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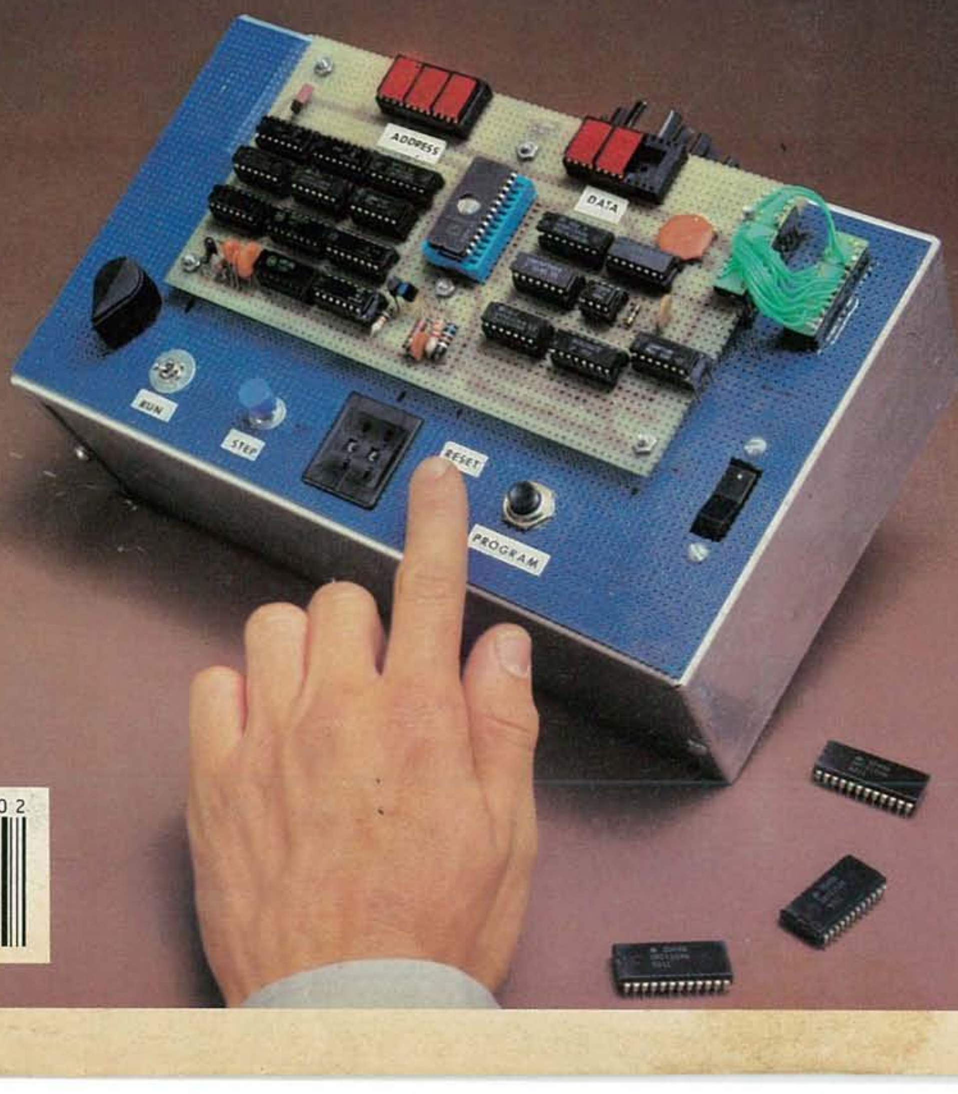

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CIRCLE 2 ON FREE INFORMATION CARD

We gave solderless breadboarding a new name.

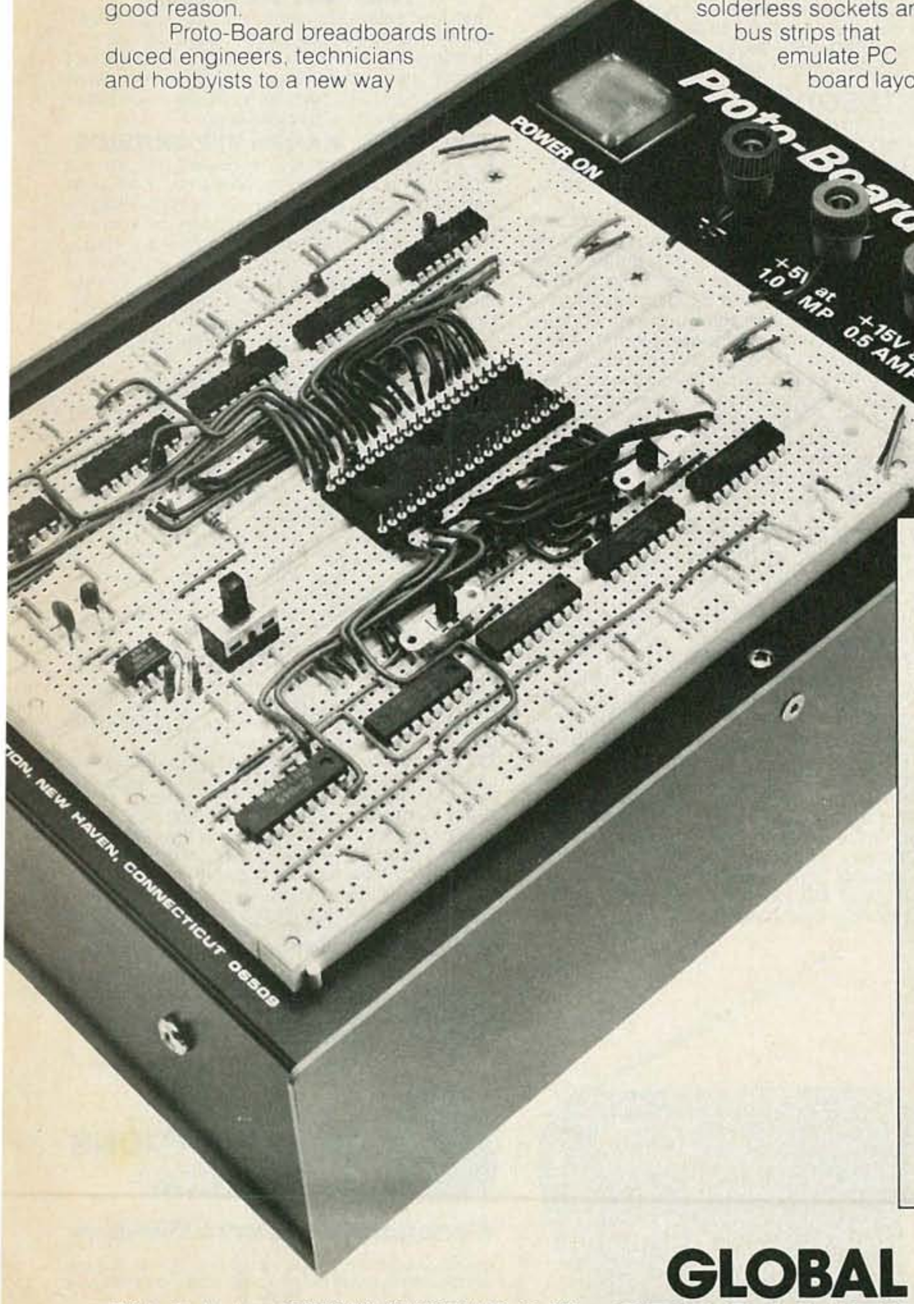
Proto-Board® breadboards, by Global Specialties. The leading name in solderless breadboarding.

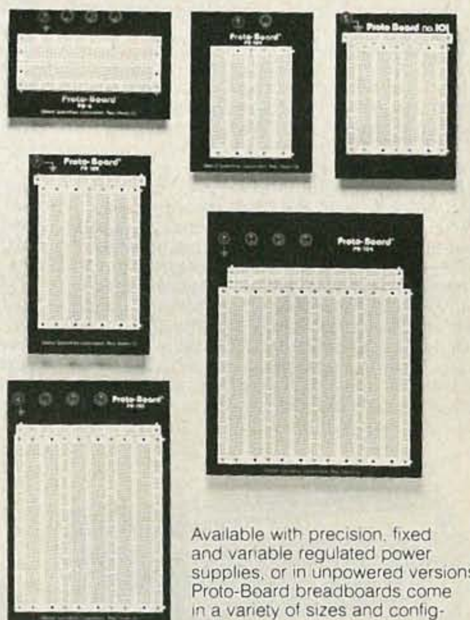
You find them wherever electronics is important. From labs to production lines to classrooms to home workshop benches. Their name, synonymous with solderless breadboarding. And for good reason.

Proto-Board breadboards introduced engineers, technicians and hobbyists to a new way of designing and building electronic circuits: as fast as they can think. Testing, modifying and expanding as quickly as new thoughts occur. Saving precious time and money by freeing creativity from manual labor.

Global Proto-Board products are arrays of solderless sockets and bus strips that emulate PC board layouts while permitting instant insertion and removal of components from the largest DIP to the smallest discretes. With a rugged construction built to provide positive connections and withstand day-in, day-out professional use—even as test fixtures. And mounted on sturdy metal backplanes, for extended high-frequency use and extra durability.

Their value and versatility are why so many professionals and hobbyists are "Proto-Board"-ing. And why you should be, too.





Available with precision, fixed and variable regulated power supplies, or in unpowered versions, Proto-Board breadboards come in a variety of sizes and configurations, to meet virtually any circuit design challenge.

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All Panasonic shortwave receivers sold by **Communications Electronics** bring the real live excitement of international radio to your home or office. With your Command Series receiver, you can monitor exciting radio transmissions such as the BBC, Radio Moscow, Ham Radio and our own Armed Forces Radio Network. Thousands of broadcasts in hundreds of different languages are beamed into North America every day. You can actually hear the news *before* it's news. If you do not own a shortwave receiver for yourself, now's the time to buy your new receiver from **CE**. Choose the receiver that's right for you, then call our *toll-free* number to place your order with your credit card.

We give you excellent service because **CE** distributes more scanners and shortwave receivers worldwide than *anyone* else. Our warehouse facilities are equipped to process thousands of orders every week. We also export receivers to over 300 countries and military installations. Almost all items are **in stock** for **quick shipment**, so if you're a person who needs to know what's *really* happening around you, order today from **CE**.

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Allow 30-120 days for delivery after receipt of order due to the high demand for this product.

List price $749.95/**CE price $499.00**

Bands: LW 150-410 KHz., MW 520-1610 KHz., SW1-5 1.6-30 MHz., FM 87.5-108 MHz.

The new Panasonic RF-6300 Command Series PLL synthesized 8-band portable communications receiver, lets you hear the world. The RF-6300 has features such as microcomputer pre-set tuning and PLL quartz synthesized digital tuner. Microcomputer stores up to 12 different frequencies for push-button recall. FM/MW/LW/SW1-5 reception. Manual tuning knob. Wide/Narrow bandwidth selector. Double superheterodyne system. Fast/Slow manual tuning. Built-in quartz digital alarm clock. 5 inch dynamic PM speaker. 3 antennas. Multi-voltage. Detachable AC cord. Operates on 6 "D" batteries (not included). Made in Japan.

Panasonic
RF-6300

RF-4900

Panasonic® RF-4900

List price $549.95/**CE price $389.00**

Bands: MW 525-1610 KHz., SW1-8 1.6-30 MHz. FM 88-108 MHz.

The Panasonic RF-4900 shortwave receiver features a 5-digit fluorescent display for all 8 SW bands, as well as for AM/FM. AC or battery operation. Full coverage from 1.6 to 30 MHz on SW. Covers SSB and CW. Premix Double Superheterodyne. Fast/slow 2 speed tuning. AFC Switch on FM, narrow/wide selectivity switch for AM and SW. Antenna trimmer. Calibration control. FET RF circuit. Mode switch for AM-CW/SSB. BFO Pitch control. ANL switch for AM. RF gain control. Tuning-Battery meter with meter function switch. Separate bass and treble tone control. Dial light switch. Digital display on/off switch. Separate power switch. Rack type handle. Made in Japan.

Panasonic® RF-3100

Allow 30-120 days for delivery after receipt of order due to the high demand for this product.

List price $369.95/**CE price $269.00**

Bands: MW 525-1610 KHz., SW1-29 1.6-30 MHz. FM 88-108 MHz.

The Panasonic RF-3100 portable 31-Band portable radio has PLL Quartz-Synthesizer tuning that "locks" onto SW stations. Operates on AC or battery. SW frequencies from 1.6 to 30 MHz. are in 29 bands. All-band 5-digit frequency readout. Horizontal design with front mounted controls for shoulder strap operation. Double superheterodyne for clean SW reception. BFO pitch and RF gain controls. Separate bass and treble controls. Wide/Narrow bandwidth selector. Meter for tuning and battery strength. LED operation indicator. Meter light switch. 3½" PM dynamic speaker. Comes with detachable shoulder belt. Battery power (8 "D" batteries not included). Made in Japan.

Panasonic® RF-2900

List price $349.95/**CE price $249.00**

Bands: MW 525-1610 KHz., SW1-3 3.2-30 MHz. FM 88-108 MHz.

The Panasonic RF-2900 is a portable five-band shortwave radio with digital five digit fluorescent frequency display. Full coverage from 3.2 to 30 MHz. on SW. Covers SSB and CW. Double superheterodyne receiver. Fast/slow two speed tuning. AFC switch on FM, narrow/wide selectivity switch for AM and SW. FET RF circuit. BFO switch and pitch control. RF gain control. Tuning battery meter. Separate bass/treble tone control. SW calibration control. Dial light switch. Digital display on/off switch. Separate power switch. Detachable dial hood included. Rack type handle. Includes whip antenna and ferrite core antenna, speaker, earphone, recording output jacks, AC line and detachable adjustable shoulder belt. Made in Japan.

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RF-2900

Panasonic

Command series

Panasonic
RF-3100

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Mail orders to: **Communications Electronics**,™ Box 1002, Ann Arbor, Michigan 48106 U.S.A. Add $12.00 per receiver for U.P.S. ground shipping and handling. If you have a Master Card or Visa, you may call anytime and place a credit card order. **Order toll free** in the U.S.A. Dial 800-521-4414. Outside the U.S. or in Michigan, dial 313-994-4444. **Dealer inquiries invited.** Order your Panasonic Command Series receiver today at no obligation.

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FEBRUARY 1982 Vol. 53 No. 2

ON THE COVER

A completely self-contained PROM programmer for storing your programs in reusable 2716 EPROM's. This project is a must for experimenting with microprocessors and designing microprocessor based projects. Construction details start on page 45.

ANNUAL INDEX JANUARY—DECEMBER

1981

To present the maximum number of articles to our readers, we have not published the Annual Index as part of this issue. A 4-page brochure containing this index is available for those who need one. To get your free copy, send a *stamped self-addressed envelope (legal size) to:*

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VIDEO ELECTRONICS

DAVID LACHENBRUCH
CONTRIBUTING EDITOR

TUBELESS CAMERA

Video cameras have entered the all-solid-state age in the United States with the start of marketing of Hitachi's MOS camera, which uses a single ⅔-inch metal oxide silicon IC as an image sensor. The MOS sensor has 180,000 picture elements, providing a claimed 260-line horizontal resolution. The camera weighs 3.96 pounds.

The most noticeable aspect of the camera is its small size and light weight—indeed, the lens and viewfinder combined are larger than the camera itself. The picture differs from any made with a Vidicon pickup tube in that there is no lag, smear, or burn-in even when the camera is aimed directly at a light. Hitachi claims that the MOS is good for 100,000 hours, as compared with 5,000 hours' average life of a Vidicon. Among its advantages are low power consumption (5.3 watts), rapid start (picture appears in a half second), reliability, and ruggedness. The suggested list price is $1,995.

MINI-VHS

While Japanese manufacturers were meeting to standardize on the portable VCR of the future using quarter-inch tape, it was revealed that JVC has developed a miniature cassette compatible with the VHS system that can be in production as early as next spring.

It will record for up to an hour at the slowest VHS speed in a new ultra-compact portable VCR developed by JVC that weighs about 5.5 pounds and is about 20% smaller than the Technicolor VCR, which uses non-standard quarter-inch cassettes.

The mini-cassettes can be played back through the portable recorder, or, with an adaptor, through any VHS recorder. JVC is understood to be talking with other companies in the VHS group to adopt its new system as a standard for portables. The new mini-VHS development isn't expected to deter Japanese companies from working on a new quarter-inch standard, but it could take some of the urgency out of their efforts.

NEW MINI-VCR

The smallest and lightest VCR to date made its debut in Germany this past September, and will be headed this way soon. Ironically, it's made in Japan, not Germany, but will bear the Grundig label in this country. The new recorder is made by Funai Electric and is compatible with the small recorder Funai makes for Technicolor, but it has been completely redesigned. Weight and battery has been trimmed to five pounds (four pounds without battery) as compared with Technicolor's seven pounds, and the entire recorder is about the size of a cigar box. It provides slow and fast speeds, freeze-frame, and records for up to an hour on a quarter-inch cassette only slightly larger than an audio cassette. The price will be about $1,000 in the U.S., including power supply.

HIGH-DEFINITION TV

There have been plenty of proposals for high-definition television, most of them centering on 1,000-plus-line standards requiring about 30 MHz of bandwidth per channel. Now, along comes Imagevision, developed by Compact Video, which requires 10 MHz, is claimed to be "ready for delivery," and uses modified conventional equipment. Imagevision was demonstrated before the Society of Motion Picture and Television Engineers, where it received favorable comment.

Imagevision uses a new television standard called "PALAF" (for *P*hase *A*lternate *L*ine *A*lternate *F*rame) and has 665 lines, claimed to provide the definition of 1,250 lines in other systems, with 24 non-interlaced frames per second. All the equipment used (such as cameras and videotape recorders) was commercially available gear modified for the system. The most successful demonstration of Imagevision was the projection of part of a movie being made using the system. The movie had been transferred to 35-mm film and was projected on a theater screen. Most observers agreed it looked every bit as good as a movie made directly on 35-mm film. Somewhat less successful were satellite-relayed video pictures projected by light-valve projection-TV systems—but that may be because the projectors became the limiting factors. **R-E**

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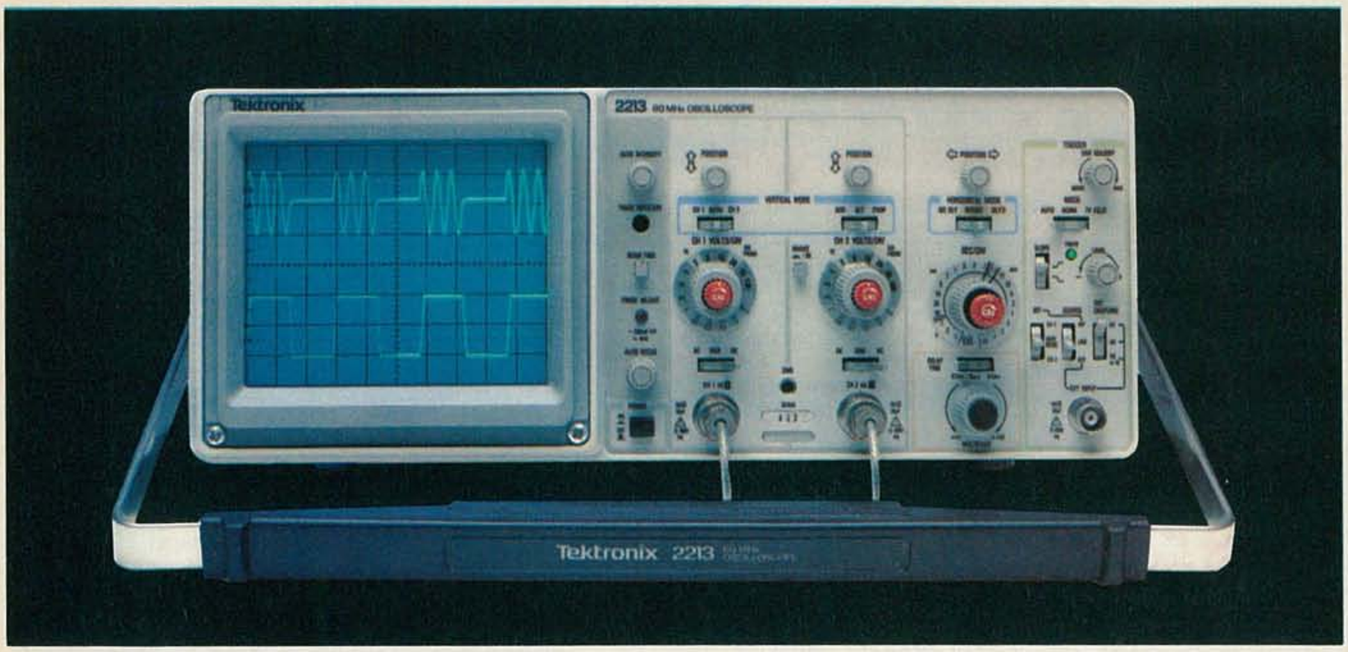

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The scope: the 2213. Its radical new design brings you Tektronix quality for well below what you would pay for lesser-name scopes.

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2213 PERFORMANCE DATA

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Complete trigger system: Modes include TV field, normal, vertical mode, and automatic; internal, external, and line sources; variable holdoff.

Probes: High performance, positive attachment, 10-14 pF and 60 MHz at the probe tip.

The price: Just $1100 complete*. Order direct from Tektronix National Marketing Center. Phones are staffed by technical people to answer your questions about the 2213. Your direct order includes a 15-day return policy and full Tektronix warranty.

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WHAT'S NEWS

Educators confer on microcomputers

Microcomputer Week '82, the third annual conference co-sponsored by the Center for Advancement of Teaching and Learning (CATALYST) of Jersey City State College, will be held at the college from the 3rd to the 7th of March 1982.

The conference centers on microcomputers in education. Some 66 all-day seminars or short courses will be offered for professional development and improved performance. Each will include eight hours of instructions. Some seminars will extend over two or three days. There will also be 24 informal evening sessions—during dinner and continuing after dinner—for groups with special interests and problems.

Cost of the seminars range from $95 for one day to $73 per day for the whole week. A brochure with complete details, registration forms, etc., has been prepared. Further information is obtainable by phone from 201-434-2154 or 201-547-3094, or by mail from CATALYST Conference, H 112, Jersey City State College, 2039 Kennedy Boulevard, Jersey City, NJ 07305.

