take it anywhere (only 17.10 lb.). Top quality optical system: 4 1/4" f/4 parabolic primary mirror (1/8 wave, 17" F.L.), prealigned 1/8 wave diagonal on a coated optical window seals optics from moisture and dust. 28mm Kellner eyepiece (gives 15X, higher without other eyepiece or Barlow). Fast focusing (25 to infinity). Bright Scharfhanian red (does not impair night vision) adj. carrying strap. A first scope must be an ideal second scope!

There is no other telescope like it. NO. 2001AVB \$149.95 Ppd.

**The Edmund BIOSONE II
turns brainwaves into an audible or visual signal. \$149.95
KNOW YOUR ALPHA FROM YOUR THETA!**

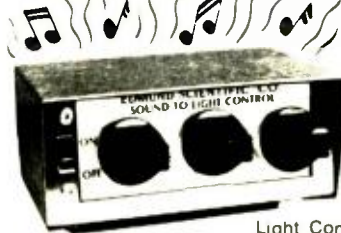
For greater relaxation, concentration... monitor your alpha/theta brainwaves.

Features Normally Found Only In Units Selling For More Than \$200.00—And 3 Feedback Modes.

The portable, professional quality Edmund Biosone II boasts 3 feedback modes—LED FM tone, threshold tone, a test mode to check overall system of operation. Easy to use, this beautiful 4-pound, simulated walnut unit (9 1/2 x 5 1/2 x 4 1/4") can be operated at home, in office or clinic. It gives you outputs to allow further monitoring of logic signal, raw EEG, filter output, meter, and FM. Total brainwave monitoring capability, incl. filter select feedback, with wide range calibration sensitivity control (5-100 microvolts). Completely safe, the Edmund Biosone II is similar to an electroencephalograph (EEG), enabling you to identify the electrochemical activity that exists at all times in the human brain. In addition to letting you know when you're most relaxed, Biosone II is a great conversation piece. Included at its low price are a set of electrodes, an earphone jack for private use. Uses latest advances in linear circuitry, runs on two 9v transistor batteries (not included).

STOCK NO. 1668AVB Just \$149.95 ppd.
LOW COST STARTERS' UNIT, No. 71,809AVB \$59.95 ppd.

"SEE" MUSIC IN PULSATING COLOR



The Edmund 3-Channel Color Organ \$18.50

COMPLETELY ASSEMBLED! LESS THAN HALF THE PRICE OF OTHER MODELS!

Create your own audio "light show", add a new dimension to your music listening pleasure with the bargain-priced Edmund 3-Channel Sound To

Light Control. Lets you modulate 3 independent strings of colored lamps with the intensity of your music. They flash and vary in brightness related to the music's rhythm, pitch and volume—a pulsating light performance to music! You get volume and frequency sensitivity to a peak rating of 300 watts per channel. Just plug in your favorite colored flood or spotlight, and turn on! Great price, too. This high quality, fully assembled unit in metal housing, with 3 individually controlled circuits, is priced at less than half that of others. Complete instructions are included with this terrific value.

ASSEMBLED \$18.50 Ppd.
No. 42,309AVB

UNASSEMBLED, IN KIT FORM \$15.95 Ppd.
No. 42,336AVB ONLY

**GIANT FREE
164 PG. CATALOG**



4500 UNUSUAL BARGAINS FOR HOBBYISTS, SCHOOLS, INDUSTRY

COMPLETE AND MAIL COUPON NOW

EDMUND SCIENTIFIC CO. 300 Edscorp Bldg., Barrington, N. J. 08007

Send me the following:

Stock No.	Quantity	Price Ea.

SEND FREE 164 PG. CATALOG "AVB"

Charge my American Exp. BankAmericard Master Chg.