TV standards converter for video recorders

Early international television broadcasts were hampered by differing television standards. Systems using the 525-line frames of the United States, Japan, and other countries were incompatible with the 625-line standard of most of Europe. (At one time, France had an 815-line system.)

Those difficulties were overcome in a number of ingenious ways for the first few broadcasts, and very soon "system converters" were designed to input the signals of one system and change the number of lines, modulation method, sync signals, etc., to those of the system to which the signal was being relayed.

Color, with its NTSC, PAL, and SECAM systems, brought new difficulties, which were also quickly ironed out with new converters. Video recording raised the problem anew, an unfortunate circumstance, since videotapes can be shipped more easily than international broadcasts can be set up.

But now a company called Instant Replay (2980 McFarlane Rd., Coconut Grove, FL 33133), has put on the market an Image Translator, in two models. The *SMP-1* permits a viewer with a PAL recorder and receiver to play NTSC tapes, witout modifying the receiver. The *SMP-2* permits a viewer to play back tapes recorded in the PAL format in full color on an NTSC VCR, using an American TV receiver, without modification. It can be used with either direct-view or large-screen projection TV. Thus international video broadcasting's objective of cultural exchange is being extended to video recording.

The Image Translator is an extension of the publishing efforts of the manufacturer, *Instant Replay Video Magazine,* "the world's first video magazine," a two-hour tape published bimonthly at a price of $59.95 per issue. Believing the television image to be the most nearly perfect medium of international cultural exchange, and the videotape the most nearly universal unit for such exchange, owner and editor Chuck Azar developed the Translator to internationalize the videotape. To promote the internationalization further, a printed list of all Image Translator owners will be sent to all subscribers, to enable them to swap tapes between countries.

Improved approach in auto-focus camera

A new Pentax 35-mm SLR camera, the *ME-F,* expected on the market in early 1982, introduces a new computerized through-the-lens electronic focusing system. Measuring the actual focal contrast at the center of the field of vision, in a manner similar to that of the human eye, the system is claimed to be far more accurate than those that cover the whole field, or range-finder electronic systems that measure the image-field distance.

PENTAX *ME-F* single lens reflex camera with new 35-mm-70-mm Zoom lens.

The new camera focuses correctly on complex patterns, subjects behind glass, and over the whole depth-of-field range.

The *ME-F* lets the photographer know when the subject is in focus by means of a dual-signal indication: An LED lights in the viewfinder at the point of optimum focus and a beep signal sounds.

The list price of the *ME-F*—with zoom lens—is expected to be about $1,000.

New VideoDisc features demonstrated in France

Dr. Jon K. Clemens, co-recipient of the Rhein Prize 1979, and Director of VideoDisc Systems at RCA's research laboratories, demonstrated the advanced capabilities of the new RCA 'CED' (*C*apacitance *E*lectronic *D*isc) system at the recent Vidcom convention in Cannes, France. Dr. Clemens showed such features as programmable random access, high-speed visual search, repeat picture, and automatic repetition of selected program segments.

In demonstrating the visual-search feature, Dr. Clemens used the prototype system's two search speeds, 16× and 120×. He also programmed the player to repeat sections of the disc, demonstrated its repeat-picture capability, and proved its wear-free feature by playing a still picture from a single groove for 20 minutes—amounting to 9,000 replays of the same groove.

No date was set for the introduction of those advanced VideoDisc player features to the market.

FAA renovating nation's air traffic control

The Federal Aviation Administration is undertaking a program to upgrade air-traffic control computers throughout the country. The program is aimed at meeting projected air-traffic demands of the 1990's and beyond. It will call for replacement of the 23 Air Route Traffic Control Center computers with an advanced system.

RCA has been awarded a $4 million contract to provide system engineering and technical analysis in the program. RCA's work will cover five areas: requirements specification and allocation; cost, schedule, and

continued on page 12

NEW! Here's a professional, portable DC-20 MHz Oscilloscope with build-it-yourself Heathkit savings

Compact enough to fit under an airplane seat, the Heathkit IO-3220 represents outstanding value in its class. Weighing only 16 pounds, the IO-3220 is designed for field service troubleshooters who need a light, portable battery-operated scope for use where AC power is not available.

Dual-trace versatility: The IO-3220 allows you to compare two different signals simultaneously – to make input/output comparisons, check phase relationships and accomplish other complex measurements. Algebraic functions add versatility.

Special invert display function: Enables you to compare two waveforms that are nearly 180 degrees out of phase – by inverting one of the waveforms.

X-Y inputs for Lissajous measurements: Feed two separate input signals to the IO-3220.

Wide DC-20 MHz bandwidth: The IO-3220 can measure a very wide range of input signals.

Outstanding sensitivity: Vertical signals as low as 2 millivolts can be accurately measured by the very sensitive IO-3220. Accuracy is as high as 3 percent (from 20-30 deg. C), on both vertical and horizontal measurements.

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It's no longer enough to be just a programmer or a technician. With microcomputers moving into the fabric of our lives (over 250,000 of the TRS-80™ alone have been sold), interdisciplinary skills are demanded. And NRI can prepare you with the first course of its kind, covering the complete world of the microcomputer.

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With NRI training, the programmer gains practical knowledge of hardware, enabling him to design simpler, more effective programs. And, with advanced programming skills, the technician can test and debug systems quickly and easily.

Only NRI gives you both kinds of training with the convenience of home study. No classroom pressures, no night school, no gasoline wasted. You learn at your convenience, at your own pace. Yet you're always backed by the NRI staff and your instructor, answering questions, giving you guidance, and available for special help if you need it.

You Explore the New TRS-80 Model III Inside and Out

NRI training is hands-on training, with practical experiments and demonstrations as the very foundation of your knowledge. You don't just program your computer, you go inside it...watch how circuits interact...interface with other systems...gain a real insight into its nature.

Training includes the new TRS-80 Model III microcomputer, 6-function LCD Beckman multi meter, and the NRI Discovery Lab with hundreds of tests and experiments.

You also work with a precision 26-scale, 6-function LCD Beckman multimeter featuring full portability and a 3½ digit display. Using it along with the exclusive NRI Discovery Lab and your TRS-80, you perform over 60 separate experiments in all. You learn how to troubleshoot and gain greater understanding of the information your tests give you.

Advanced Technology Microcomputer Is Yours to Keep

As part of your training, NRI sends you the new, state-of-the-art TRS-80 Model III microcomputer. This functional unit is complete with 65-key keyboard and 12" display in one desk-top unit. It features high-speed cassette loading, built-in interface for parallel printer, and provisions for optional disk drive. Its 4K RAM is internally expandable to 16K or 48K and its BASIC language is compatible with most Model I software.

Along with your multimeter and the NRI Discovery Lab, this latest concept in advanced microcomputers is yours to learn with, yours to keep and use for your own personal programs, business use, and other applications.

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WHAT'S NEWS

continued from page 6

risk analysis; performance analysis, simulation, and modeling; feasibility and trade studies, and technical management standards and practices.

Super circuit chips speed data tenfold

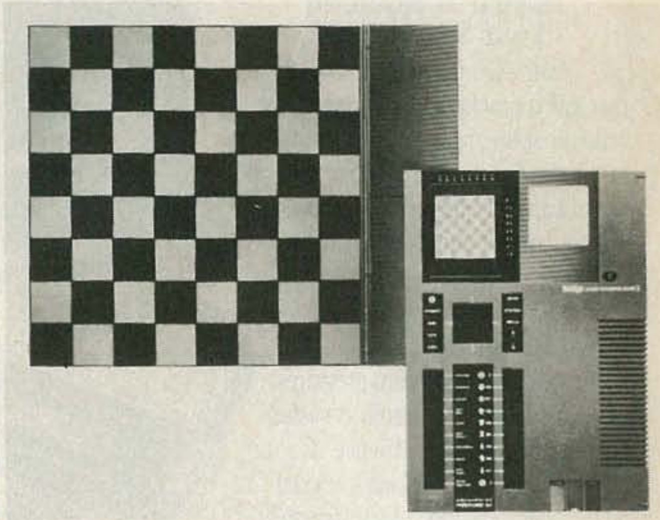
"Super chips," that Hughes Aircraft call "electronic circuits that resemble an array of 100 Los Angeles street maps on a thumb tack," are now being developed at Hughes' laboratories. Called *V*ery *H*igh *S*peed *I*ntegrated *C*ircuits (VHSIC), they will be more reliable and require less power than integrated circuits now in use.

The chip technology used in the program includes CMOS (*C*omplementary *M*etal *O*xide *S*emiconductor) and SOS (*S*ilicon *O*n *S*apphire). The SOS technology is especially significant for military systems, because it is inherently hardened against radiation.

Hughes has also received an Army contract to develop a high-speed electron-beam lithography system that will focus beams of electrons to write circuit patterns in submicron dimensions. Those circuit patterns will be converted into transistors and interconnects smaller than any now in production.

Yankee chess computer is new world champion

Chess Champion Mark V, made by SciSys Computer Inc. of New York City, emerged as the winner in the Commercial Division, World Micro Computer Chess Championships, held last Fall in Travemunde, Germany. The tournament was held under the auspices of the International Chess Association and the World Chess Federation. It was open to all chess programs executed by readily available one-chip microprocessors.



THE CHESS CHAMPION MARK V.

The *Chess Champion Mark V* is an AC-powered chess computer with an integral LCD chessboard. Its 32K memory is many times more powerful than the average home computer, and its variable time control enables it to play any form of chess, from Speed to Tournament. It can play 12 games simultaneously against humans, other computers, or even against itself. On request, it can analyze, comment, or advise on the game in progress, and can provide a complete game history or predict the outcome.

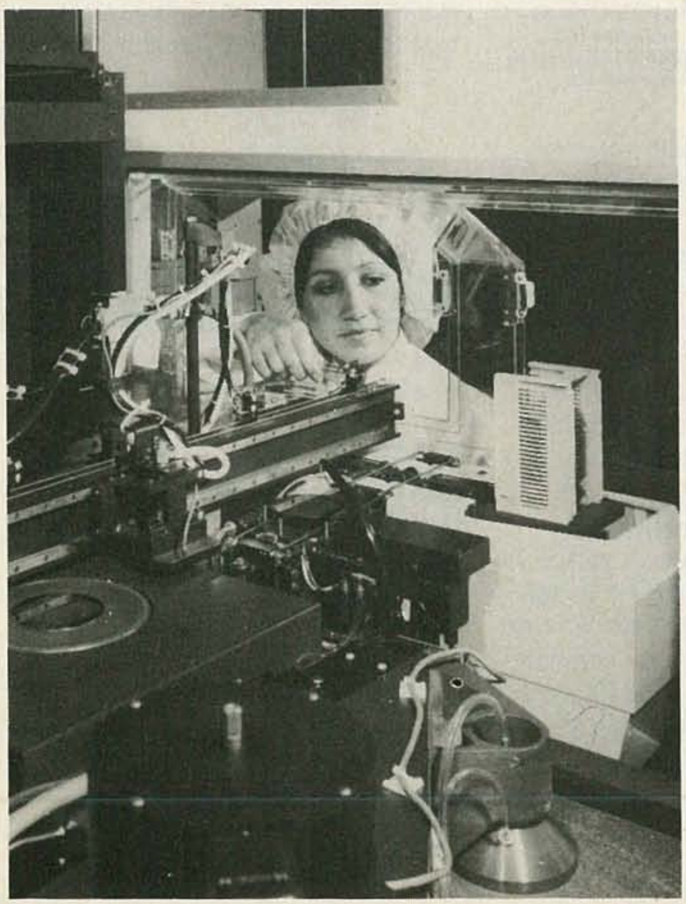


PHOTO-LITHOGRAPHY MACHINE that will be used to etch VHSIC circuits on chips the size of a thumbtack. Hughes and five other firms are in the program conducted by the Defense Department to develop the high-speed superchips. The machine is being operated by Hughes technician Margaret Sanchez.

Sony Corp sets up a U.S. laboratory

Sony Consumer Electronics Laboratories (SOCEL) a division of Sony Corp of America, will be located in the Century Plaza in Paramus, NJ, reports Sony Corp. executive vice president Kenji Tamiya. The laboratories will conduct research, development, and design work, particularly the areas of CATV systems and terminals, receivers for direct satellite broadcasts, and videotext/teletext systems and terminals. "The laboratories will offer a unique opportunity for interaction between American and Japanese engineers," said Mr. Tamiya.

The new laboratory is the latest in a number of Sony "firsts" in America. In 1972 Sony opened the first U.S. color TV plant owned by a Japanese-based company, in San Diego, CA. In 1977, it established what is now one of the largest magnetic tape plants in the world, in Dothan, AL. The Sony Technology Center in Palo Alto, CA, carries out broadcast equipment research, development, and manufacturing, and was the first Sony facility to be located outside Japan.

Electronic newspaper debuts in Chicago

NITE-OWL, a full-channel teletext publication, is now being broadcast on WFLD-TV, Channel 32, Chicago. Designed for late-night information, it supplies up-to-the-minute news, sports, weather, and other information, and advertising.

Information is presented in text form (teletext) on the screen. Teletext was first developed in Great Britain and is now being offered commercially in the United States by Field Electronic Publishing. R-E

LETTERS

SENDING GOOD CW

Fie on Herb Friedman, and a fig in his ear! He seems to be showing an infirmity of old age—intolerance—and maybe even a lack of good sense in "Communications Corner," **Radio-Electronics,** October 1981.

As a ham, from my earliest days, I tried diligently to send good CW, first on a straight key, then on a swiper (homebrew) and then on the ultimate (for those days): a bug (also homebrew). And, I, too, share his view that handwrought CW is a pure performing art.

First ticketed in 1933, I am now (after a long layoff) a reconstituted ham. Once I got back on the air, I was thunderstruck by the bad straight key fists, the miserably misadjusted and misrun bugs, and that ultimate abomination: the key running its operator instead of the other way around. Do you ever hear a "6" sent with four dots any more?

Then, I, too became aware of the beautiful CW coming from microprocessor keyboards, whether at 20 or 60 wpm. What a joy! As with good writing, I believe that CW should be sent with clarity and intelligibility, and to hell with dialects or accents. If it takes a machine to do it, so be it! It's all right with me.

So come on, Herb. Don't display the length and condition of your teeth. Get a good keyboard and join the fun. I have one (homebrew) and it's better than crackerjack.

C.H. FRERES, KJ6G,
San Diego, CA

NIKOLA TESLA

I would like to associate myself with the thoughts expressed in the letters by Marc Seifer and Vince Marasco in the June 1981 **Radio-Electronics** about Nikola Tesla.

Tesla is one of my favorites. I can turn on my Edison light bulb and visualize, in some vague manner, Tesla's rotating magnetic field at some remote point miles away. Yes, it is truly Tesla's rotating magnetic field—the one he discovered before he invented a device wherein the field could reside and produce rotating power: the induction motor. And subsequently, he was forced to invent a device to generate that magnificent field—the polyphase alternator.

Had Edison's proposal for electric power distribution prevailed, we would now have direct-current generating power plants spaced about every mile where electricity is in use today. And we would know no such thing as the sealed motor-compressor system used in modern refrigeration and air-conditioning systems. Edison's DC voltage could not be stepped up or down with transformers, and the losses in his system would be great.

What about electric-power transmission without wires? Some large company —I would suggest Westinghouse—should embark upon a research project to rediscover that lost art.

I could go on and on. I am interested in Tesla and his discoveries. A machinist friend of mine is also fascinated, as are others in the electronics field. Had Nikola Tesla never existed, nevertheless, civilization would have required one like him just the same.

Knowledgeable people have been made aware of most of the other great men of the past—so why not the unique Nikola Tesla?

ALFRED C. POWELL,
Pensacola, FL

Why not, indeed? Well, you're doing your part.

LED VU METER ENCLOSURE

Reading through the May 1981 **Radio-Electronics,** I was struck by the appearance—in the article, "Build This LED VU Meter"—of an enclosure produced by our client, PacTec Corp., subsidiary of LaFrance Corp. I checked carefully for a reference to the PacTec Enclosure, to no avail. In fact, I noted that the kit for the VU-1 available from BFA Electronics actually includes no case at all.

Your readers might like to know that the case seen in the article is available from PacTec, Enterprise and Executive Avenues, Philadelphia, PA 19153. It is one of the series CM enclosures, and appears specifically to be a CM 5-200.

We have many prototyping kits in our line. The kits are particularly useful to designers and hobbyists, and are available in a wide range of sizes. I hope that you and your readers will find this material useful.

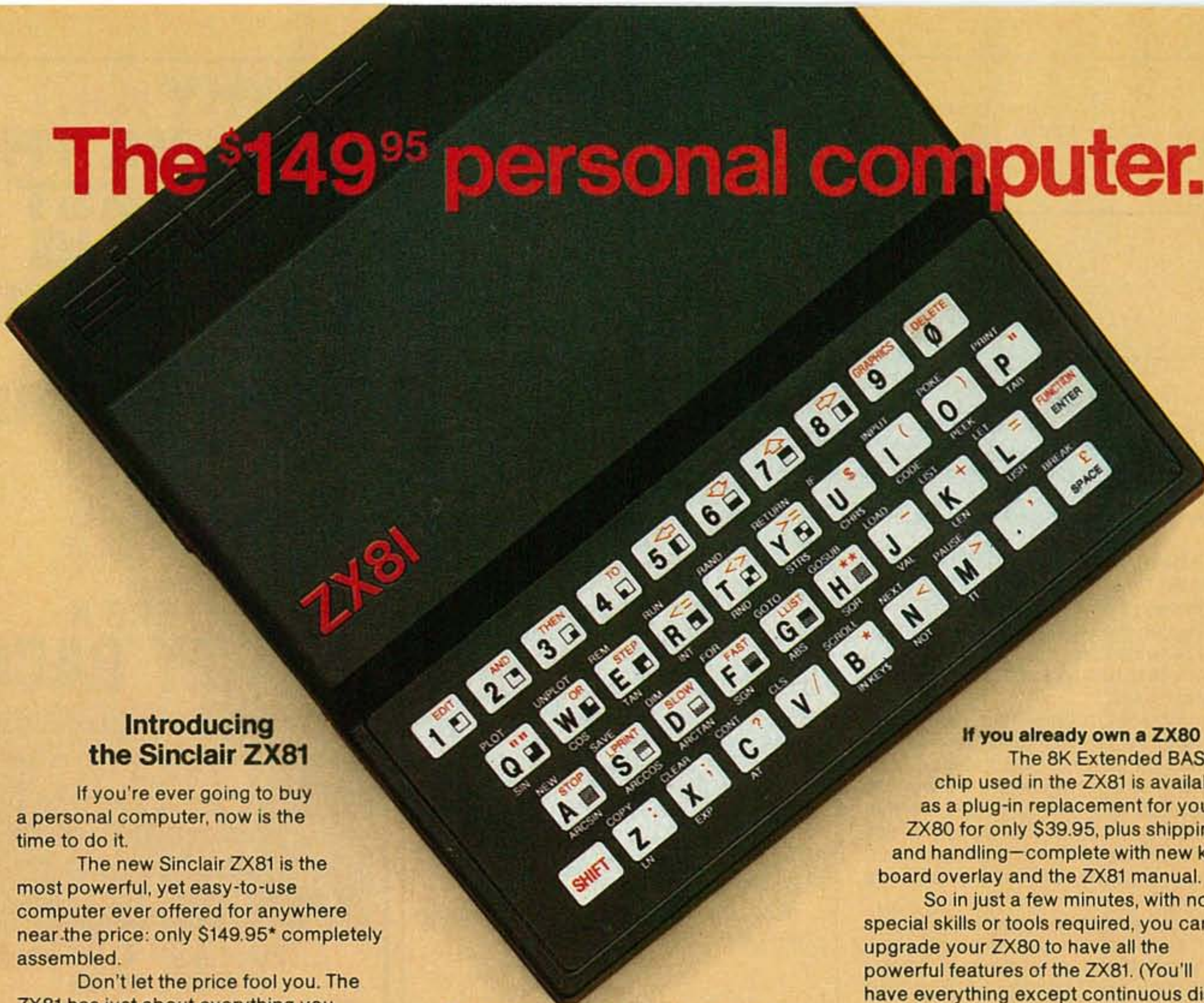
JON H. CLINCH,
Larwin/Livers Associated, Inc.

RADAR DETECTORS

In reading the "Letters" department in **Radio-Electronics,** and being the owner of one of the best "Super Het" radar detectors on the market, I can only feel sorry for those people who must constantly challenge the right to own and operate such devices. It is a shame that, for once, the foxes were "outfoxed themselves" by allowing a hole in the law big enough to

continued on page 22

The $149.95 personal computer.



Introducing the Sinclair ZX81

If you're ever going to buy a personal computer, now is the time to do it.

The new Sinclair ZX81 is the most powerful, yet easy-to-use computer ever offered for anywhere near the price: only $149.95* completely assembled.

Don't let the price fool you. The ZX81 has just about everything you could ask for in a personal computer.

A breakthrough in personal computers

The ZX81 is a major advance over the original Sinclair ZX80—the world's largest selling personal computer and the first for under $200.

In fact, the ZX81's new 8K Extended BASIC offers features found only on computers costing two or three times as much.

Just look at what you get:

- Continuous display, including moving graphics
- Multi-dimensional string and numerical arrays
- Mathematical and scientific functions accurate to 8 decimal places
- Unique one-touch entry of key words like PRINT, RUN and LIST
- Automatic syntax error detection and easy editing
- Randomize function useful for both games and serious applications
- Built-in interface for ZX Printer
- 1K of memory expandable to 16K

The ZX81 is also very convenient to use. It hooks up to any television set to produce a clear 32-column by 24-line display. And you can use a regular cassette recorder to store and recall programs by name.

*Plus shipping and handling. Price includes connectors for TV and cassette, AC adaptor, and FREE manual.

If you already own a ZX80

The 8K Extended BASIC chip used in the ZX81 is available as a plug-in replacement for your ZX80 for only $39.95, plus shipping and handling—complete with new keyboard overlay and the ZX81 manual.

So in just a few minutes, with no special skills or tools required, you can upgrade your ZX80 to have all the powerful features of the ZX81. (You'll have everything except continuous display, but you can still use the PAUSE and SCROLL commands to get moving graphics.)

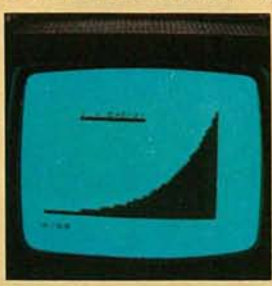
With the 8K BASIC chip, your ZX80 will also be equipped to use the ZX Printer and Sinclair software.