Interbank No. _____ Add handling charge \$ _____ 1.00

Card No. _____ Enclosed is _____ check, _____ M.O. in amount of \$ _____

Expiration Date. _____ Signature _____

30-DAY MONEY-BACK GUARANTEE. You must be satisfied or return any purchase in 30 days for full refund. Address _____

City, State, Zip _____

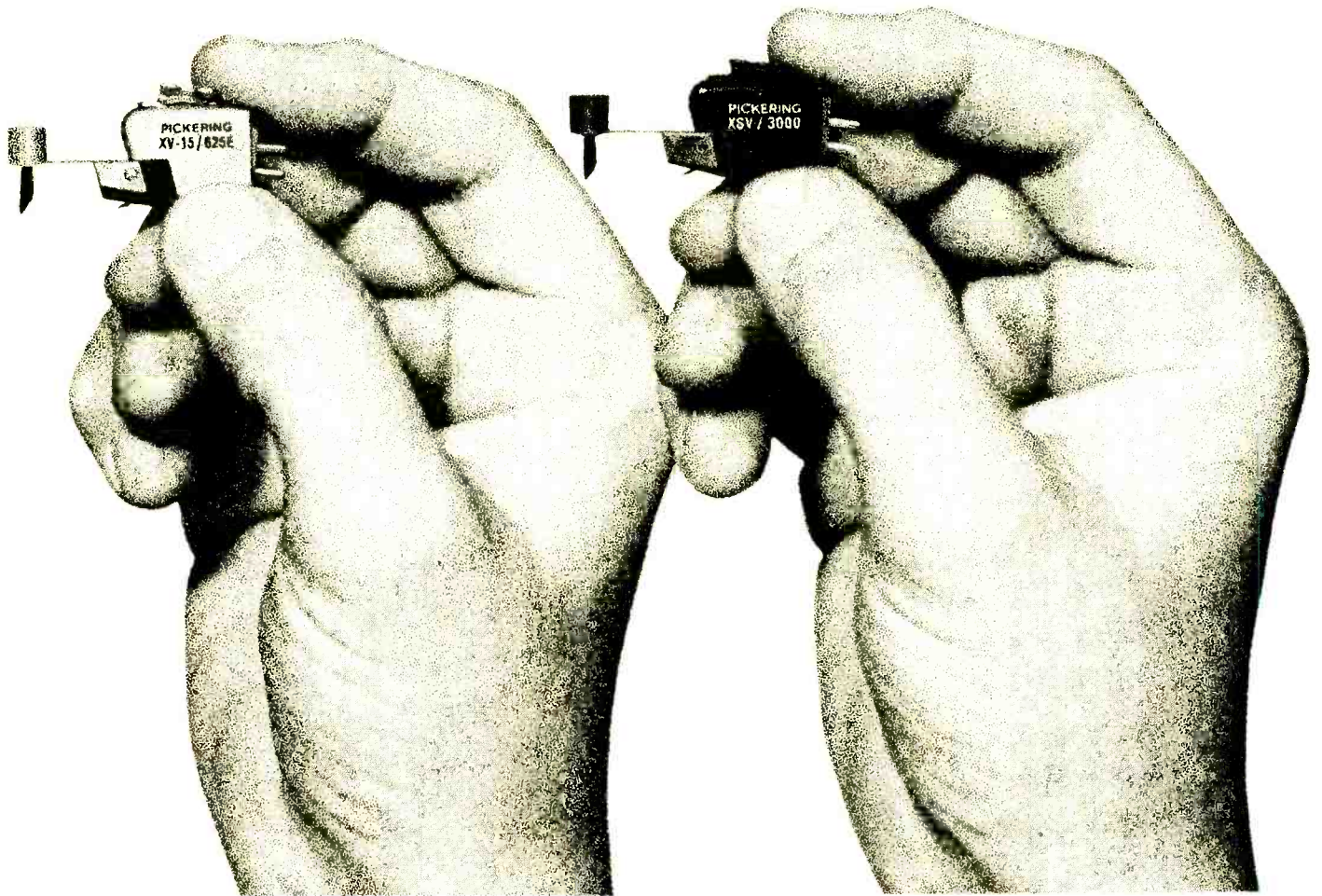


EDMUND SCIENTIFIC CO.

300 Edscorp Bldg., Barrington, N.J. 08007 • (609) 547-3488
America's Greatest Science • Optics • Hobby Center

CIRCLE NO 27 ON FREE INFORMATION CARD

Two sources of perfection in stereo sound.



Match one to your equipment

"The right Pickering Cartridge for your equipment is the best Cartridge money can buy."

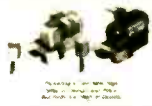
We've been saying that for years; and tens of thousands of consumers have profited by applying this principle in assembling their playback systems.