Order at no risk**

We'll give you 10 days to try out the ZX81. If you're not completely satisfied, just return it to Sinclair Research and we'll give you a full refund.

And if you have a problem with your ZX81, send it to Sinclair Research within 90 days and we'll repair or replace it at no charge.

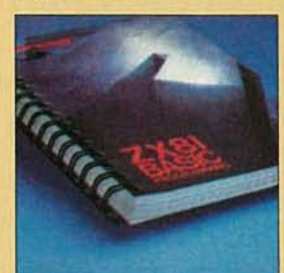
**Does not apply to ZX81 kits.



NEW SOFTWARE: Sinclair has published pre-recorded programs on cassettes for your ZX81, or ZX80 with 8K BASIC. We're constantly coming out with new programs, so we'll send you our latest software catalog with your computer.

ZX PRINTER: The Sinclair ZX Printer will work with your ZX81, or ZX80 with 8K BASIC. It will be available in the near future and will cost less than $100.

16K MEMORY MODULE: Like any powerful, full fledged computer, the ZX81 is expandable. Sinclair's 16K memory module plugs right onto the back of your ZX81 (or ZX80, with or without 8K BASIC). Cost is $99.95, plus shipping and handling.



ZX81 MANUAL: The ZX81 comes with a comprehensive 164-page programming guide and operating manual designed for both beginners and experienced computer users. A $10.95 value, it's yours free with the ZX81.

EDITORIAL

The FCC's Teletext Non-Standard

This issue of **Radio-Electronics** presents the third and concluding article of a series that describes the teletext proposal now before the FCC. When teletext is fully implemented, it will offer the general public interactive access to a virtually limitless supply of information—information that will be broadcast as part of a standard TV program. A special decoder attached to your TV set will pick off the information and display on the TV screen. To provide interactive access, the user will be tied to a central data bank via either a cable-TV connection or via a modem and telephone line.

Teletext promises to provide a massive array of services to the general public. Some of the services being considered include home banking; home shopping, with purchases billed directly to your bank account and the items shipped direct to your front door; airline reservations; books; magazines; etc., etc. The possibilities are endless, limited only by our imagination. Indeed, the benefits of a fully implemented teletext service will be enormous; it will even help energy conservation.

Up until now, the FCC has been considering three systems: Prestel, Antiope, and Telidon. I say "up until how" because as we go to press the FCC has made a decision—actually a *non-decision*! The FCC has ruled to let the three competing formats fight it out in the marketplace. That means that we will live with three incompatible teletext systems; consumers will be buying non-compatible teletext decoders until two of the competing formats die.

At this point, I would like to remind you that the FCC was set up to regulate electronic forms of communication within the borders of the U.S. That was to maintain order and insure compatibility for our citizens. Their latest ruling appears to contradict the very reason for the FCC's existence. What, may I ask, was the FCC doing for the last three years while it was supposedly considering the three systems? Why did the FCC waste two years of an EIA subcommittee's time evaluating the three systems. And what answer will the FCC offer to those consumers who now must purchase three decoders to receive all teletext broadcasts instead of just one? I wonder what heights of non-wisdom have finally overtaken our non-commissioners in this non-ruling.

Art Kleiman

ART KLEIMAN
Managing Editor

At CIE, you get electronics career training from specialists.

If you're interested in learning how to fix air conditioning, service cars or install heating systems – talk to some other school. But if you're serious about electronics...even earning an Associate Degree... come to CIE – The Electronics Specialists.

John E. Cunningham

Special Projects Director
Cleveland Institute of Electronics

My father always told me that there were certain advantages to putting all your eggs in one basket. "John," he said, "learn to do one important thing better than anyone else, and you'll always be in demand."

I believe he was right. Today is the age of specialization. And I think that's a very good thing.

Consider doctors. You wouldn't expect your family doctor to perform open heart surgery or your dentist to set a broken bone, either. Would you?

For these things, you'd want a specialist. And you'd trust him. Because you'd know if he weren't any good, he'd be out of business.

Why trust your education and career future to anything less than a specialist?

You shouldn't. And you certainly don't have to.

FACT: CIE is the largest independent home study school in the world that specializes exclusively in electronics.

We have to be good at it because we put all our eggs in one basket: electronics. If we hadn't done a good job, we'd have closed our doors long ago.

Specialists aren't for everyone.

I'll tell it to you straight. If you think electronics would make a nice hobby, check with other schools.

But if you think you have the cool – and want the training it takes – to make sure that a sound blackout during a prime time TV show will be corrected in seconds – then answer this ad. You'll probably find CIE has a course that's just right for you!

At CIE, we combine theory and practice. You learn the best of both.

Learning electronics is a lot more than memorizing a laundry list of facts about circuits and transistors. Electronics is interesting because it's based on some fairly recent scientific discoveries. It's built on ideas. So, look for a program that starts with ideas – and builds on them.

That's what happens with CIE's Auto-Programmed® Lessons. Each lesson uses world-famous "programmed learning" methods to teach you important principles. You explore them, master them completely . . . before you start to apply them!

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You work with experienced specialists.

When you send us a completed lesson, you can be sure it will be reviewed and graded by a trained electronics instructor, backed by a team of technical specialists. If you need specialized help, you get it fast . . . in writing from the faculty specialists best qualified to handle your question.

People who have known us a long time, think of us as the "FCC License School."

We don't mind. We have a fine record of preparing people to take . . . and pass . . . the government-administered FCC License exams. In fact, in continuing surveys nearly 4 out of 5 of our graduates who take the exams get their Licenses. You may already know that an FCC License is needed for some careers in electronics – and it can be a valuable credential anytime.

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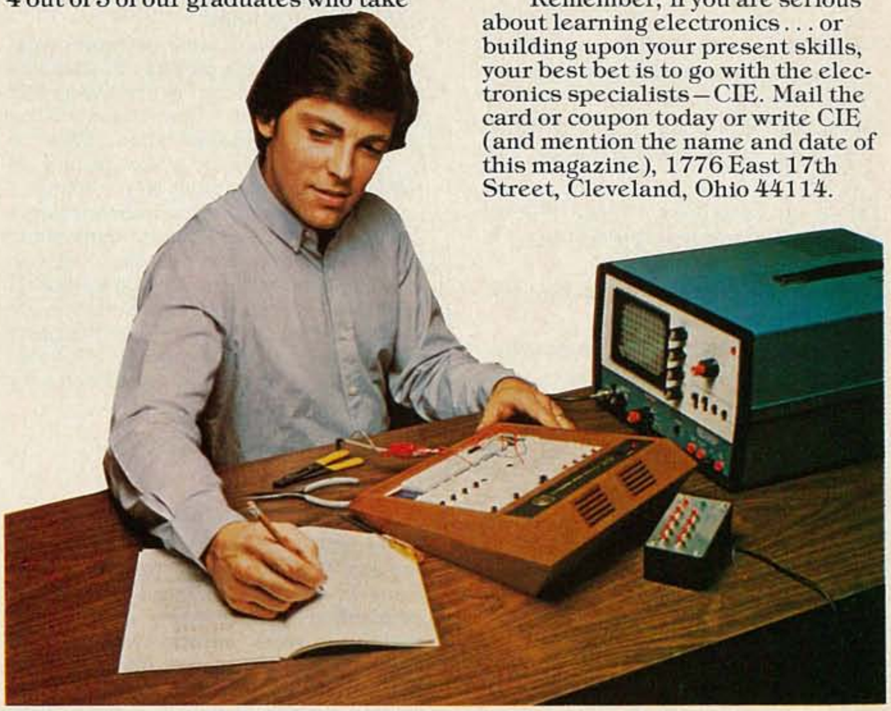

Pattern shown on oscilloscope screen is simulated.

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

Mail today!

RE-30

LETTERS

continued from page 13

squeeze my Q-1000 detector through.

I don't believe for one moment that the policeman operating the radar unit is primarily interested in saving my life on the roadways, or is instructed and knowledgeable enough to use the device without error. When I see a policeman just *sitting* behind a bush, operating those objectionable devices, I see my state and local tax money being wasted.

With crime the way it is today, I think that speeding is the lowest rung on the ladder when it comes to breaking the law. If as much time went into combatting other areas of crime as is spent in playing "cat and mouse" with the motorist, I think we would see a sharp decline in crime in those really important areas. Besides, if it were not for the high revenue collected by ticketing motorists for their deeds, I doubt whether we would see policemen just sitting around, relaxing in their cars with their radar units.

To say that every radar-detector owner has it solely for the purpose of speeding without getting caught is like saying that anyone who owns a gun is planning a bank job or an assassination. What the complainers need is to be tagged by radar; then their attitudes would change. I have seen so many radar traps that were cleverly set up, that I hate to think about how much money was collected that way.

Let us face the facts: As long as radar is used the way it is, and radar detectors are legal—as they should be—then the game will continue on the highways. I, for one, will continue to plug in my detector for protection.

M.J. RYBICKI,
Berwyn, IL

THE PIANOCORDER

We read Warren Baker's article about the Pianocorder in your November 1981 issue with much interest. It is certainly a fascinating development, and we are pleased to have licensed Superscope to reproduce many of our piano rolls on their cassettes.

I do object to a few minor points, however. The so-called "old-fashioned" pneumatic players are still being manufactured by the thousands; and so are the rolls, which are not nearly as "fragile" as you might be led to believe. Some of our products are 80 years old, and still performing well.

In addition, rolls bear not only the music but the printed lyrics as well, positioned to appear simultaneously with their corresponding notes. Grouping around an "old-fashioned" player, and singing along with the rolls, is a pleasure that no electronic update has yet surpassed.

QRS MUSIC ROLLS, INC.,
Robert J. Berkman, Adm. Assistant

BACKSCATTER

I'd like to comment on the article by Mr. Stanley Leinwoll, "Why Radio Moscow is

continued on page 103

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SATELLITE/TELETEXT NEWS

GARY ARLEN
CONTRIBUTING EDITOR

TELETEXT LOOK-ALIKE SERVICES

Although line 21 of the vertical blanking interval is used primarily for closed captions for people with impaired hearing, a number of new activities are making that channel look more like teletext. Dozens of programs on ABC, NBC, and PBS are transmitted with those closed captions each week; a special *TeleCaption* decoder is required.

But in the past few months, several projects have gotten underway to add more text services. For example, early in the year the networks began transmitting "InfoData," which is a text sequence, used intially to announce which programs will be captioned during the coming week. More recently, KCET-TV Channel 28 in Los Angeles began carrying "Newsline," a version of the Associated Press news "ticker" used by cable TV systems. In that service, electronic versions of the news wire scroll across the screen of TV sets keyed into the captioning system. WHA-TV in Madison Wisconsin, KWCM-TV in Appleton, Minnesota and WNET in Newark, NJ are planning similar news and information systems on line 21. All are public-TV stations.

TEXT VIA SATELLITE

Several teletext packages, intended primarily for cable-TV usage, are going aloft via satellite during the coming months. The most ambitious is one that will supplement "The Weather Channel," a new all-day weather-information service due to get under way in 1982. The teletext portion will include local weather reports transmitted from the Weather Channel's Atlanta headquarters to "Weather STAR" addressable teletext receivers in various cities. Meanwhile, another 24-hour text-only weather-information service, "View Weather," is being transmitted as part of the CableText package on Satcom I Transponder 6.

Perhaps the most substantial teletext-via-satellite project is the one now under way at Time Inc. About 4,000 pages of information are being sent over a full transponder from Time Inc. headquarters in New York to Southwestern Cable TV in San Diego (owned by a Time subsidiary) as part of a major teletext test.

AROUND THE SATELLITE CIRCUIT

Blonder-Tongue Laboratories, a long-time respected supplier of cable-TV hardware, is getting into the earth-station business with a new dish and earth-station modulator.

Forget any ideas about using satellites to collect solar power and beam it down to earth as the next big wave of satellite activity after communications satellites. The U.S. Department of Energy gave a tentative approval to such a concept, which would probably take 50 years to put into place. But a few months ago the National Research Council recommended against such a plan, saying it would be far too costly—as much as 3 trillion dollars. Furthermore, such a solar-power satellite would probably create interference with communications satellites and there would be other technical and political problems in developing such a system. But, just in case, NASA is going to continue keeping an eye on the idea. ...

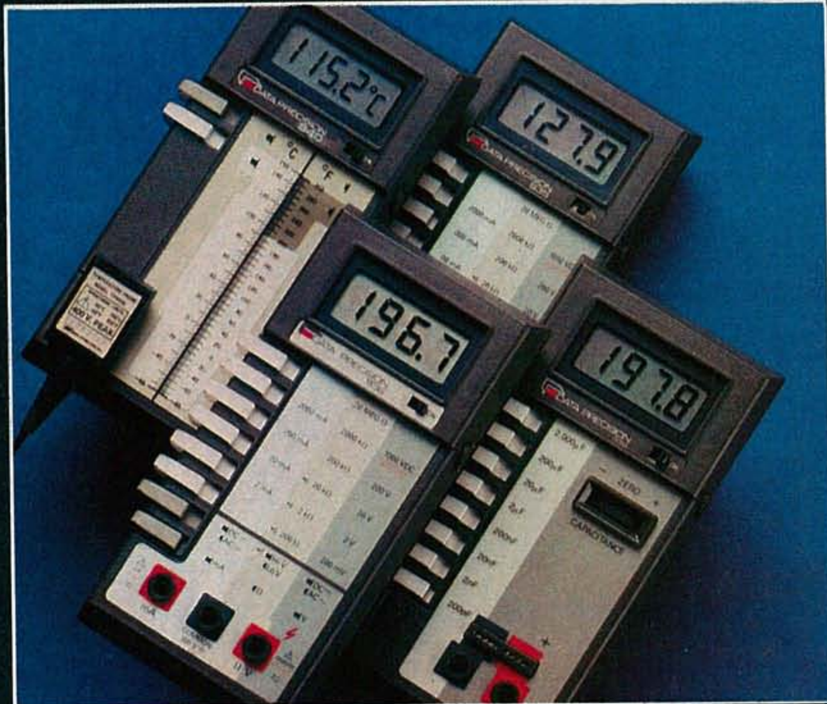
Metromedia is now sending the Merv Griffin Show to TV stations; Merv's show is transmitted on Westar III every morning, to be taped by stations which run it later in the day.

CANADIAN JUDGE APPROVES PRIVATE TERMINALS

A British Columbia judge has found an apartment-house manager "not guilty" of accusations that he operated a private satellite dish to provide video programming to tenants. The decision is seen as a victory for backyard satellite-receiver users in Canada, where the federal government has been trying to crack down on use of such private terminals. The ruling, however did not resolve the question of reception of video transmissions via satellite from across the border.

Meanwhile, prosecuters in other Canadian provinces are continuing their cases against other private-terminal owners—both commercial operators (such as the apartment-house manager) and personal users. The Canadian Radio-Television Commission requires earth-station operators to have a technical certificate and a broadcast license. **R-E**

PERFORMANCE BEYOND PRICE



Just what you expect from Data Precision.

A Better Way to Get A Better Meter.

If you've been holding off getting a digital meter until the right deal came along, it's here!

Data Precision is offering better-than-ever prices on its most popular high-performance hand-held 3½ digit meters. It's the ideal time to get rid of finicky, hard-to-read analog meters—or even digital meters that have seen better days.

No matter what you measure, now's the time to upgrade your bench. With Data Precision.

3½ DMMs

Model 936: ~~$165~~ $145 with coupon
Model 935: ~~$155~~ $135 with coupon

Get 29 ranges with all the functions, with 0.1% basic accuracy, protection up to 6kV spikes and hi/lo ohms excitation. All in a one-hand case toughened for the field, yet accurate enough for most bench needs.

Both models read 100μV-1000VDC, 100μV-700VAC; 1μA-2A AC or DC; and 100mΩ-20MΩ.

The 936 also features audible continuity beep and overvoltage alarm, for faster "eyes-off" testing.

CAPACITANCE METER

Model 938: ~~$219~~ $199 with coupon

Measure from 0.1pF to 2000μF with 3½ digit 0.1% accuracy. This surprisingly economical meter offers immediate direct reading, and simple pushbutton operation, outperforming capacitance meters, DC time constant meters, and even bridges costing 2 to 5 times as much.

TEMPERATURE METER

Model 940: ~~$195~~ $175 with coupon

You can read -65°C (-85°F) to 150°C (302°F), with 0.1° resolution below 200°. You also get a detachable 6" semiconductor probe with 4' cable. The 940 offers an extremely short settling time, and maintains 0.4°C (0.7°F) accuracy.

Every one of these high-performing LCD meters operates up to 200 hours on a standard 9V transistor battery, and is warranteed for 2 full years.

We want you to discover Data Precision quality, so from now through March 31 we are offering a $20.00 saving when you present this coupon to one of our distributors.

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Two ways to find replace

When you think about the number o new electronic gizmos that come off th boat every year, it's staggering.

If you happen to be a repairman, it's enough to drive you crazy. It seems there's absolutely no way for you to keep on top of all those new electronic components required.

But don't worry. There's a very easy way to keep up. Get a Sylvania ECG®

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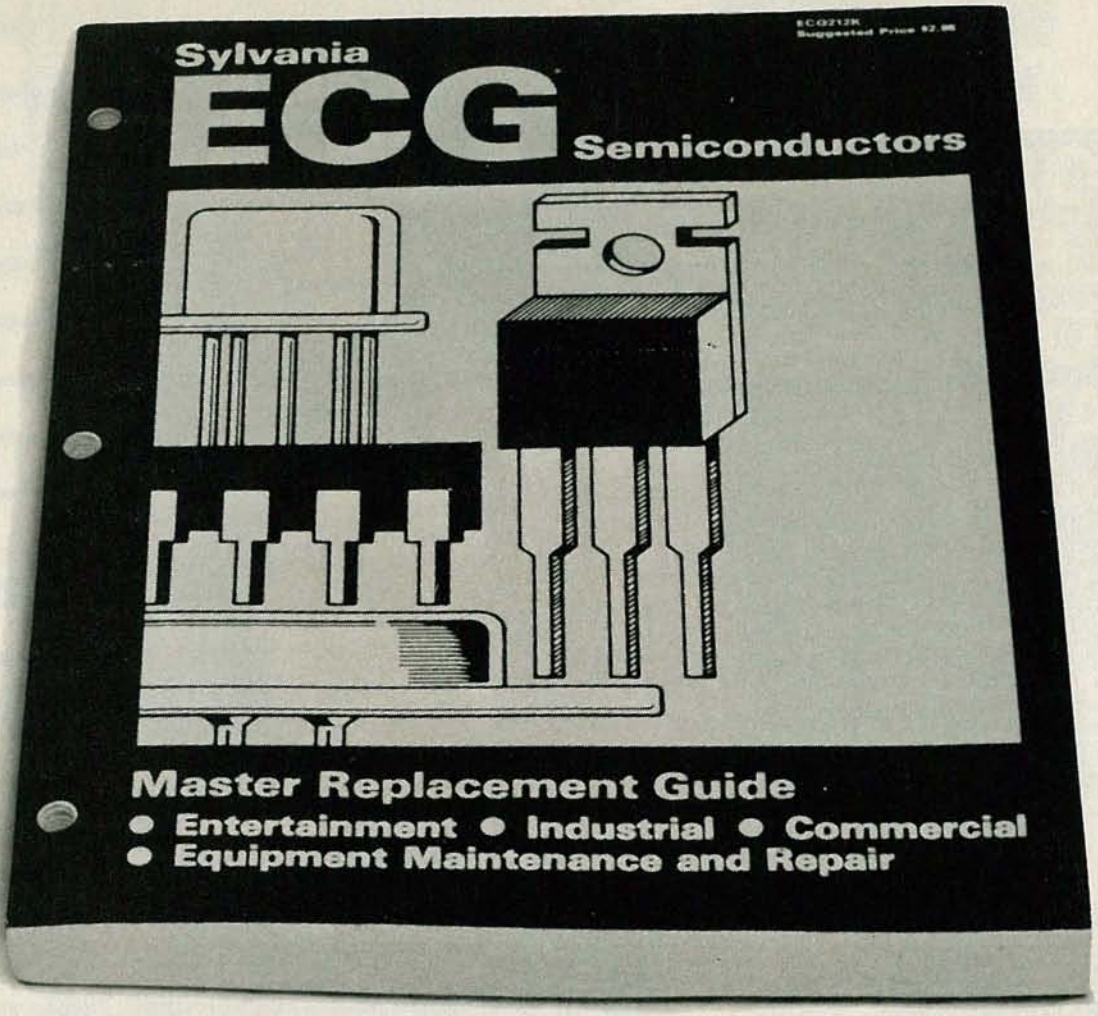

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laster Replacement Guide from your
hilips ECG distributor.

It cross references more than 170,000 ndustry part numbers to over 2,500 CG devices including most of the ard-to-find foreign parts.

You get concise descriptions on each vith clear illustrations of packaging and ircuit diagrams. And, you have the full echnical resources of Philips at your disposal for any tricky replacements you might have questions about.

What's more, the ECG parts you receive are of the highest quality. Specifications on these devices are equal to, and usually exceed, those of the original part. To maintain quality and performance levels, all of the ECG's are checked in accord with military standard testing procedures.

But the best part is that you don't have to go every which way to get them. You just go to your nearest ECG distributor.