If you have a fine manual turntable, the XSV/3000 is a perfect choice.

If you have a high quality automatic turntable, then installing an XV-15/625E in its tone arm is a perfect choice.

The summary advice of **Stereo's** Lab Test, in an unusual dual product review, we think brilliantly states our position: "The XV-15/625E offers performance per dollar; the XSV/3000, the higher absolute performance level." That makes both of these cartridges **best buys!**

**STEREO
LAB TESTS**



FREE!

Pickering's new XSV/3000 is a remarkable development. It possesses our trademarked Stereohedron Stylus Tip, designed to assure the least record wear and the longest stylus life achievable in these times with a stereo cartridge. Its frequency response is extraordinarily smooth and flat; its channel separation is exceptional; its transient response affords superb definition. It represents a whole new concept of excellence in stereo cartridges.

Read the whole evaluation report. Send for your free copy of the **Stereo** "Lab Test" reprint; write to Pickering & Co., Inc., 101 Sunnyside Blvd., Plainview, N. Y. 11803. Department PE

 **PICKERING**

"for those who can hear the difference"

PICKERING & CO., INC., COPYRIGHT 1977

"...in the same class with a number of more expensive products, including many of the direct-drive record players we have seen!"

This quote, from the Hirsch-Houck Labs' report in *Stereo Review*, refers to the Dual 510, a semi-automatic belt-drive turntable. Since direct-drive models (especially our own) are accepted as *the* standard of performance, Hirsch-Houck's comparison is not to be taken lightly.

The 510 also benefits from comparison with other semi-automatic turn-

We'll let someone else tell you how good our belt-drive turntables really are.

tables. Dual's unique sensor locates the 12-inch and 7-inch lead-in grooves for you. You don't have to guess where they are. And there's no way to drop the tonearm accidentally; the cue-control lifts it automatically at the end of play and supports it until you release it.

You might also compare the 510 with your present turntable, or any other you may be considering. When you do, keep in mind the 510's many other features and refinements described below. Your old records will sound better, your new ones last longer.

Dual United Audio Products, 120 So. Columbus Ave., Mt. Vernon, N.Y. 10553

Dual 510. Semi-automatic, single-play. True four-point gimbal tonearm suspension. Synchronous motor, precision-ground belt, unique Vario-pulley, dynamically-balanced platter, 6% pitch-control, illuminated strobe. Lead-in groove sensor. Cue-control viscous-damped in both directions. Less than \$200.

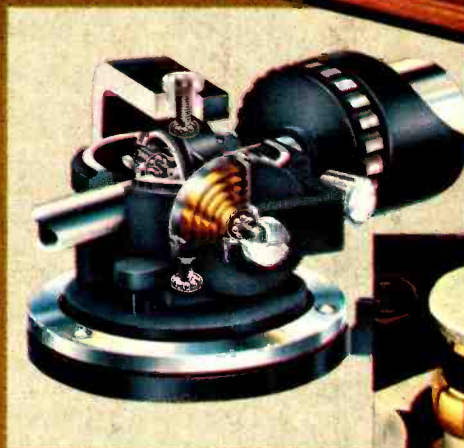
Dual 502. Similar except less sensor, pitch-control and strobe. Less than \$160.

Dual 1249, fully automatic single-play/multi-play. Less than \$280.



True four-point gimbal centers and pivots the tonearm mass at intersection of horizontal and vertical axes. Tonearm is dynamically balanced in all planes. The four needle-point pivots are first hardened, then honed, a process which produces microscopically smooth surfaces. The precision ball-bearing races are only 0.157 inch diameter. Bearing friction: vertical, $\lt; 0.007$ gram; horizontal, $\lt; 0.015$ gram.

Stylus force, applied by long coiled spring around vertical pivot, remains perpendicular to record even if turntable is not level.



Unique Vario-pulley used in Dual's three belt-drive models is precision-machined for perfect concentricity and balance. Speeds are adjusted by expansion and contraction of pulley circumference; belt is never twisted or distorted.

Specifications (DIN B) Rumble, >63dB Wow and flutter, $\pm 0.05\%$

CIRCLE NO. 4 ON FREE INFORMATION CARD

www.americanradiohistory.com