PhilipsECG
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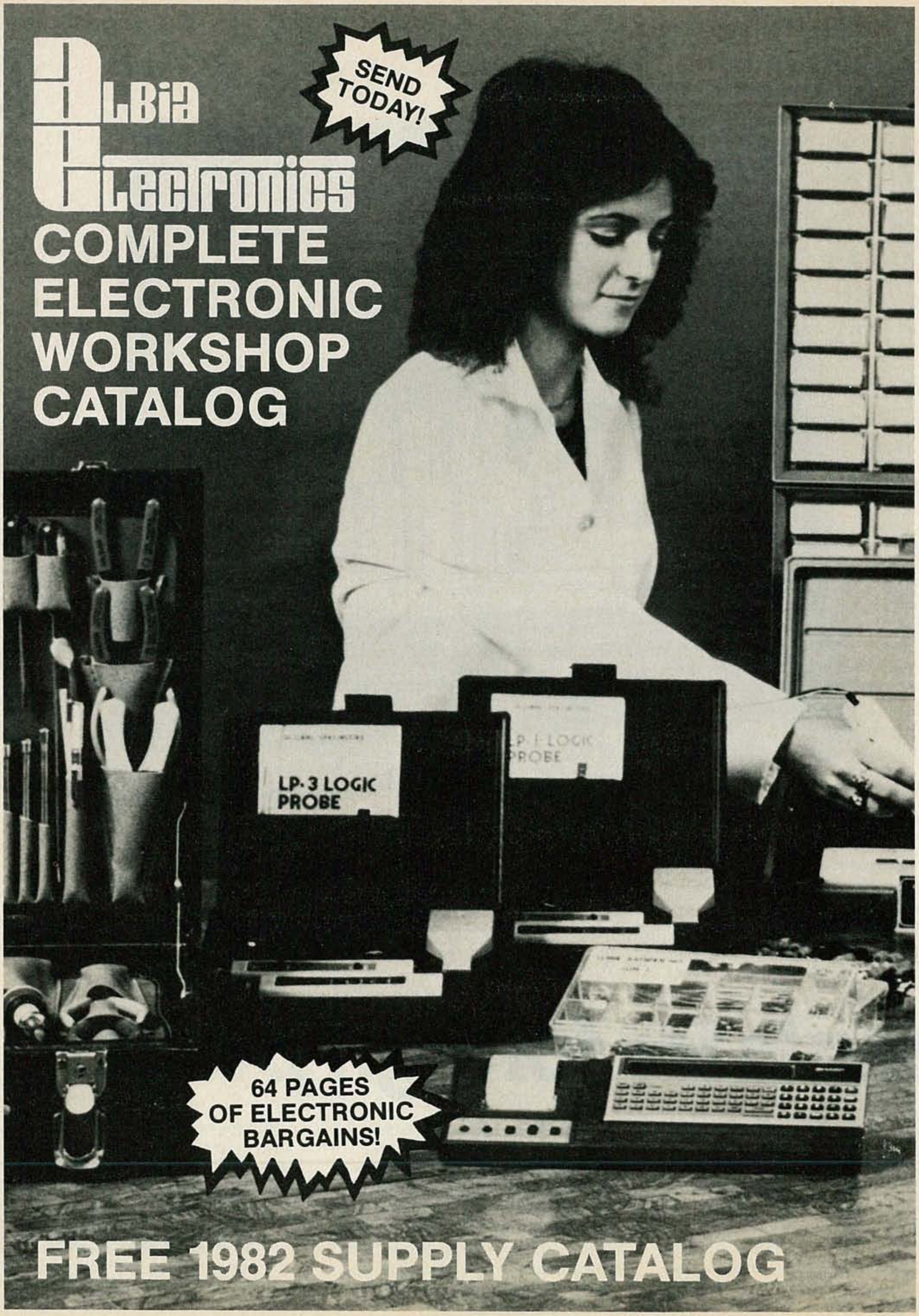
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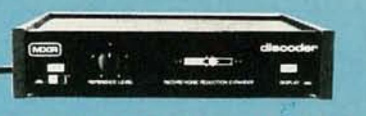
EQUIPMENT REPORTS

MXR Model 156 CX Decoder



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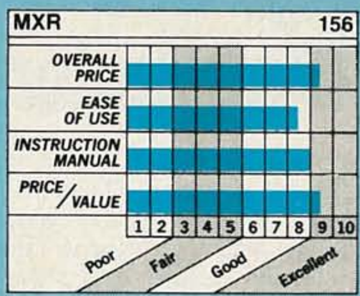


MXR INNOVATIONS, INC. (740 DRIVING Park Avenue, Rochester, NY 14613) offers an interesting line of audio accessories. Their latest one is a *CX* decoder, the *model 156*.

As you must be aware by now, *CX* is a compatible companding system for *CX*-encoded records. Without a decoder, the records sound normal. With a decoder, they attain a dynamic range of about 85 dB, with the extension being at the "quiet" end. That means that the noise floor drops by 20 dB, resulting in virtually noise-free playback and a much more natural-sounding reproduction of the recorded material.

My first experience with the *model 156* decoder was uncanny. I cued the turntable arm, stepped back, and waited for the music to begin. Nothing happened. Thinking that maybe I had switched my speakers off, I went up to check them. As I was looking, the music began. There'd been no noise when the stylus contacted the record, and no noise from the lead-in groove. Nothing!

And the quality of the sound! Loud passages were, of course, loud—*CX* doesn't concern itself with headroom. What was amazing was that during quiet passages, I could hear things that I would otherwise have missed because of record surface-noise. And, between cuts, there was nothing to indicate that a record was on the turntable—just dead silence. It was like being present at a performance in a hushed room. The only thing you heard was what you were *supposed to* hear, and then, you heard it all. It's something that has to be experienced to be believed.

About the time you read this, CBS is expected to have about 50 *CX*-encoded records on the market, and a number of other recording companies have signed agreements with CBS to also use the *CX* companding system.

The MXR decoder

The *model 156* is extremely simple to connect and use. Two sets of audio cables connect it to the tape-recorder loop of your preamp or receiver; it obtains its power from a 117-volt power line. (My early-model decoder did not have provisions for restoring the use of the jacks that it occupied; MXR tells me that this will be remedied in later models. In any event, the fact is that the decoder can be placed just about anywhere in the loop with other equipment, thus still allowing your sound system full flexibility.)

All the controls are located on the small unit's front panel (the jacks are on the rear apron). A 7-inch calibration record is included with the decoder, and calibration is simply a matter of playing the record and adjusting the REFERENCE LEVEL control until neither one of the two LED's mounted in the front panel is on. That's all there is to it. The adjustment isn't even critical—an error of as much as 6 dB will not be noticeable.

After the unit has been calibrated, nothing has to be adjusted until a different phono cartridge or amplifier is brought into the system.

Aside from the REFERENCE LEVEL control, there are only two others—one for DISPLAY that brings the LED's into the circuit, and one to switch the decoder into or out of the system. There's no power switch—the device draws only 2.4 watts when in use and the assumption is made that it will probably be connected to a switched outlet on your equipment, anyway.

The frequency response of the decoder is given as 20 Hz-20 kHz, +0, −0.5 dB. THD is less than 0.09% over that range, with 0.05% typical at 1 kHz.

Total dynamic range available is specified as 100 dB.

The manual, while short, explains everything you'll need to set up and use the decoder.

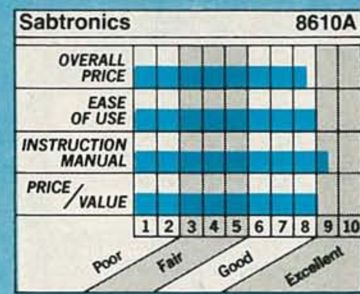
One word of caution: The decoder works *only* for *CX*-encoded records. If a *CX*-encoded record is recorded on tape and played back through the decoder, only the characteristics of the material on *that record* will be modified; any tape hiss that was present before will still be there.

Finally, while *CX* records are on the shelves, they may be hard to locate—the fact that a recording is *CX*-encoded is shown on the *back* of the jacket, not the front. (That may be due to the fact that, since the records can also be played on ordinary equipment without a decoder, the record companies don't want to scare away record buyers who don't know about the system and don't have special equipment.) Once *CX* gets a foot in the door, though, the *CX* logo will probably move to the front, where it can easily be seen.

The MXR *model 156* decoder is a good example of how simple it is to improve the pleasure you can get from a good recording. It has a suggested list price of $99.95...and don't forget to watch for the *CX* logos on the back of the record jackets. **R-E**

Sabtronics Model 8610A 600-MHz Frequency Counter

CIRCLE 102 ON FREE INFORMATION CARD



FOR ANYONE—WHETHER HE'S A TECHnician, ham, or designer—who has to measure signal-frequencies, a frequency counter is a necessity. For a long time I tried getting along without one. I'd borrow one from friends or, more usually, take the equipment to be checked out—usually an amateur radio handie-talkie or a piece of digital equipment I'd put together—to someone who had a counter.

Eventually that became too much. The stuff I was building was getting too awkward to carry, and frequently required more than a simple yes-or-no frequency check. So, I finally broke down and purchased a counter of my own.

My choice was the Sabtronics *model 8610A* 600-MHz counter. Although it has a smaller brother (the *model 8110A*, good to 100 MHz) and a bigger one (the *model 8000B*, that goes up to 1 gigaherz), the 600-MHz version offered just what I needed, with a little bit to spare.

It covers all the radio bands I use and has a low-frequency limit of 20 Hz; some of my projects involve audio frequencies and the *model 8610A* is ideal for that end of the spectrum, too.

Putting it together

The counter is available either as a kit or assembled. Naturally, I chose the kit form. I was very pleasantly surprised with the quality of the components—and of the manual—that came with the kit. The main PC board is silk-screened and solder masked. The 600-MHz prescaler board is not, but very clear diagrams make it difficult to go wrong.

The construction manual is excellent. There are plenty of diagrams and (literally) step-by-step instructions with

continued on page 32

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EQUIPMENT REPORTS

continued from page 30

a space for you to make a mark indicating that you've successfully completed that step.

There are also a number of construction hints along the way, at places where a novice builder might find himself wondering exactly what he was supposed to do. There's even an introductory section on how to make good solder connections. The manual includes a table showing what readings should be obtained with different switch settings and, finally, provides troubleshooting hints. Sabtronics leaves nothing to chance!

Calibration of the unit is easy. An internal SENSITIVITY control is adjusted using a voltmeter, and a small variable capacitor trimmed to bring the counter right on frequency. That calibration can be performed in two ways. The first is conventional—input a 10-MHz signal from a known-to-be accurate source. The second method requires a shortwave receiver, but is just about as accurate. A receiver tuned to WWV at 10 MHz is used as a standard, and the counter, placed close to the receiver, adjusted to read the same frequency. The accuracy of the receiver isn't critical—when the National Bureau of Standards says it's transmitting on 10 MHz, who's to doubt it?

Construction went quickly, and the unit worked the first time it was turned on.

Features

The *model 8610A* has an 8-digit LED display. The decimal point, which adjusts its position automatically, also serves to indicate the gate time: 0.1, 1, or 10 seconds, by flashing at that rate. There is also an overflow indicator on the display to indicate an out-of-range condition.

Three switches on the front panel select frequency range, gate time, and turn the counter on and off. A single BNC connector is used for input. Power is supplied either by four "C"-type nickel-cadmium rechargable cells (optional) or from a power supply/charger, also available as an option. The counter can be used while the batteries are being charged.

Earlier, I mentioned a low-frequency limit of 20 Hz. I should clarify that by stating that the *guaranteed* operating range is 20 Hz-600 MHz. Typical operating range, though, is specified as being from 10 Hz to 750 MHz. Resolution is claimed to be 0.1 Hz up to 10 MHz, 1.0 Hz to 100 MHz, and 10 Hz to 600 MHz.

The counter features input protection —from 150-volts RMS up to 10 MHz to 4-volts RMS above 100 MHz. Its sensitivity is 10-mV RMS up to 100 MHz, 70-mV RMS up to 450 MHz, and 150-mV RMS to 600 MHz.

The unit uses a temperature-controlled crystal oscillator and, while there is some drift—under 200 Hz during the first few minutes of operation—the counter is essentially rock-stable after less than half an hour. Temperature stability is given as 0.1 ppm (*P*arts *P*er *M*illion) per °C, with an aging rate of less than 5 ppm per year. According to the specifications, setability is claimed to be ±2 ppm; I found it even better.

The counter measures 8 × 6.5 × 3 inches and weighs 1.2 pounds without batteries. A bail is provided to tilt the unit up for better visibility. There's quite a lot of empty space in the enclosure, which leads me to wonder what other items Sabtronics has in mind to put in there.

I feel that the *model 8610A* frequency counter is one of the best equipment choices I could have made for my bench. It's available from Sabtronics International, Inc., 3709 N. 50th Street, Tampa, FL 33610 for $119.00 in kit form and $149.00 assembled, plus $5.00 for shipping and handling. **R-E**

continued on page 34

EQUIPMENT REPORTS

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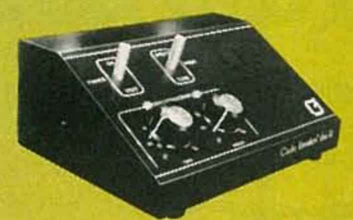
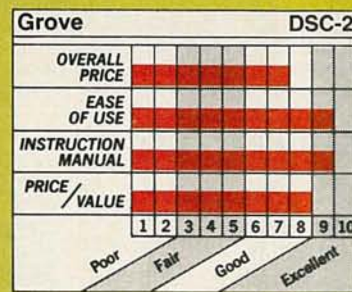
Grove Enterprises Model DSC-2 Code Breaker



CIRCLE 103 ON FREE INFORMATION CARD



WITH THE CASUAL MONITORING OF VHF/UHF frequencies at an all-time high, it is not surprising that many law-enforcement agencies, among others, are concerned with the privacy of their communications. While many of those agencies prefer to use a simple "10" code, or a variation of it, still others prefer the additional protection of a voice privacy system.

There are many ways to garble a voice transmission including speech inversion, rolling code, spread spectrum, frequency hopping, and voice digitizing. The new model *DSC-2* from Grove Enterprises restores intelligibility to speech-inverted communications.

In speech inversion, high voice-frequencies and low voice-frequencies are transposed by the mixing action of a local audio-oscillator. A descrambler simply takes the inverted speech and restores it by passing it through a circuit that is identical to the one that originally scrambled it. That is what this unit does.

Since an agency that wishes to scramble its transmissions can choose any oscillator frequency it wants, the unit has a control to "fine tune" the restored speech. Often, a speech-inverted signal will also have an audio tone superimposed over it for increased security. That technique, called tone masking, reduces the intelligibility of even restored speech. The *Code Breaker* has a tunable audio notch-filter to remove such an audio tone, leaving the restored speech out in the clear. The unit can also be used with shortwave receivers to remove heterodyne interference that is often heard on broadcast transmissions as well as when monitoring single-sideband and CW signals.

The unit requires 12-volts DC for operation. There is an optional power supply available from the manufacturer, or you can use any mobile power supply. The power jack is of the recessed coaxial variety, eliminating the possibility of a short circuit while plugging in the power supply. There is also an internal diode that is used to prevent damage if the power-supply connections are accidentally reversed. Although designed for 12-volt operation, in our tests (more on that later) we noticed that the unit operated at power inputs ranging from 8 to 16 volts without any noticeable degradation of the audio signal. Incidentally, all of the required interconnection cables are included with the unit.

The unit has an internal speaker. If you wish, an external speaker, earphones, or a recording device can be connected using the rear-panel-mounted external speaker jack. Other rear-panel jacks allow you to connect up to two receivers to the descrambler.

Our test

The notch-filter control allowed for considerable rejection (up to 60 dB at midrange) over the 800-3000-Hz frequency range. Tuning was sharp, permitting the removal of distracting tones without destroying the audio character of the speech. Incidently, the audio quality of the speaker seemed quite good; that may be because the rugged metal cabinet provides a favorable acoustical housing. The local oscillator for the speech descrambler was tunable from 2600 to 4000 Hz, defeating all types of single-inversion speech-scrambling systems.

Quiescent current during idle (no input driving the unit) was measured at 55 mA. The current increased to approximately 200 mA during high-level audio transients. Since the audio circuitry is designed around a 2.5-watt LM380N, no appreciable heating or distortion was evident.

At normal volume levels, a 2N3904 twin-T oscillator injects a sine-wave tone into a Motorola MC1496P balanced-mixer IC. The output is passed through the notch filter to the audio stage. Signals can be processed by the audio filter even when the unit is not in the descramble mode, allowing for greater flexibility.

The decoder sells for $97.95, plus $2.25 shipping, with the AC adaptor; $89.95, plus $2.25 shipping, without. It is available from Grove Enterprises, Brasstown, NC 28902. R-E

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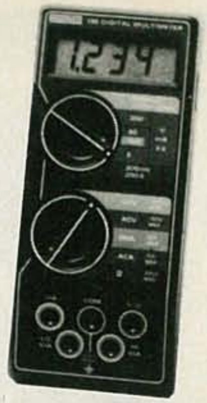

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DC CURRENT	2mA, 20mA, 200mA, 2000mA, 10A	2%
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CAR TELEPHONES
Cellular Technology Promises More Channels

DANNY GOODMAN

Long waiting lists for phones and a lack of channels have limited the usefulness of the mobile-telephone system. A sophisticated new system is about to change all of that.

AN EXECUTIVE HEADS FOR HIS CAR parked in a downtown Chicago office-building garage, hoping to make it home to suburban Lake Forest in time to entertain dinner guests. Weighing heavily on his mind are sensitive negotiations taking place in California with which he must be in constant touch during his drive up the expressway.

Still in the garage, he dials the number of his Los Angeles contact on the pushbutton mobile phone, just as he would from his office upstairs. In a couple of seconds the phone in L.A. is ringing, and our busy executive starts his drive. During his hour-long mobile conversation, neither he nor his associate will notice that their full-duplex communications channel will have shifted frequency three times, with the mobile call going through three separate base-station sites.

The entire process is channelled through one of the most sophisticated land-based communications systems available to the general public, cellular mobile telephone. A cellular mobile-telephone system divides a metropolitan area into a mosaic of small cells, each with its own low-power transceiver, so that the same channel can be used for different conversations in non-adjacent cells. The result is more available channels for mobile-phone customers. To accomplish that, cellular telephone uses a remarkable system of computer-controlled radios that "hand off" a mobile call from one cell to the next as a vehicle travels across town. The hand-off is done so smoothly that the caller will probably not even notice it.

In a conventional mobile-telephone setup, with a high-power base transmitter covering an entire metropolitan area, our executive would have just a 50% chance of getting an open channel at some time during his hour drive. If he did manage to get on the air, he would be occupying one of the 23 valuable channels in the Chicago area. (There are only 12 such channels in New York City!) But with the cellular system, there is a 99% chance that his call would go through on the first try. And, as he moves from one cell to another, our friend's telephone call shifts to a different channel on that other cell's transmitter/receiver, and the original channel opens up for another caller.

Additionally, the cellular system makes portable telephones feasible.

This is not a science fiction dream, but a real system proven in two trials in congested areas: Chicago, sponsored by an AT&T subsidiary called AMPS (*A*dvanced *M*obile *P*hone *S*ervice), and Washington, D.C./Baltimore, sponsored by Motorola and operated by American Radio-Telephone Service Incorporated. Because of the success of those tests last year, the FCC, in a preliminary action, allocated two 20-MHz segments of the 800-MHz band for cellular-telephone communications. If final approval is granted (a decision was expected just after this issue went to press early last December), within two years the first fully operational systems could be in place; the system should be available in 70 cities within 5 or 6 years. When that happens, a cellular network will allow so many more people to have mobile phones in their automobiles and trucks, that the usual waiting list for those phones will all but disappear.

FIG. 1—CELL-SITE BUILDING is dwarfed by the 150-foot antenna tower. The two antennas below the platform are used for reception; the antenna above the platform is used for transmission.

Basic cell systems

A cellular mobile phone system consists of a deceptively simple network of remote duplex transceivers. Cells are connected by landlines (telephone lines) to a central MTSO (*M*obile *T*elecommunications *S*witching *O*ffice). It is at the MTSO that mobile calls are automatically patched into the regular telephone network, without the need for mobile operators.

A typical cell site, like AMPS' Lyons, Illinois site, is little more than a small building (about 20 feet by 20 feet at Lyons) to house the equipment racks, and a 150-foot tower for the antenna system (see Fig. 1). In more urban areas, cell sites can be located on building roofs.

The base station's receiving antennas are two vertical monopoles set up in a diversity reception mode. Two antennas are used in diversity reception so that a moving vehicle can maintain contact with the base station at all times. In that mode, the base-station's receiver is able to choose between the stronger of the two signals coming from the antennas; if a car is temporarily shielded from one antenna, the receiver simply switches over to the other.

The base station's transmit antenna, which is also a vertical monopole, is capable of handling up to eight transmissions on different frequencies at once. Since line losses at 800 MHz can be incredibly high with conventional cables, all antennas are fed with Heliax gas-filled coaxial cables that are maintained at a constant pressure.

Equipment in the small building is completely automated. One typical site that we visited recently with an AMPS official had two racks of transceivers, each rack with eight channels in operation (see Fig. 2). Small fans on the 45-watt air-cooled amplifiers hummed quietly. Each cell site performs repeated self-testing of its equipment and reports irregularities to a central AMPS office. Only then is a service technician dispatched to a site. In addition, an outside transmitter tests the voice quality of each channel throughout the system by sending a 1-kHz tone and comparing the signal coming through the radios and phone lines to the original. That, too, is automatic, with a central printer logging the results of each test at approximately one-minute intervals.

In the event of power failures at the site, a wet-battery back-up power supply can operate the communications gear for about eight hours. Part of that back-up is also a power inverter to keep the automatic test gear in operation.

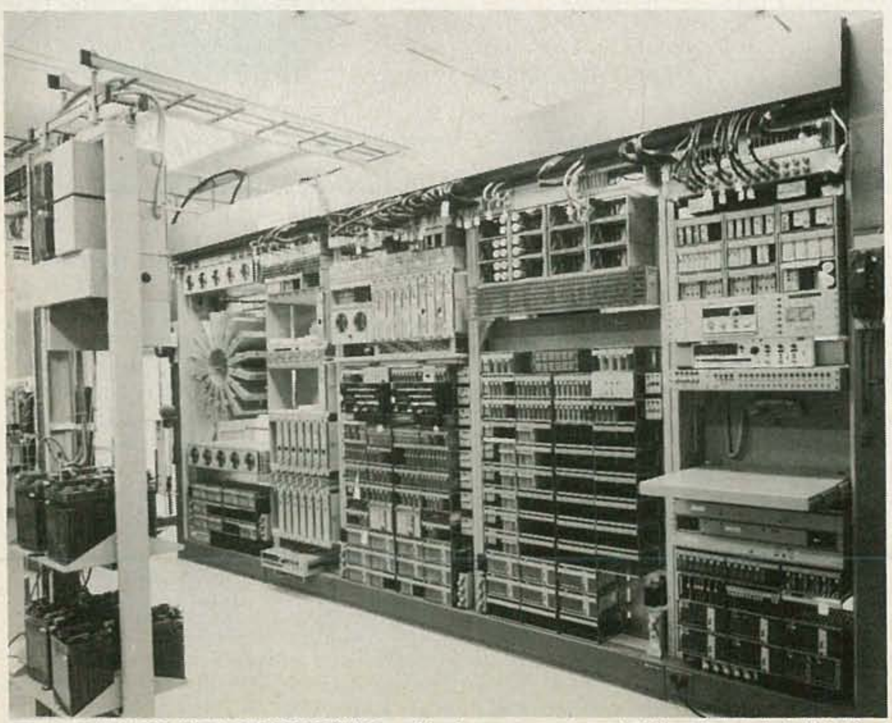


FIG. 2—RACK-MOUNTED TRANSCEIVERS and logic components are totally automated. Self-testing is done by the equipment on the right and the battery back-up system in the foreground is provided in case of a power failure.

Mobile installations

Vehicle installations are quite simple affairs. A one-piece trunk-mounted unit is a combination 800-MHz duplex FM-transceiver and sophisticated logic unit. Installation in most vehicles takes about 4½ to 5 hours, including complete testing. The vehicle's phone number is entered into the radio by way of a PROM chip that is programmed at the installation site. Because of the 45-MHz separation between the transmit and receive frequencies, cellular mobile phones use two 2.5-dB gain antennas at the car; one each for transmit and receive. The antennas are precisely tuned for the proper segment and can be either roof or trunk-lid mounted; roof-mounted antennas are ⅝ wavelength, while the longer trunk-lid antennas are ½ wavelength center-fed verticals.

Control heads vary somewhat with manufacturer. In the Chicago test, for example, mobile equipment was supplied by Motorola, Oki, and E.F. Johnson. Some heads have a *Touch-Tone* pad and resemble a standard desk phone (see Fig. 3). The deluxe model has a pushbutton pad and digital display built into the modern-looking angular handset.

Costs for cellular phone privileges have not been set, but the rates used in the Chicago test will give you an idea of how much is involved. Mobile equipment is leased for $45-60 per month, depending on control-head style and options. For air time, there is a basic charge of $25 per month, which includes 120 minutes of air time. Additional minutes are 25 cents each

The Chicago test divided the 2100-square-mile metropolitan area into ten cells as shown in Fig. 4. While the downtown cell had the smallest geographical area, it also had the highest number of voice channels (26). Mobile units used 10-watt transmitters, but when the operational system is permanently set up, there will be more and smaller cells, allowing the mobile units to communicate comfortably using 3 watts. In the test, cells at opposite ends of the city used the same nine channels.

Growing cells

Cell sites are assigned a number of channels, based on the projected number of calls within that cell. More congested sites, such as the central business district of a major city, will have perhaps three or more times as many channels as an outlying cell. Because the base transmitters run at a low power-level of about 40 watts, the signal does not cover the entire metropolitan area—channels can be used by several cells as long as those cells are far enough apart. Motorola uses a four-cell cluster, while AT&T perfers a seven-cell cluster before reusing a channel.

Moreover, as the number of users increases within a cell, or throughout the system, cells can be subdivided into smaller cells with lower-power transmitters and directional antennas allowing channels to be used even more times within the system. Theoretically, a cell can be as small as one mile in diameter. With the number of channels currently allocated to cellular telephones, a large city with 500 one-mile cells could serve a quarter of a million users!

Typically, a cell will go through three stages to accommodate greater traffic. In the first stage, a transceiver and omnidirectional antenna are centrally located within a cell. The second, or transitional stage, establishes additional cell sites, with directional antennas for some of the channels. The new cell sites will service a more localized area with a lower-power transmitter. More channels are switched over to the new cells until the original cell becomes a final-stage cellular system, consisting of a complete network of directional, low-power cell sites. In practice, the growing system will always be in a transition stage because service needs in any area will always be changing. And since the mobile units are capable of switching to any channel, as instructed by the MTSO, the user will be unaware of any of the changes in cell locations and frequencies.

FIG. 3—HUMP-MOUNTED CONTROL HEAD with handset and *Touch-Tone* keypad. A deluxe model (not shown here) also has a readout of the last number dialed.

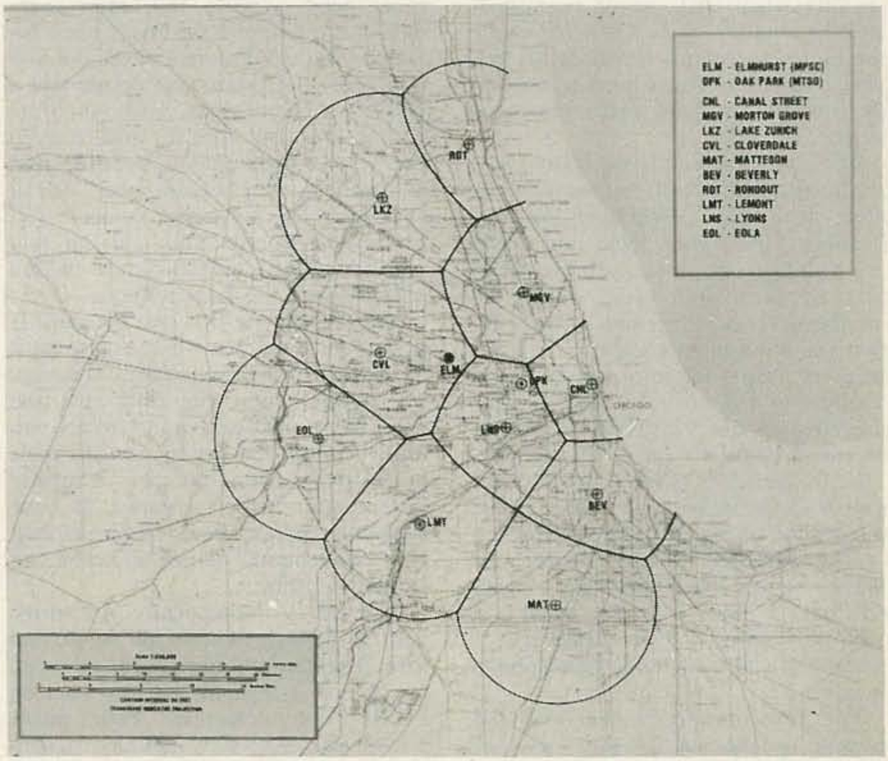


FIG. 4—THE CHICAGO TEST of the cellular mobile phone system divided the metropolitan area into 10 cells. Future networks will have smaller cells and use lower-power equipment.

How cellular phones work

The secret to the cellular system lies in two-way digital-data communications between car-and-cell, and cell-and-MTSO, plus one central computer at the MTSO keeping everything under control.

Perhaps the best way to describe all the intricacies of the system is to follow a couple of telephone conversations from start to finish, with a cell hand-off added for good measure. This example is based on calls through the Chicago developmental system, operated since 1978 by Bell Laboratories and Illinois Bell Telephone, and used by about 2000 willing customers from a cross-section of professions and businesses.

You get in your car and turn on the engine as you always do. Then you switch on your deluxe telephone-control head mounted on the transmission hump. Using the *Touch-Tone* buttons, you key in your own three-digit security code that makes sure you're the only one making calls from your mobile phone. Nothing is coming through the speaker, but the logic unit of the trunk-mounted transceiver scans through the control channels of all cell sites in your metro area and determines by Cell A's set-up channel's signal strength tht you are in Cell A. The set-up channel is a data-only frequency pair, and is a critical link in cellular telephone. Your radio is then kept on Cell A's set-up channel as long as the data signal there stays strong enough. At the cell site, there is a back-up setup channel transceiver if one should fail. The setup process takes less than a second.

As you drive along, you want to call your friend to see if he needs your help with a personal-computer problem he's been having. Without picking up the headset, you enter his telephone number on the *Touch-Tone* pad. An audible "beep" comes from the head's built-in speaker when each button is pushed, and the number appears in a display by the buttons. A quick glance at the display confirms you have properly entered the number, so you press the SEND button.

The following sequence takes place about as quickly as if you were calling your next door neighbor from your kitchen: The mobile logic unit sends out a data burst on the setup channel that identifies your radio, sends the number you're calling, and alerts Cell A that you have an outgoing call. Cell A's receiver passes the information over a landline to the central MTSO, where the Western Electric computer assigns an unused voice channel for the call. That frequency is passed back through Cell A to the mobile radio. The mobile transceiver obeys, and shifts frequency to the specified channel. When the MTSO senses the mobile unit's signal on that channel (the information is again relayed via Cell A's receivers), it places the call over the landline phone system.

The next sound you hear over the console speaker will be the ringing of your friend's phone. If the called number is busy, no problem. You will hear a busy signal, as you would expect. Simly press END, which alerts the MTSO to "hang up." Your channel opens immediately for other callers, as your radio shifts back to silently monitor the setup channel. Since that last number you dialed is still shown by the display, pressing SEND will automatically re-dial the call. The same instantaneous data exchange and frequency shift, though perhaps on a different channel, will take place.

Well, this time your friend answers the phone, and you become engaged in a long conversation. Unknown to you or him, your car is about to go from Cell A to Cell B. Here's what happens at a hand-off: The MTSO computer is busy monitoring the signal strength of every mobile signal coming through every cell site. It "sees" that your signal is starting to fall off from Cell A (though you don't realize it on your end) and it must find an open channel for you in Cell B. Since channels are not shared by adjacent cell sites, your hand-off involved a shift in both transmit and receive frequencies in addition to a change in cell sites.

The computer spots an open channel for you in Cell B. When your signal drops to a specified level, the MTSO sends a data burst (at a data rate of 10 megabytes-per-second) to your radio's logic unit via Cell A. In that one-quarter second, the audio is interrupted as the radio gets its instructions to shift channels—which it does without your even suspecting that brief "blank and burst" sequence.

When you hang up the handset, your radio goes back to the setup channel—but a different set-up channel, because you are now in Cell B. As you continue your drive, you decide that a quick call home may save you from having to go out later for milk. So you press a two-digit memory code to speed dial your home phone number, one of several frequently called numbers you previously stored. You find out that you are to pick up your children at a softball game on the way home.

At the field you find that the game is just about over, so you decide to park the car nearby and watch the last inning. Meanwhile, your wife finds that she does need milk, and wants to let you know before you get home. She dials your mobile phone number—a regular seven-digit number assigned to your telephone through an exchange located at a conventional (landline) telephone switching office.

The call is automatically sent to the central MTSO, whose job is to find you. It sends your identity code through every cell site in the service area on every set-up channel. Your radio, which you purposely left on, is constantly listening to the setup channel. When it hears your number, it tells Cell B via the setup channel that you are in Cell B. The MTSO then assigns a voice channel in Cell B for your wife's call. Your radio shifts to that channel, and your phone rings. Fortunately, you select the option that honks your horn when the phone rings.

As in that example, business users in the AMPS Chicago test found that the system saved them time and gas. A survey found that 84% of them were "very satisfied" with the service provided by the cellular telephone system.

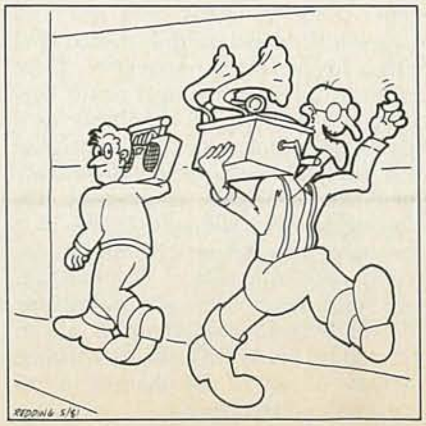
Our test

To test for ourselves the voice quality of the AMPS system, we took a ride in a car with a specially equipped mobile telephone. In addition to the telephone control head, that unit had a little box under the dash called a System Access Monitor, which gives a readout of the channel currently being used and has a signal-strength meter.

Local and long distance calls were as easy to make as if from a desk. Audio quality of the mobile phone was equal to any land-line, except when going through very low-elevation tunnels and extended viaducts. Even then, a couple of static crackles at the mobile end were at a very low level—perhaps inaudible to someone who did not know what he was listening for. None of those we called suspected we were talking on a mobile phone until we let them in on the secret. Communication was consistently flutter-free, even when the System Access Monitor meter showed that there were extreme changes in signal level.

The next test was to force a hand-off to an adjacent cell to detect the blank-and-burst used to shift frequencies. As the channel readout changed on the System Access Monitor, we heard a slight electronic "click," and that was all. Again, we were listening for it with a tuned ear; otherwise we would have missed it. And since normal installations don't have the Monitor readout or meter, you would never know when to expect a hand-off—or when one had occurred.

As the demand for mobile communications increases, especially with the growth of microwave digital telecommunications, a system is needed that will make every megahertz count. Cellular mobile telephone is such a system, and it will soon provide many of us with high-technology, reliable, two-way voice communications that will be just as convenient as dialing your home or office telephone. **R-E**



PROM PROGRAMMER

It is frequently convenient for the computer or microprocessor user to store his programs in reusable EPROM's (Erasable Programmable Read Only Memories). This programmer for 2K 2716 EPROMS allows the job to be done quickly and efficiently.

ROBERT N. BEABER

THE 2716 EPROM (*E*RASABLE *P*ROGRAMmable *R*ead *O*nly *M*emory)—currently available for ten dollars or less—is ideal for microprocessor-based projects. It permits storage of 2K (2048 bytes) of user program and operates from a single 5-volt supply. Because it can be erased by strong ultraviolet light, its contents can be changed if a modification must be made to the program it contains, or it can simply be erased for reuse in another project.

The programmer described here allows the project designer to program the 2716, using hexadecimal code, at each memory location by entering the required data with two thumbwheel switches and pressing a single PROGRAM switch. After programming a given memory location, the device automatically selects the next highest one. It also has a SINGLE STEP or CONTINUOUS RUN option to provide access to address locations at a rate determined by the user. Those options provide the control needed to verify the data contained by the EPROM. Both the memory location addressed and its contents are indicated by 7-segment LED's.

Circuit operation

Figure 1 is a schematic of the EPROM programmer. Refer to it as we discuss how the circuit works.

The programming sequence begins when the PROGRAM switch, S3, is pressed. That switch is debounced by IC11-c, and the resulting pulse is used to clock one-shot IC7-b. The output of the one-shot enables NAND gate IC8-c and allows the 40-Hz oscillator—IC9-b—to clock counter IC14.

Initially, the counter's output is set at 0. As it is clocked by IC9-b its outputs go to a logic-high (+5 volts) state one at a time, in sequence. *Note that only five of the ten possible outputs are used—pins 1, 4, 5, 7 and 11; they correspond to counts of 5, 2, 6, 3 and 9, respectively.* As the outputs of IC14 change state, they control the actions of latches IC13-a and IC13-b.

When pin 4 of IC14 goes high, pin 1 of IC13-a is latched high. That, through buffer IC2-c, brings pin 20, CS (*C*hip *S*elect—sometimes referred to as "data enable") of SO1, which contains the EPROM, high, and readies the EPROM for programming.

The output of IC14's pin 4 also turns on Q1 and Q2, which provide the programming voltage (25.5 volts) to pin 21 of SO1, and enables the three-state drivers, IC1 and IC2. The inputs of those two IC's are connected to S1 and S2, the BCD-output thumbwheel switches used to provide the programming data. The outputs of the two IC's are connected to pins 9-11 and 13-17 of SO1, which correspond to the eight data lines of the 2716 EPROM.

After 25 milliseconds—1/40-second, equal to one period of the 40-Hz clock—pin 7 of IC14 goes high and IC13-b is also latched high. That, in turn, takes pin 18 ($\overline{CE}$/PGM—$\overline{\text{CHIP ENABLE}}$/PROGRAM) of SO1 high and the data from the thumbwheel switches is programmed into the EPROM. The address programmed usually starts with 0, but can be selected by S4, (SINGLE STEP), and S5 (RUN).

When 50 milliseconds have passed, pin 1 of IC14 goes high. That resets IC13-b, removing the logic-high from pin 18 of the EPROM. After another 25 milliseconds, pin 5 of IC14 goes high, resetting IC13-a. That removes the CS voltage, removes the 25.5 volts from pin 21 by turning Q1 and Q2 off, and disables IC1 and IC2, thus removing the thumbwheel-switch data from the EPROM's data lines.

When pin 11 of IC14 goes high, it resets one-shot IC7-b, disabling NAND gate IC8-c and cutting IC14 off from the 40-Hz clock. Pin 11's going high also resets IC14 to 0 and advances counter IC3 to the next address to be programmed.

The remainder of the logic circuitry provides RESET, SINGLE STEP, and RUN functions.

Switch S6 (RESET) is used to reset the cascaded address counters IC3, IC4, and IC5, to zero. Switch S4 provides SINGLE STEP capability—every time the switch is pressed, IC7-a, a one-shot, supplies a pulse to counter IC3, causing the memory location being addressed

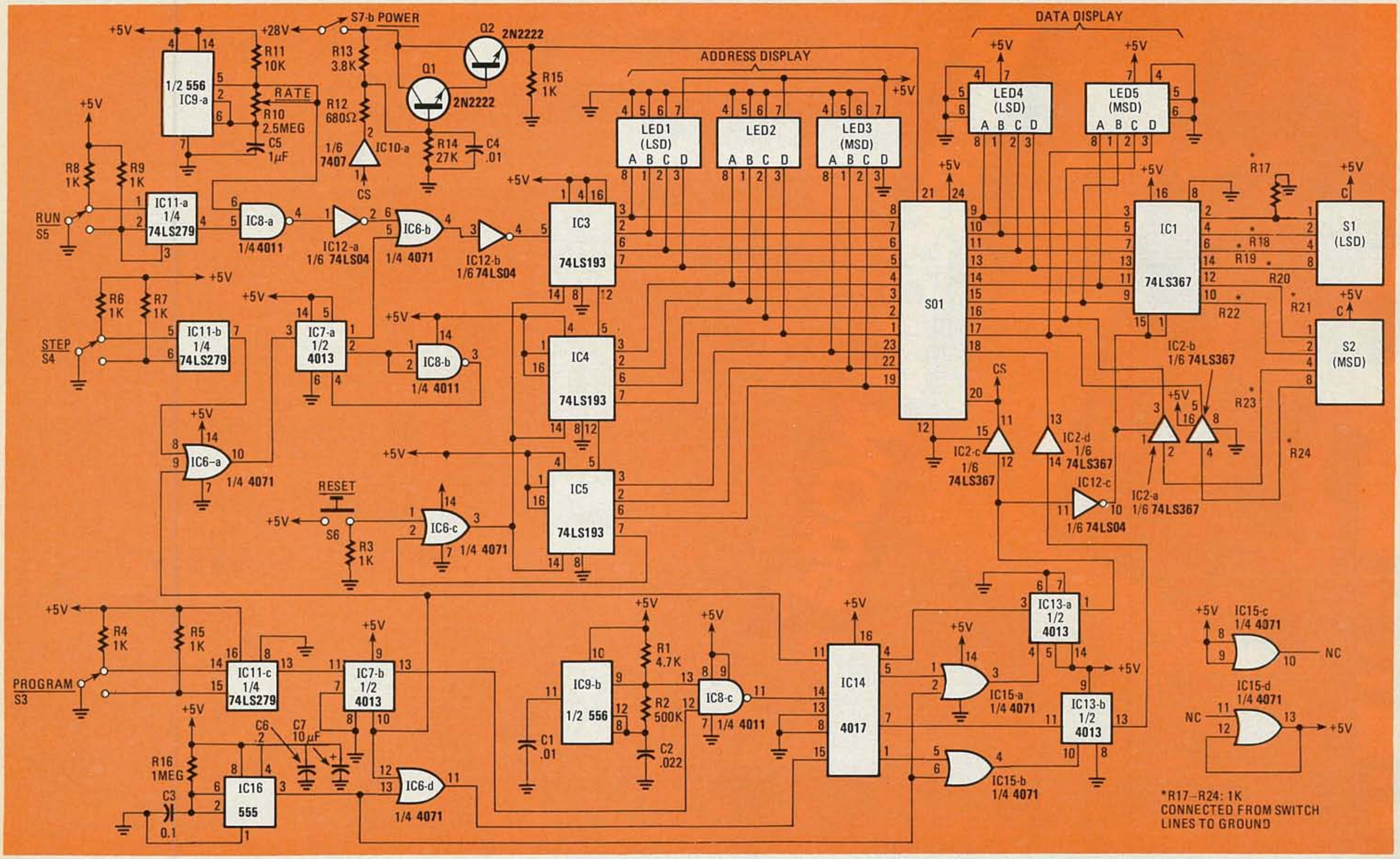


FIG. 1—WHILE ONLY R17 IS SHOWN, resistors R17-R24 are connected from the eight output-lines of S1 and S2 to ground.

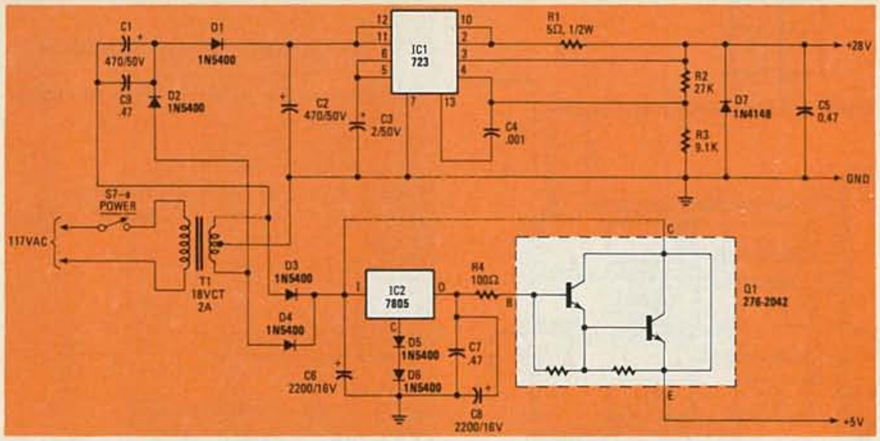


FIG. 2—POWER SUPPLY provides both the 5-volts needed for the logic circuitry and the 25.5-volts used to program the EPROM.

to be incremented by one. Finally, S5 (RUN) allows the variable-frequency oscillator formed by IC9-a and controlled by R10 to clock counter IC3 at a rate determined by the user.

The three switches provide the user with several means for accessing EPROM memory addresses to enter or verify data. The LED displays on the address and data lines provide a continuous indication of the memory address being accessed and of its contents.

Power supply

The power supply shown in Fig. 2 provides all the voltages required by the programmer. Power switch S7 has two sections—one for 117-volts AC (Fig. 2) and one for 28-volts DC (Fig. 1). That is necessary because when the AC voltage is cut off by S7-a, an induced current in the secondary of the transformer will cause a pulse to appear on the 28-volt DC line. Since that pulse can be transmitted to pin 21 (V_{PP}) of the EPROM—a pin used in the programming process—erroneous data may be entered into the IC. Therefore, S7-b is used to cut off the 28-volt supply at the same time the main 117-volt supply is turned off.

PARTS LIST—POWER SUPPLY

All resistors 5%, ¼-watt unless otherwise specified
R1—5 ohms, ½-watt
R2—27,000 ohms
R3—9100 ohms
R4—100 ohms
Capacitors
C1, C2—470 μF, 50 volts, electrolytic
C3—2 μF, 50 volts, electrolytic
C4—.001 μF, ceramic disc
C5—0.47 μF, ceramic disc
C6, C8—2200 μF, 16 volts, electrolytic
C7—0.1 μF, ceramic disc
Semiconductors
IC1—LM723N adjustable voltage regulator
IC2—7805 5-volt regulator
Q1—high-power Darlington, NPN-type (Radio Shack 276-2042 or similar)
D1–D6—1N5400, 3 amps, 50 PIV
T1—18 volts, center-tapped, 2 amps
Miscellaneous: TO-3 heat sink, PC board or perforated construction board, 14-pin IC socket, hardware, etc.

Construction

The 2716 EPROM programmer can be constructed on perforated construction

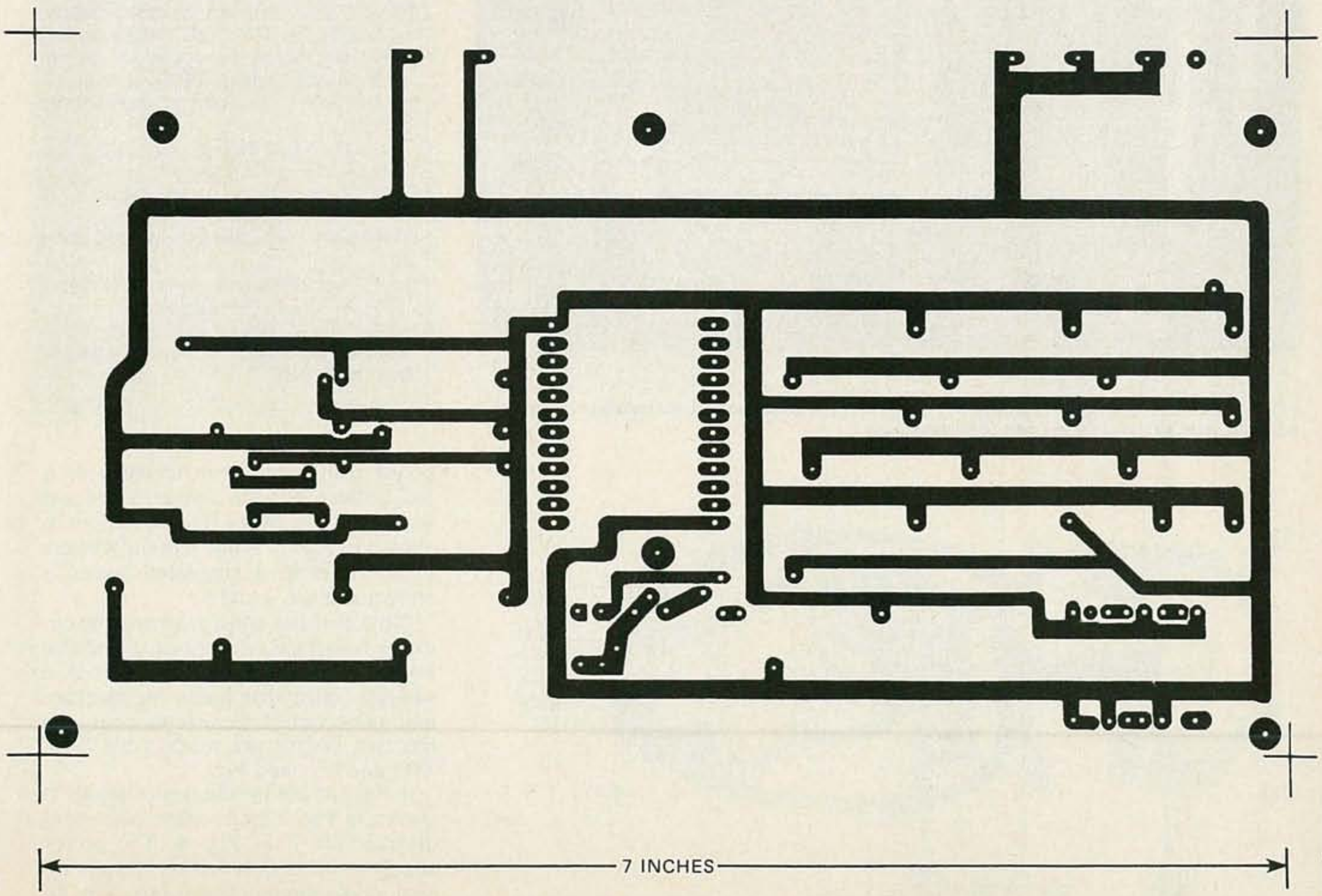


FIG. 3—PERFORATED CONSTRUCTION BOARD is used to mount components. Stick-on copper traces can be applied to serve as power and ground buses.

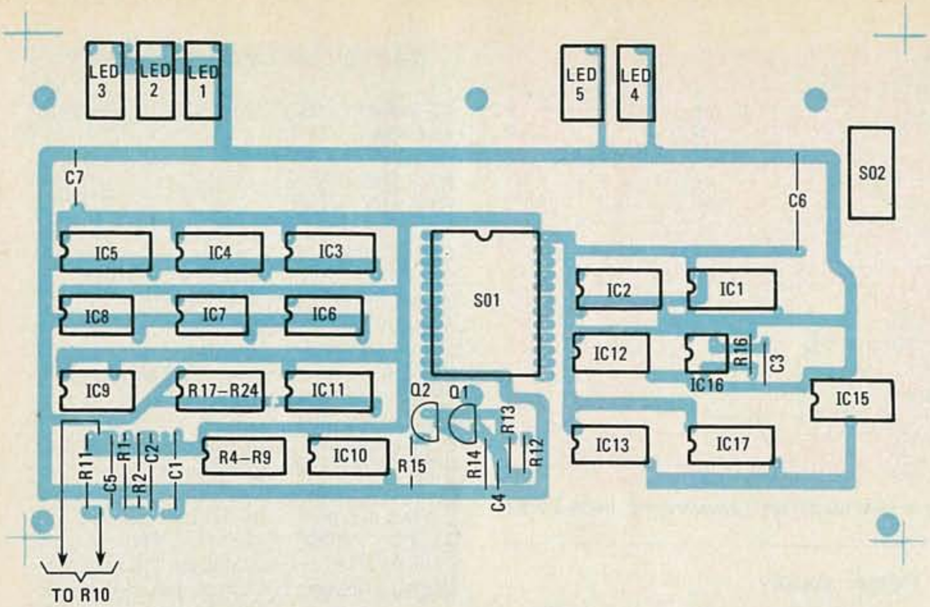


FIG. 4—SOCKET SO1 is a 24-pin zero-insertion-force socket used to hold the 2716 EPROM. Zero-insertion-force sockets allow IC's to be inserted and removed many times without causing wear or damage to either the socket or the IC.

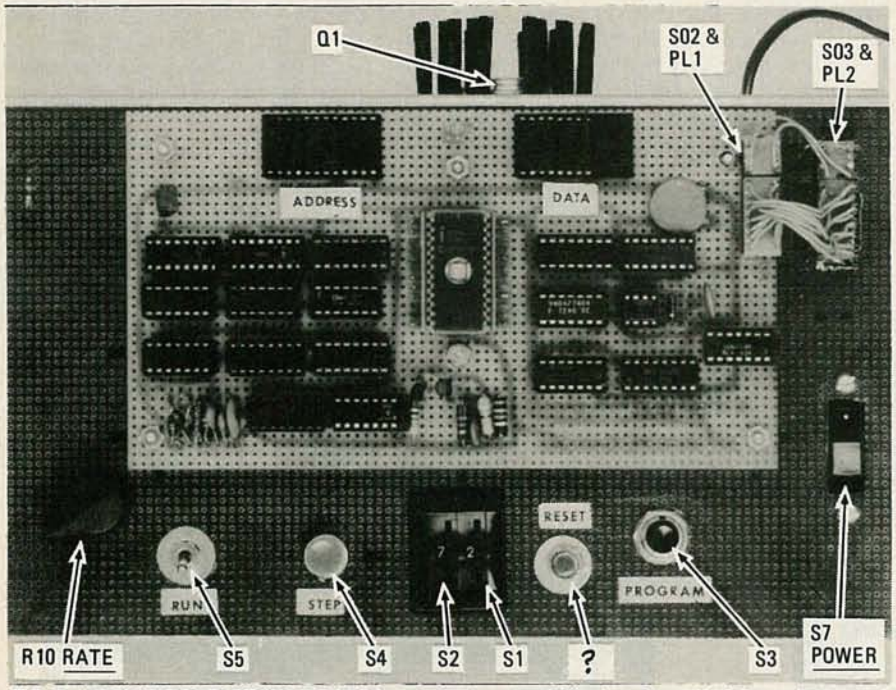


FIG. 5—LOGIC/PROGRAMMING BOARD is mounted on standoffs above board holding switches and controls. Heat sink and Q1 are part of power supply.

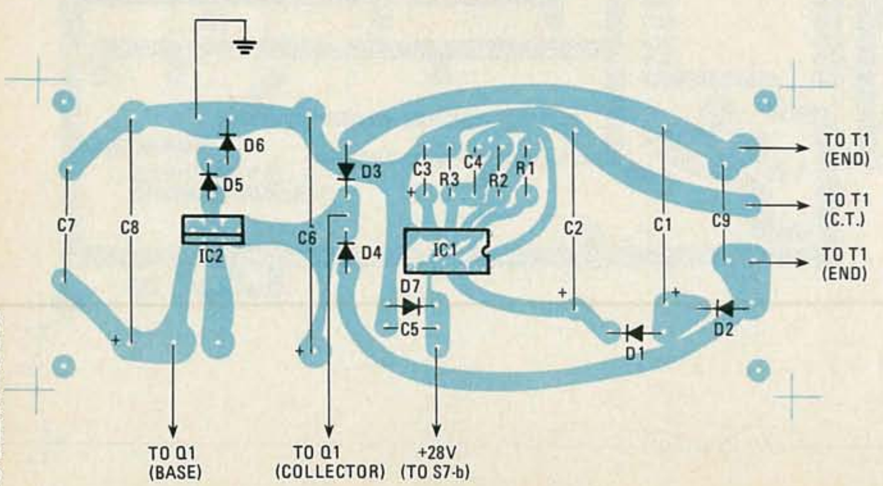


FIG. 6—PADS MARKED "TO T1 (END)" may be connected to either end of transformer's primary winding. Pad marked "C.T." must go to center tap.

PARTS LIST—PROGRAMMER

All resistors 5%, ¼-watt unless otherwise specified
R1—4700 ohms
R2—500,000 ohms
R3-R9, R15, R17-R24—1000 ohms
R10—2.5 megohms, ½-watt, potentiometer
R11—10,000 ohms
R12—680 ohms
R13—3800 ohms
R14—27,000 ohms
R16—1 megohm
Capacitors
C1, C4—.01 µF, ceramic disc
C2—.022 µF, ceramic disc
C3—0.1 µF, ceramic disc
C5—1.0 µF, tantalum
Semiconductors
IC1, IC2—74LS367 or 80C97 three-state hex buffer
IC3–IC5—74LS193 or 74C193 up/down binary counter
IC6, IC15—4071 CMOS quad 2-input OR gate
IC7, IC13—4013 CMOS dual-D flip-flop
IC8—4011 CMOS quad 2-input NAND gate
IC9—556 dual timer
IC10—7407 hex buffer, high-voltage, open-collector
IC11—74LS279 quad S-R latch
IC12—74LS04 hex inverter
IC14—4017 CMOS decade divider/counter
IC16—555 timer
Q1, Q2—2N2222 or similar NPN-type
LED1-LED5—7 segment hexadecimal decoder/display (H-P 5082-7340 or similar)
S1, S2—hexadecimal thumbwheel switch, BCD output (Unimax SF-54 or similar)
S3, S4—SPDT momentary pushbutton switch
S5—SPDT toggle switch
S6—N.O. pushbutton switch
S7—DPDT toggle or rocker switch, 125 VAC minimum rating
SO1—24-pin zero-insertion-force IC socket
SO2, SO3—18-pin wire-wrap IC socket
PL1, PL2—18-pin DIP header
Miscellaneous: wire-wrap IC sockets, perforated construction board, chassis-box, wire, etc.

board using wire-wrap techniques. A foil pattern for the power buses and several of the IC-to-IC connections is shown in Fig. 3. While parts-placement is not critical, a suggested layout is shown in Figs. 4 and 5.

Note that the logic/programming circuitry is located on one board, and that board is mounted on spacers over a second board that holds the switches and RATE control. Connections between the two boards are made using SO2, SO3 and PL1 and PL2.

A foil pattern for the power supply is shown in Fig. 7, and a parts-placement diagram for it in Fig. 6. The power supply can be mounted on spacers inside an aluminum chassis-box (Fig. 8). A heat sink should be used for the power supply's Q1.

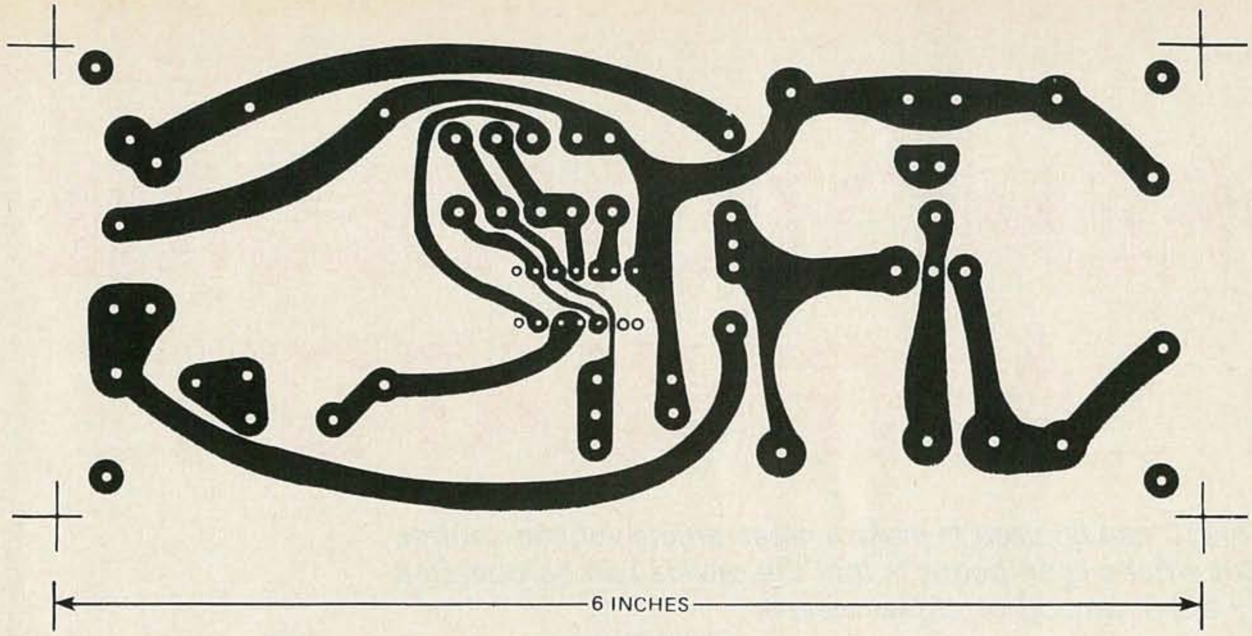


FIG. 7—FOIL PATTERN FOR POWER SUPPLY allows quick and easy construction. Ordinary copper-clad board can be used here.

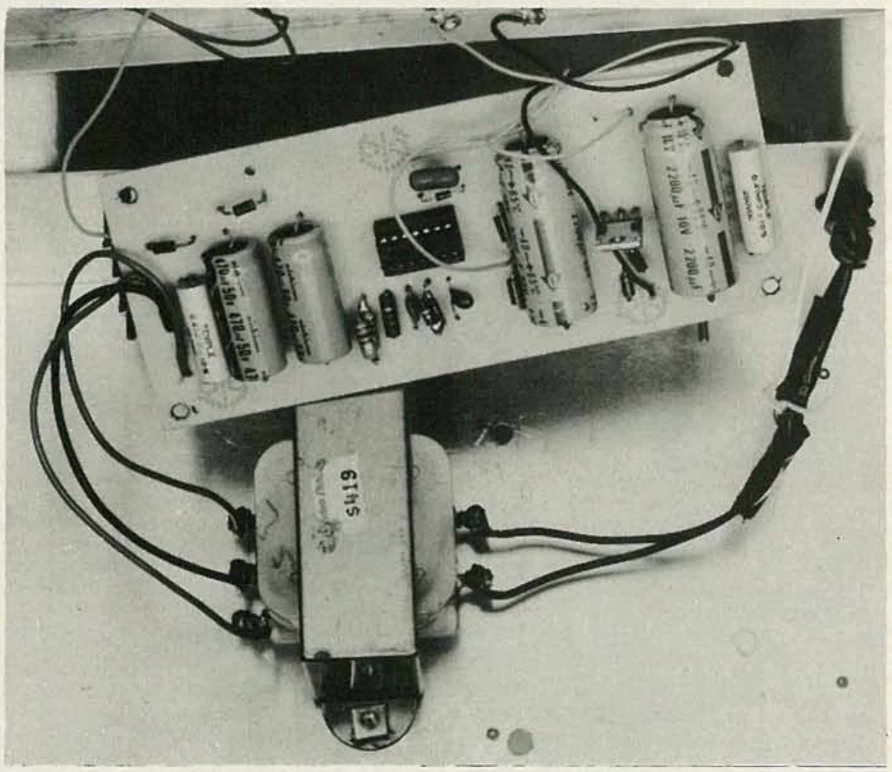


FIG. 8—TRANSFORMER IS MOUNTED on chassis-box bottom; power-supply board on standoffs at enclosure's rear.

Checkout and use

Before any of the logic IC's are installed in their sockets, the usual visual checks for correct component-orientation, solder bridges, etc. should be made. The unit can then be powered up and voltage checks made at the appropriate points. If everything checks out at that point, the IC's can be installed.

Now, with no EPROM in SO1, apply power again. The DATA LED's should show "FF," and the ADDRESS LED's should indicate "ØØØ" after the RESET has been pressed. Each time the SINGLE STEP switch is pressed, the ADDRESS display should advance one count. With the RUN switch in the ON position, the ADDRESS display should advance continuously, at a speed that can be varied by R10, the RATE control.

Still with no EPROM in the socket, set up a data byte on the thumbwheel switches. When you depress the PROGRAM switch, the DATA LED's should show that value briefly, and then return to "FF." If all those conditions are met, the programmer is ready to go to work.

With the power turned off, insert a 2716 EPROM into SO1. Apply power and depress the RESET switch to start programming at address ØØØ. Use the thumbwheel switches to set the data byte that is to be programmed into that location and press the PROGRAM switch. The DATA LED's should momentarily show this value, and then return to "FF"—the contents of the next memory location (ØØ1, shown on the ADDRESS LED's). The data for that address can then be set on the thumbwheel switches and the process repeated until the EPROM is completely programmed.

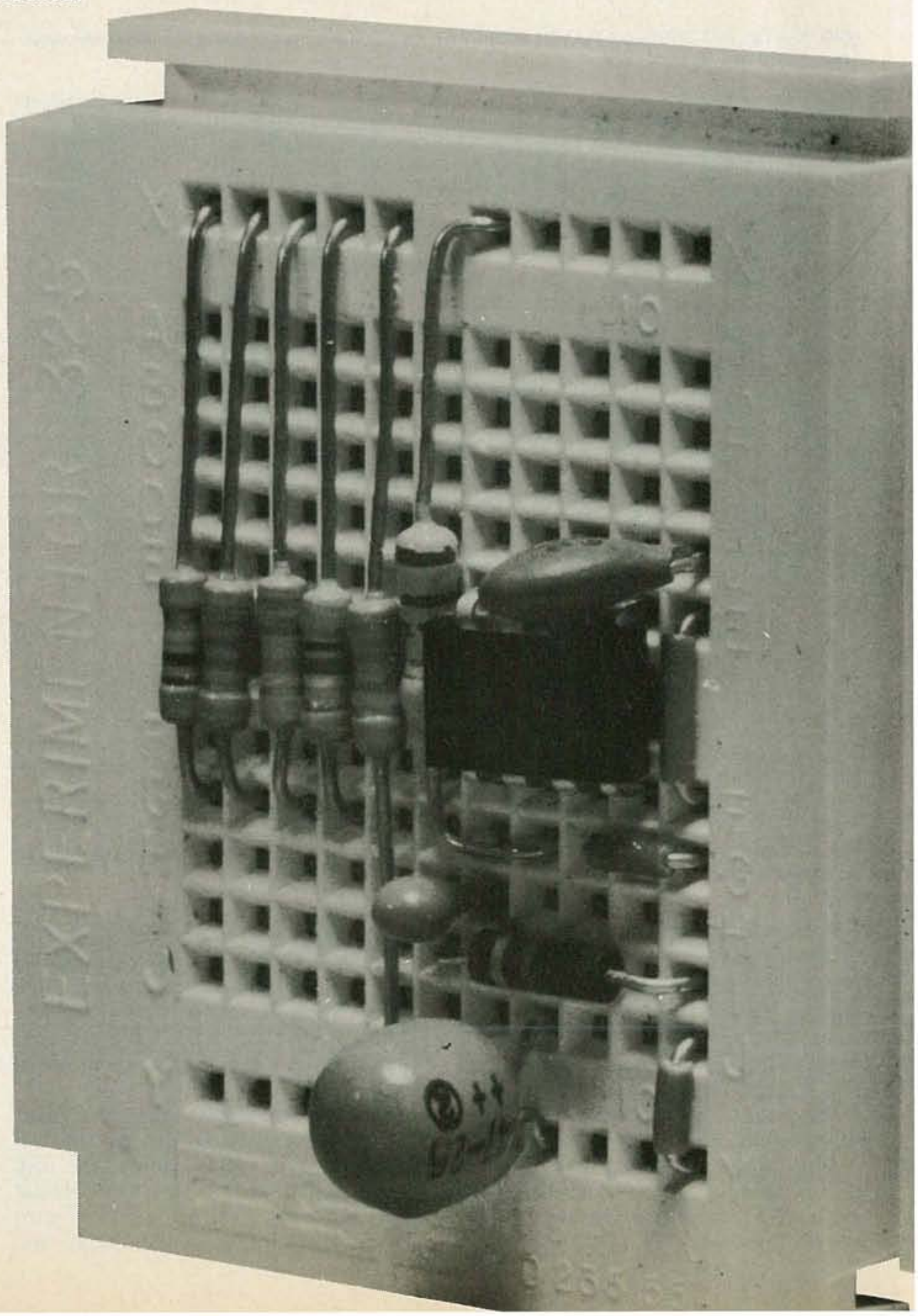
The EPROM's contents can be verified by resetting the counter to ØØØ and using the RUN switch and RATE control to automatically sequence through the memory locations. They, and their contents, will be shown on the LED's. Alternately, you can single-step through the addresses at leisure by using the SINGLE STEP switch. **R-E**

"I thought that voice synthesizer would tell me my weight—not scream in pain."

REMOTE VOLUME ATTENUATOR

This IC can be used to make a great remote volume-control. But what's even better is that the device can be operated by either analog or digital means.

MARTIN BRADLEY WEINSTEIN



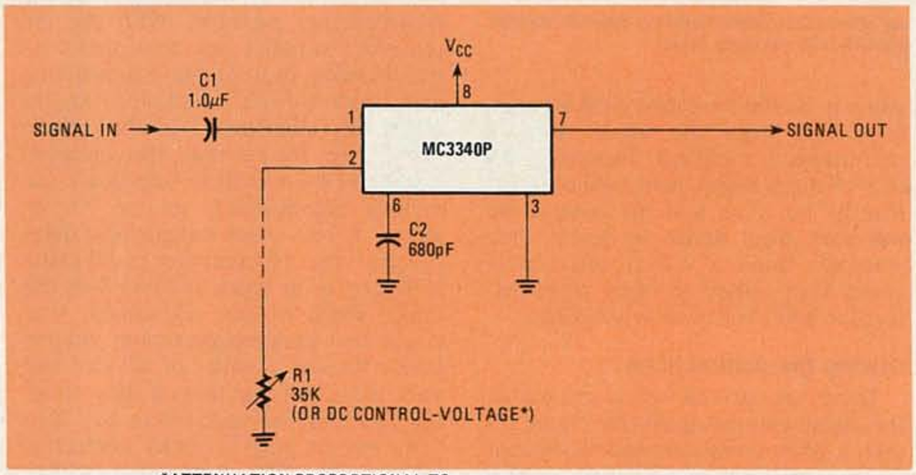
THERE'S AN INTEGRATED CIRCUIT AVAILable from Motorola, the MC3340P, capable of effectively attenuating an audio signal by 90 dB or introducing up to 13 dB of gain (or anything in between) while exhibiting a total harmonic distortion of about 0.6%. Attenuation can be controlled by either a DC voltage (between 3.5 and 6.0 volts) or a resistance (0-33 kilohms) applied to its control pin and referenced to ground. Suggested for use with approximately 100-millivolt RMS input-signals, it can be used with signals up to 0.5-volt RMS. The supply-voltage range is wide—9-18 volts DC. And it's priced in the $1.00-$1.50 range.

This little wonder can accomplish a number of remarkable wired-remote-control functions. For example, a radio receiver in the trunk of your car feeding a rear-deck speaker can be easily modified by using the circuit shown in Fig. 1 in place of its volume control; a single wire to a dash-mounted pot then provides complete control of its volume. But there's an even better way to use this device.

Digital control

The circuit shown in Fig. 2 gives you complete control over attenuation using a set of resistors arranged in a network. Grounding any combination of four (or fewer) lines (labelled A, B, C, and D) provides a specific degree of attenuation.

Getting the circuit to perform properly is harder than it appears. The control characteristics of the MC3340P are far from linear. Another complication is getting a reasonably linear analog control characteristic starting with binary values and off-the-shelf resistors.



*ATTENUATION PROPORTIONAL TO VOLTAGE AT PIN 2 WHEN 3.5VDC $< V_C <$ 6.0 VDC, OR PROPORTIONAL TO RESISTANCE FROM 0 TO 33K OHMS

FIG. 1—THIS SIMPLE ATTENUATOR CIRCUIT allows you to control the volume of a receiver hidden in the trunk of your car with a dash-mounted potentiometer.

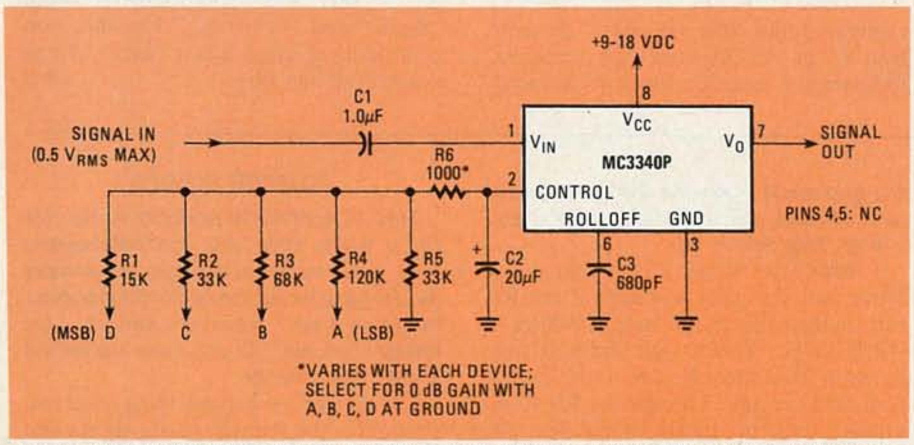


FIG. 2—SCHEMATIC DIAGRAM of a digitally-controlled attenuator circuit. Lines A, B, C, and D, can be driven by the simple circuit shown in Fig. 4.

The technique required is common to a number of digital-to-analog conversion schemes. You can get a fairly linear response by using resistors with a 1-2-4-8 (powers-of-two) relationship. But there are no combinations of standard resistors with that relationship, although the 15K-33K-68K-120K-ohm combination used here (for R1, R2, R3, and R4) comes very close.

Trial-and-error had a great deal to do with establishing the final component values, but there were also a few educated guesses involved. The parallel combination of R1, R2, R3, and R4, for example, is itself in parallel with a 33K resistor (R5) because that value is the maximum control resistance and corresponds to the maximum attenuation of the IC. It took a very long night with a scientific calculator to double-check the calculated performance of the circuit, and that's why R6 is there—to adjust the performance so that it is slightly more linear. Table 1 gives the calculated net resistance for each control code and Fig. 3 plots both net control-resistance and calculated attenuation values against the binary control codes.

Unfortunately, errors can occur almost anywhere in this design. For one thing, the manufacturer's curves, while accurate enough when you're controlling the IC with a potentiometer, aren't very precise as far as determining actual attenuation vs. resistance performance when you're using fixed values. Another problem is that even 5%-tolerance resistors can vary enough to cause jarring nonlinearities in their combined performance in this network. For example, one combination can easily yield a lower net resistance than another combination representing a higher binary value. The solution is either expensive precision resistors

PARTS LIST

Resistors ¼ watt, 5% or better
R1—15,000 ohms
R2, R5—33,000 ohms
R3—68,000 ohms
R4—120,000 ohms
R6—5100 ohms (see text)
Capacitors
C1—1.0 μF
C2—20 μF, electrolytic
C3—680 pF
Semiconductors
IC1—MC3340P (Motorola)

TABLE 1

D	C	B	A	Net resistance
Ø	Ø	Ø	Ø	7650Ω
Ø	Ø	Ø	1	8040Ω
Ø	Ø	1	Ø	8370Ω
Ø	Ø	1	1	8860Ω
Ø	1	Ø	Ø	9330Ω
Ø	1	Ø	1	9950Ω
Ø	1	1	Ø	10500Ω
Ø	1	1	1	11310Ω
1	Ø	Ø	Ø	12960Ω
1	Ø	Ø	1	14280Ω
1	Ø	1	Ø	15510Ω
1	Ø	1	1	17500Ω
1	1	Ø	Ø	19750Ω
1	1	Ø	1	23220Ω
1	1	1	Ø	26880Ω
1	1	1	1	34000Ω

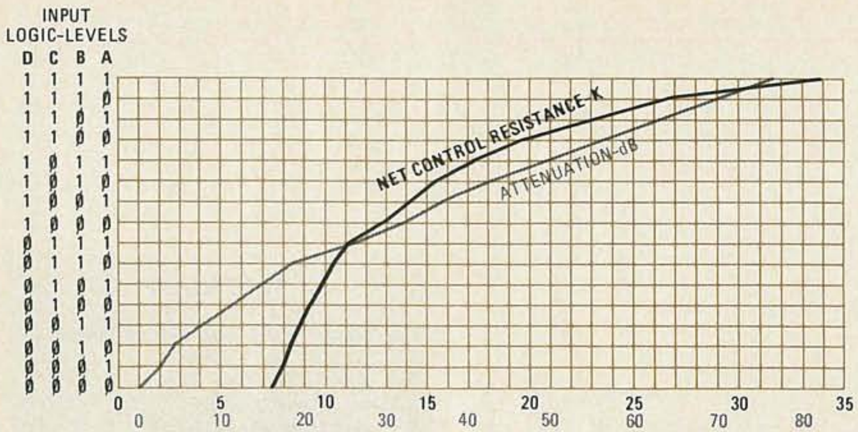


FIG. 3—NET CONTROL RESISTANCE and calculated attenuation plotted against four-bit control signals. Note that the calculated attenuation curve is nearly, but not quite, linear.

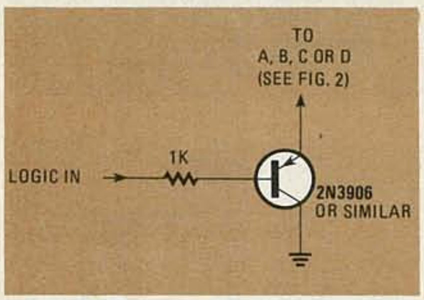


FIG. 4—THIS CIRCUIT can be used to drive a digital volume attenuator's control lines. Almost any PNP transistor can be used.

or—as you'll probably choose—hand-selection of 5% resistors.

Even with selected resistors, the performance of the breadboarded circuit was not as predicted by the graph in Fig. 3 when input and output signals were measured and actual attenuation calculated. The problem turned out to be R6: the value I had chosen was too small and the circuit had some gain when it should have had 0-dB attenuation. That made the whole system's performance nonlinear. Increasing R6 to 5100 ohms helped performance significantly, but note that **the value of R6 will vary from device to device.** You wouldn't think a circuit this simple could have caused so many problems. But the end result was worthwhile.

Driving the control lines

There are several ways to provide the digital control-signals the circuit requires. Most computers and digital control-systems can easily drive a PNP transistor (Fig. 4), possibly using a latch. A hexadecimal thumbwheel switch (or any 4-bit binary-encoded switch) can be used without drivers. A four-channel optical system could be used where isolation was required.

A SIPO (*S*erial *I*n, *P*arallel *O*ut) shift register could also be used. A serial Baudot or ASCII code, for example, following a specific control-character on a teletypewriter circuit could raise the volume of an alert tone-generator or monitor receiver in a network or a remote-control application.

Perhaps more exciting is the prospect of full keyboard control of a communications system, including volume levels, with or without the assistance of a computer. A single dashboard-mounted keypad could select synthesizer frequencies or channels, set volume and squelch levels, adjust mike gain, and more—even for several transceivers. All the valuable hardware could then be secured in the trunk.

Most exciting of all is the fact that this simple circuit makes computer coordination of our living and working environments possible. With the attenuators installed and the proper control bussing routed, the "turn-it-up" and "turn-it-down" nuisances in life might be eliminated. If the phone should ring, for example, the computer might use the circuit to turn down the volume automatically on the TV or stereo. If your clock radio wasn't quite rousing you, the computer could make it louder; or at night, it could fade the music down as you fell asleep. You could also program maximum volume levels for any number of devices and vary them with the time of day—to let the kids blast the stereo from, say, 4 to 5:30, but to keep it under control at other times. (The prospects for fading in romantic mood-music are also promising.)

Basically, this circuit is just an elaborate volume control (although the MC3340P responds very well to signals up to 600 kHz, and fairly well through 2 or 3 MHz)—a potentiometer with "bells" and "whistles." I'm sure you can think of quite a few places to use something like this. **R-E**

SERVICE QUESTIONS

TUBE BURNOUT

In a GE M704 (a Canadian model) the horizontal-output tube went out too often. I wrote to you and you said that the problem could be caused by the failure of the horizontal oscillator to start, resulting in overload of the output stage. You suggested that I change the capacitors across the oscillator coil. I did, and that did the trick. Thanks.—*D.H., London, Ontario*

SNOW, NO AGC

I've got a CTC-43A with far too much snow on all channels. The RF AGC control has no effect at all. The plate of the 2DS4 RF-amp tube reads +250 volts and the grid reads −30 volts. The 16K resistor isn't shorted, and a new tube didn't help. —P.B., Ewa Beach, HI

I think you've got your finger on it. Note that the plate voltage on the RF tube is the same as the supply voltage— +250 volts. You're not drawing any current. That must be due to the excessive grid voltage. The normal RF-AGC voltage with no signal should be only +0.79 volts. Check the AGC keyer collector; also the 10-megohm resistor that feeds it from the +270-volt supply. Also check the 2.2-megohm resistor between that point and the tuner.

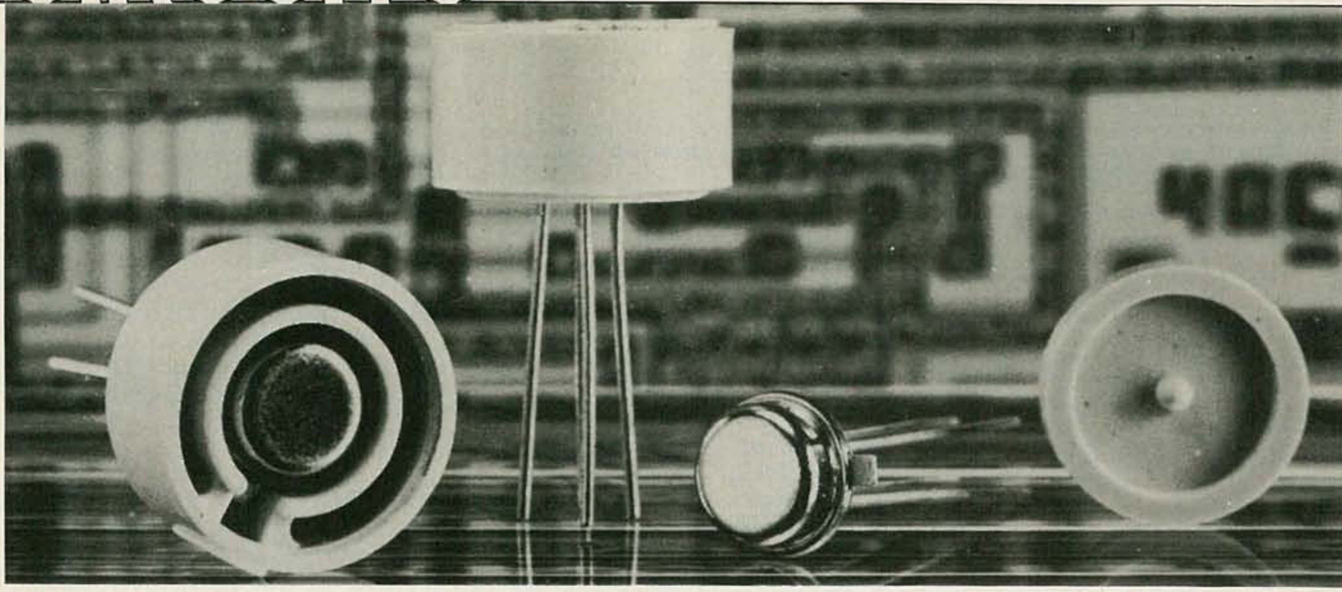
I'd be inclined to suspect a leaky AGC transistor. Check to see whether the IF-AGC voltage works. If so, something is wrong in the resistors in the RF-AGC circuit and I am inclined to suspect the 10-megohm one (we've had problems with that resistor changing value before).

DAMPER DIODES

This RCA EP454W portable works fine for a while, then the horizontal-output tube gets red hot and blows the damper diode. I suspected the oscillator stopping, but every time I check, it's running. I am totally confused, do you have any ideas? —J.G., Mentone, IN

I think you've got one thing reversed. Probably, the damper diode shorts and *that* blows the tube. Check the solid-state damper. If it's a single unit, Part No. 125932, it's the original. That part has been known to cause problems. RCA recommends replacing it with a dual "piggy-back" type, Part No. 120818.

By the way, the parts list you're using is incorrect. It recommends using a GE-504 as a replacement. That's a plain sine-wave type, but you must use a fast-recovery type here and in all horizontal-frequency circuits. **R-E**



Precision Voltage References

An electronic instrument or circuit can only be as accurate as the reference used to calibrate it. Build your own low-cost, high-precision voltage references using the information presented here.

JOSEPH CARR

PRECISION VOLTAGE-REFERENCE CIRcuits are constantly needed by anyone who works with electronics. They are needed in an electronics workshop, for example, to calibrate voltmeters and oscilloscopes. In the laboratory, they can be used to troubleshoot, test, and calibrate instruments such as pH-meters. Computer applications include A/D and D/A converters; most of the popular circuits that are used for those applications require an external voltage reference to make them reasonably accurate. In addition, projects such as electronic thermometers, and anything based on the Wheatstone bridge (and that includes quite a few electronics instruments) will require a precision voltage-reference.

Commercially available voltage references can be very expensive, but we can make references that are precise enough for all but the most demanding applications for a small cost. The technology that is available today allows us to do things that a hobbyist could only dream about a decade ago. In this article, we will discuss some of the more common precision voltage-references, and offer both finished projects and design notes for those who would like to "roll their own."

Why does a hobbyist need a precision voltage-reference? Let's say, for example, that you want to build an A/D or D/A converter. We all know that the greater the bit-length of those converters, the better the accuracy and resolution of the measurements made, or voltage produced. But no data converter is better than the analog voltage-reference used to make the conversion. All data converters produce an output that is the product of a binary word and an analog reference voltage (or current, in some cases). In practical terms, that means that an error in the voltage reference will foul up the accuracy of the conversion.

Let's consider two data converters that a hobbyist might use: 8-bit and 10-bit D/A converters. The resolution of the 8-bit converter is 0.391%; the resolution of the 10-bit converter is 0.098%. Those figures are the maximum possible resolution based only on bit-length. If the reference voltage for both is 10.00 volts, then the actual reference voltage must fall within the range of 10.00 volts ±391 mV in the 8-bit case and 10.00 volts ±98 mV in the 10-bit case. A 12-bit D/A converter, which is now available at relatively low cost, requires an analog reference of 10.00 volts ±24 mV.

Clearly, as the bit length of the converter increases, the voltage reference must become more precise. Reference voltage sources for 8-, 10-, and 12-bit D/A converters are easily constructed at a low cost using components available today.

Zener diodes

One of the most important voltage references used in electronics is the Zener diode. Figure 1 shows the basic circuit for a Zener-diode regulator; a graph of the voltage-versus-current characteristic for a typical Zener diode is shown in Fig. 2.

The Zener diode acts much like an ordinary PN-junction diode as long as the applied voltage is less than a specified value of reverse bias (V_Z), or when the diode is forward biased. In the range between V_Z, and a forward bias of approximately 700 mV (the actual figure is usually 600 to 700 mV), the current through the diode is a small reverse current called leakage. The diode is essentially turned off in that region. When the voltage exceeds a forward bias potential of 700 mV, the

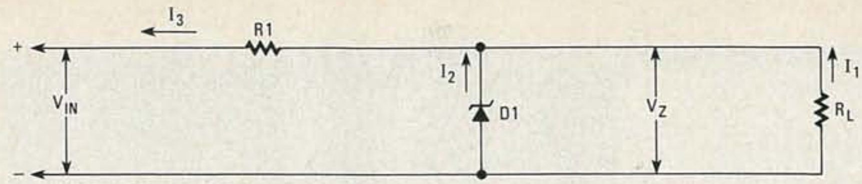


FIG. 1—THE ZENER DIODE is often used as a voltage reference or as a simple voltage regulator. A basic circuit for a Zener diode regulator is shown here.

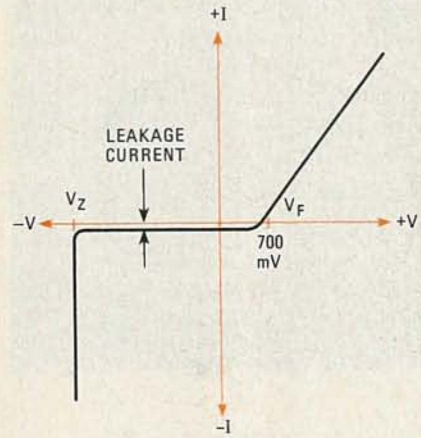


FIG. 2—WHEN THE REVERSE BIAS exceeds V_Z the negative current through the Zener increases rapidly.

positive current increases in the same manner as in an ordinary PN junction. The Zener acts quite differently, however, when the reverse bias exceeds V_Z. When that voltage is reached, the negative current rapidly increases. No matter how much more negative the applied voltage becomes, the voltage across the diode remains relatively constant.

But the Zener diode is not the best voltage reference for many applications. The Zener's voltage rating is nominal, not absolute. When the package says "6.2 volts," it may mean some potential in the neighborhood of 6.2 volts. It is also true that the Zener's voltage tends to change a little bit with changes in temperature—hardly something that you would want a voltage reference to do!

Figure 3 shows a circuit that overcomes the temperature-drift problem of Zener diodes. Two Zeners are used in that circuit; the output is the difference between their two V_Z potentials. The circuit works reasonably well as long as both Zener diodes are kept in the same thermal environment. It is common practice to bond the two diodes together and coat them with silicone grease in order to keep them at the same temperature.

Several manufacturers once offered four-terminal "Zener diode" packages that used four to eight Zeners, in two series circuits, to form the output potential. Those devices were arranged like the circuit in Fig. 3, except for the number of diodes and the fact that all were on a common substrate, thus tracking each other in temperature.

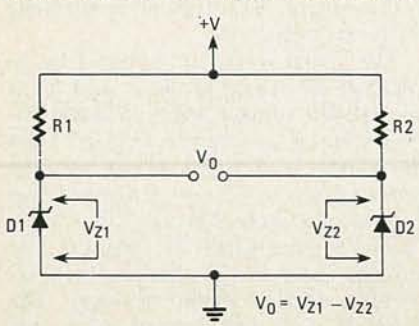


FIG. 3—THIS CIRCUIT shows one way to overcome the problem of temperature drift in Zener diodes.

Op-amp voltage-reference sources

One problem with Zener references, even precision Zener's that have been trimmed to a specific, accurate voltage, is that they are limited to values selected by the diode manufacturer—often not the voltage required in some particular application. We can, however, use an op-amp circuit to scale the voltage to a needed value. Such a circuit will also keep the load across the Zener at a constant, low level.

Almost any op-amp will do for that type of circuit, but it is generally best to use a premium-grade type. Some of the best are BiMOS and BiFET op-amps, such as the RCA CA3140 device.

The basic properties of an operational amplifier tell us that applying a voltage to one input will cause a voltage to appear at the output. In the circuit of Fig. 4 we apply the voltage from a Zener diode to the non-inverting input of the op-amp. That means that the output voltage will have a value equal to that voltage times the gain of the operational amplifier, or:

$$V_O = V_Z[(R2+R3)/R1+1]$$

If we make the gain larger than one, then the output voltage will be greater than the Zener voltage. Similarly, if we make the gain one (i.e. if we short out R2 and R3, causing the output to be connected directly to the inverting input), then the output voltage is the same as the Zener voltage.

We can trim the value of the output voltage by making the feedback resistance variable. To keep tight control over the feedback resistance, a series combination of a fixed resistor and a potentiometer (R2 and R3) is used. It is generally good practice to make the resistance of potentiometer R3 approximately 10 percent of the total resistance (R2 + R3), and to make it a 10-, or 15-turn trimmer pot.

Special devices

In the past couple of years, semiconductor manufacturers have brought out several different types of voltage references. Some of those are two-terminal devices that act like diodes in the circuit, even though they are complete integrated circuits in themselves.

An example of such a device is the LM199 from National Semiconductor (2900 Semiconductor Dr., Santa Clara, CA 95051); the functional block diagram of that IC is shown in Fig. 5. That reference is a four-terminal device that combines a 6.95-volt Zener diode with an on-chip heater element. The Zener diode is maintained at the same temperature as the heater because it is buried on the same I.C. die (silicon chip) as the heater element.

The heater is not an actual resistance element, but is a Class-A amplifier with the input shorted. One property of such an amplifier is that it will dissipate a constant power, so that the amplifier will maintain a constant heat level after the die comes to equilibrium.

Burying the Zener in the same die as the heater element has many benefits including lower noise operation and thermal stability. Ordinary discrete Zener diodes have a drift specification on the order of 5 mV/°C, while for the LM199 devices the drift is specified in terms of microvolts per degree.

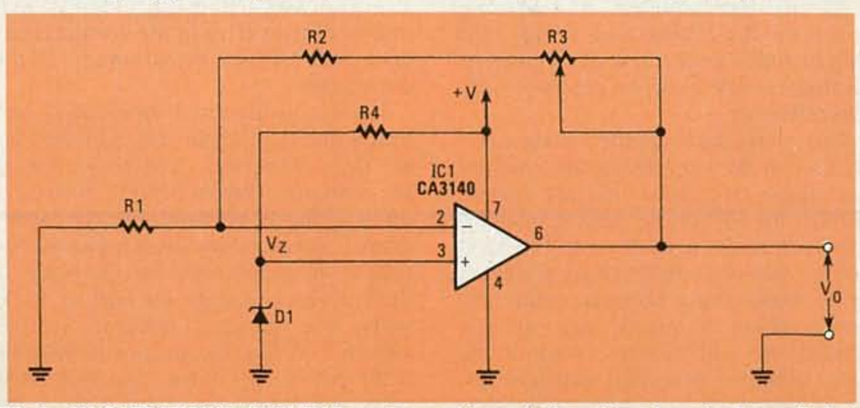


FIG. 4—AN OPERATIONAL AMPLIFIER can be used to scale the voltage from the Zener diode to whatever value is needed.

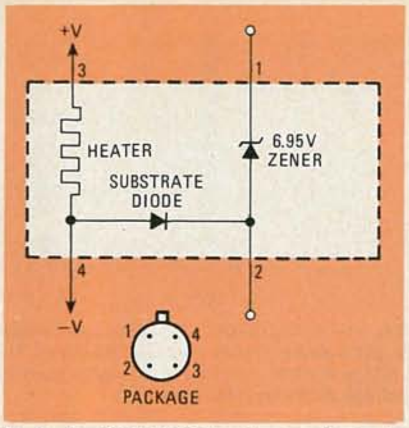


FIG. 5—A ZENER DIODE and an on-chip heater element are combined in the LM-199. The resulting IC is a highly stable voltage-reference device.

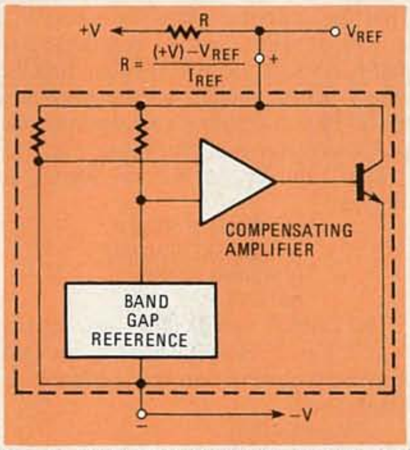
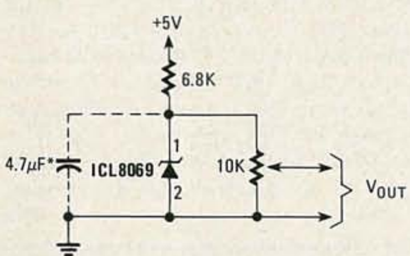


FIG. 6—THIS TWO-TERMINAL REGULATOR from Ferranti Electric can be used just like a Zener diode. It has a stability as great as 10 ppm per 1000 hours of operation.



*OPTIONAL

FIG. 7—A 1.2-VOLT temperature-compensated voltage reference, the Intersil ICL8079 used in this circuit is well suited to high-speed A/D and D/A converter projects.

The LM199 is rated to have an initial operating voltage of ±2 percent of the rated nominal voltage, and the device is very stable over periods of time. The long-term stability is rated at 20 ppm, while the short-term stability is 1 ppm.

In most cases, the LM199 device is operated with a potential of 9- to 40-volts DC across the heater terminals (pins 3 and 4), while the Zener is hooked up in a circuit in the normal manner.

Ferranti Electric (87 Modular Ave., Commack, NY 11725) offers a two-terminal regulator. Those devices can be used in the same manner as ordinary Zener diodes, but they use band-gap technology to produce a stable output voltage. Ferranti offers versions with output voltages of either 2.45 or 1.26 volts. The internal circuitry for the different types is essentially the same, and is shown in Fig. 6.

The Ferranti band-gap devices are available in five versions: ZN404, ZN458, ZN458A, ZN458B, and ZN423. The first four of those are 2.45-volt reference devices, while the last is a 1.26-volt reference device. All of the devices except the ZN423 are capable of sinking anywhere from 2- to 120-mA DC; the ZN423 can sink 1.5- to 12-mA DC.

The long-term stability of the Ferranti devices is 10 ppm per 1000 hours. Temperature coefficients range from 30 ppm to 200 ppm, depending on the device.

As in ordinary Zener-diode operation, a single series current-limiting resistor is used with the Ferranti regulators (see Fig. 6 for the formula to calculate the value of that resistor). For example, using a 2.45-volt regulator (V_{REF}=2.45), a +5-volt DC power supply (+V=5), and a current of 3.75 mA (I_{REF}=.00375), the resistance required would be 680 ohms.

The Intersil (10710 N. Tantau Ave., Cupertino, CA 95014) ICL8069 diode shown in Fig. 7 is another of a band-gap reference source. That device is a 1.2-volt temperature-compensated voltage reference that features very low-noise operation. As a result, it is suited well to applications in high-speed data conversion projects, at Zener currents up to 50 microamperes.

Various versions of that device are made with differing temperature coefficients and temperature ranges. Of course, the selection of a particular device depends upon the nature of the application it is to be used for. A device that would be suitable for an 8-bit A/D converter would not be suitable for a 12-bit converter.

Two applications for the ICL8069 are shown in Figs. 8 and 9. The application shown in Fig. 8 is similar to the operational amplifier circuit shown earlier. That circuit uses the ICL8069 in the feedback loop of a premium-grade LM108 op-amp. A potentiometer is used to trim the output to exactly 10.00 volts. That circuit can be used in a wide variety of applications. The circuit in Fig. 9 uses the ICL8069 device in a data-converter application. While an Intersil ICL7107 is used in that specific circuit, the ICL8069 can be used with any similar device whose output voltage is within the operating range of the diode.

Precision Monolithics, Inc. (1500 Space Park Dr., Santa Clara, CA 95050) offers two different IC voltage references, the REF-01 and REF-02. The REF-01 is a 10.00-volt device. It is housed in an eight-pin TO-99 case

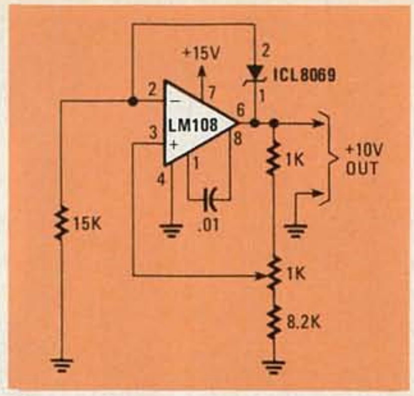


FIG. 8—A ICL8069 IS PLACED in the feedback loop of an LM108 op-amp in this voltage reference circuit. The potentiometer is used to trim the output to exactly 10.00 volts.

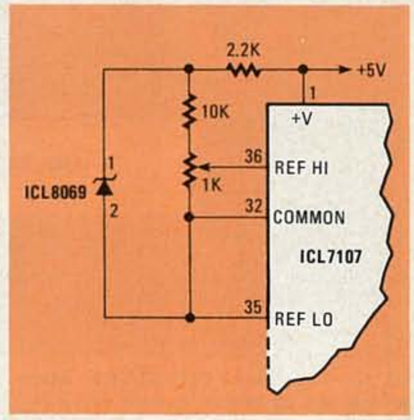


FIG. 9—USED HERE in an A/D converter circuit, the ICL8069 is well suited for such an application.

although just four of the pins are used. The REF-02 is a 5.00-volt device. It is also housed in a TO-99 case, but in this instance five of the pins are used. The fifth pin is a temperature-dependent terminal so that the REF-02 can be used as a temperature sensor.

The simple circuit shown in Fig. 10 contains a potentiometer that lets you set the output of either the REF-01 or REF-02 to exactly 10.00 volts. Either device can be used in a number of A/D or D/A converter circuits.

Selectable output supplies

All of the circuits presented thus far supply just a single output voltage. Even in the devices and circuits that use a potentiometer, it is used to adjust the output to a single value and then left alone. Sometimes however, a multiple-output voltage reference is needed. An example of that might be a voltage calibrator used with oscilloscopes and voltmeters.

The simplest way to make a multiple-output voltage reference is to place a resistance network between the output of one of the circuits presented in this article and the load. A typical network is shown in Fig. 11. In that network, each tap is a decade higher in voltage than the next lower tap. The lowest value shown is 10 ohms, but that might

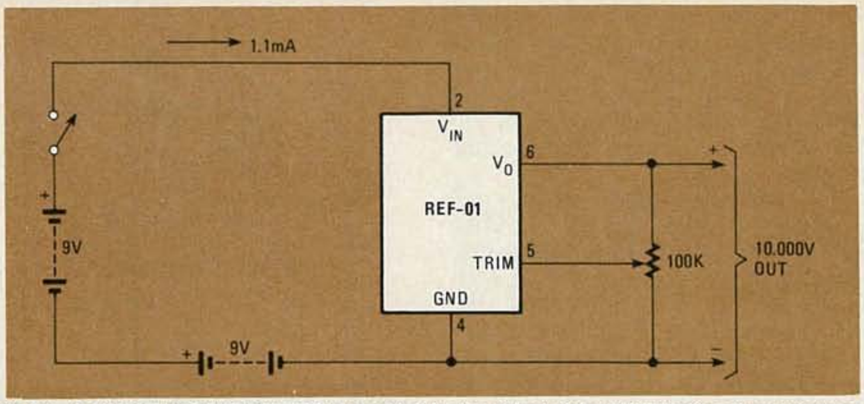


FIG. 10—A SIMPLE POTENTIOMETER is used to trim the output of the PMI REF-01 voltage reference to exactly 10.00 volts.

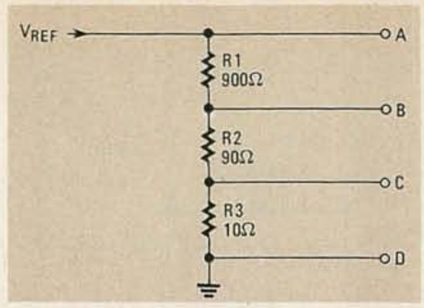


FIG. 11—A RESISTOR NETWORK can be used to get a multiple-output voltage reference. The voltage at each tap is 10 times higher than the voltage at the tap below it.

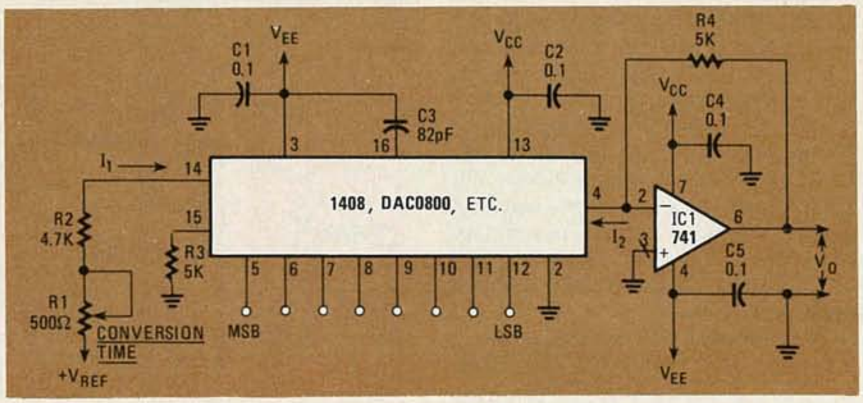


FIG. 12—A DIGITALLY SELECTABLE voltage reference. Once the input current (I_1) to the D/A converter is set, the output from the circuit (V_O) is determined by digital input (pins 5-12) to the D/A converter.

be too low for some applications. In that case, make the lowest value 100 ohms, and increase each of the other resistances by a factor of ten (i.e. make the sequence 100-900-9000-90,000-900,000 etc.). With the resistances used in Fig. 11, the voltages found at the taps would be as follows:

A—10.00 volts
B—1.00 volts
C—100 millivolts
D—0 volts

We can also make a digitally selectable reference source by using a D/A converter. Figure 12 shows how such a converter can be used to control the output voltage (V_O) of a reference supply.

The output current of any D/A converter is the product of the input current (I_1) and the binary word input, divided by the maximum possible value of the binary word:

$$I_2 = I_1 \times (N/2^n)$$

Where: I_1 is the reference current, I_2 is the output current, N is the decimal value of the binary word input, and n is the bit-length of the D/A converter.

Try this problem out as an example: Find the output current (I_2) when V_{ref} is +10.00 volts, and R1 is adjusted so that I_1 is exactly 2 mA. Assume that the binary word applied to the output is 10010110 (i.e. decimal 150), and that the D/A converter is 8-bits (as in Fig. 12).

The solution would be found as follows:

$$I_2 = (2mA)\ (150/2^8)$$
$$I_2 = (2mA)\ (150/256)$$
$$I_2 = (2mA)\ (0.586)$$
$$I_2 = 1.17\ mA$$

The output voltage from the circuit (V_O) in Fig. 12 is the product of the D/A converter current and the feedback resistors, so:

$$V_O = (I_2)\ (R4)$$
$$V_O = (1.17\ mA)\ (5.00\ kilohms)$$
$$V_O = 5.895\text{-volts DC}$$

Once the reference current I_1 is set, the output from the D/A converter is determined by the digital input to the converter. It is a simple matter to vary that input to give us precisely the reference voltage that is needed. There are many ways to do that, including connecting the D/A converter's digital input to the output port of the microcomputer or to binary-output thumbwheel switches. **R-E**

Solid State News

Power FET's data sheets

Power MOS Field-Effect Transistors is the title of a 30-page booklet from Motorola. It includes data sheets, cross-references, and operating theory for the company's enhancement-mode N-channel silicon-gate TMOS FET.—**Motorola Semicondutor Products,** Box 20912, Phoenix, AZ 85036.

RCA COS/MOS product guide

COS/MOS Digital Integrated Circuits (COS-278H) is a 30-page product guide written to aid the user in selecting the optimum types of devices for specific applications. It provides maximum ratings, recommended operating conditions, static electrical-characteristics, selection charts, and functional diagrams for the complete line of RCA A-Series (15-volts maximum rating) and B-Series (20-volts maximum rating) COS/MOS devices. Devices covered include gates, buffers, inverters, encoders, decoders, multivibrators, flip-flops, and triggers. Also included are IC's intended for use in microprocessor, memory, and timekeeping circuits.—**RCA, Solid State Division,** PO Box 3200, Somerville, NJ 08876.

RF diodes catalog

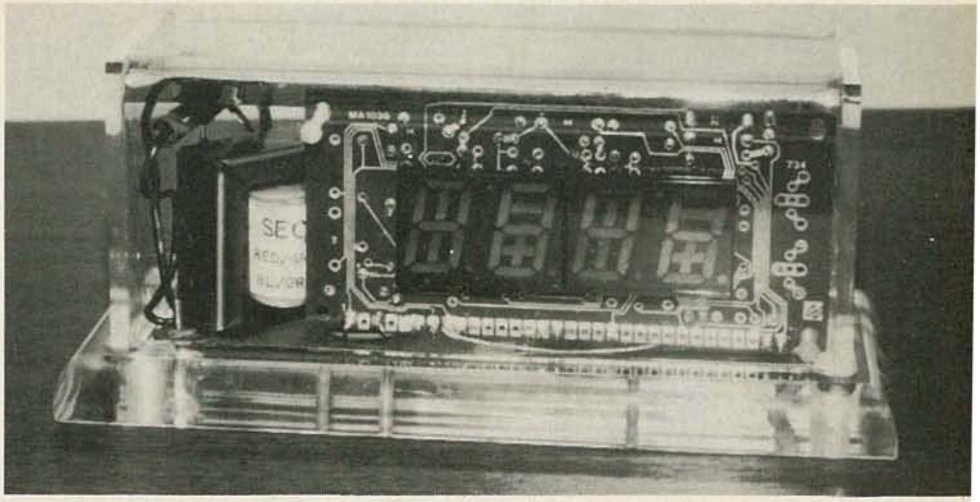
RF Signal-Processing Diodes Selector Guide is a 6-page listing of all Motorola tuning diodes for frequency control, hot-carrier diodes for mixing and detection, and PIN diodes for switching. Included are design curves and package outlines.—**Motorola Semiconductor Products,** PO Box 20912, Phoenix, AZ 85036.

RF transistor catalog

Transistor Designers 1981 Catalog is a 159-page VHF/UHF/microwave transistor selection-guide. Included are detailed data on low-noise, general-purpose, and linear power silicon-transistors, and low-noise and linear power GaAs FET's for use between 60 MHz and 18 GHz. Charts show performance curves and typical contours for the constant-gain and noise-figure functions. Some devices are available both packaged and as unmounted chips.—**Avantek,** 3175 Bowers Ave., Santa Clara, CA 95051. **R-E**

AN EYE-CATCHING AND USEFUL PROJECT need not cost a great deal of money. The device described here is a combination digital clock/outdoor thermometer; the total cost of project as shown is less than fifty dollars.

To make things more interesting visually, the project was housed in a clear case—an acrylic butter dish—so that the entire circuit can be seen. Three reed switches are used to set the time or turn on the thermometer; that is done by bringing a magnet near the case, close to where the appropriate switch is located. Although standard subminiature panel mounted switches can be used, we choose the reed switches because it simplifies the construction and gives the completed project a modern appearance. As a thermometer, the project displays temperature in either °C or °F over a range of −40°C to +90°C or −40°F to +193°F. The temperature sensor does not require a separate power supply and is not affected by lead length.



DIGITAL THERMOMETER

Know the time and temperature instantly with this easy-to-build project. The clear, acrylic case makes it an interesting conversation piece.

MICHAEL RIGSBY

About the circuit

The heart of the circuit is a National Semiconductor MA1026 digital LED alarm clock/thermometer module as is shown in Fig. 1. That module features a 0.7-inch LED display, snooze alarm, 24-hour alarm, 12/24 hour mode, 50/60-Hz select, fixed/flashing colon, and sleep cycle. The sleep cycle can be used, with external circuitry, to turn off a radio or appliance after a time period of 59 minutes or less.

For this project, the module can be treated as a "black box," requiring just a transformer for input power, switches for display selection, and sensors for temperature measurement. The transformer has three windings—a 120-volt primary, a 6-volt center-tapped secondary (125-milliampere current-handling capability on either side of the tap), and a 10.5-volt secondary capable of supplying 25 milliamperes. Power consumed by the module is minimal, therefore the power-handling capacity of the switches is not important. An LM334 adjustable current source is used as the temperature sensor; that three-legged device looks like a small plastic transistor. A 220-ohm resistor, R1, is used to scale the output of the LM334 so that the IC will supply a current of one microampere-per-°C. Because the output from the sensor is a current, lead length is not critical. Note that a low temperature-coefficient resistor should be used for R1 (either a metal-film or, if you can find it, wire-wound unit), and that it should be part of the sensor package so that it will change temperature with the IC. To make the sensor package, mount the LM334 and the resistor on a small piece of perforated construction board.

In the basic clock/thermometer shown in Fig. 2, pin 8 is tied to pin 16, letting you set the time using the FAST SET and SLOW SET switches. Closing the TEMP switch puts the device in the "thermometer mode." In that mode, if pin 10 on the clock module is left unconnected, the temperature readings will be in °F; if pin 10 were tied to pin 8, the temperature readings would be in °C.

The basic clock/thermometer can also be adapted for battery operation. If you want to do that, the schematic shown in Fig. 3 should be used. In that circuit, a

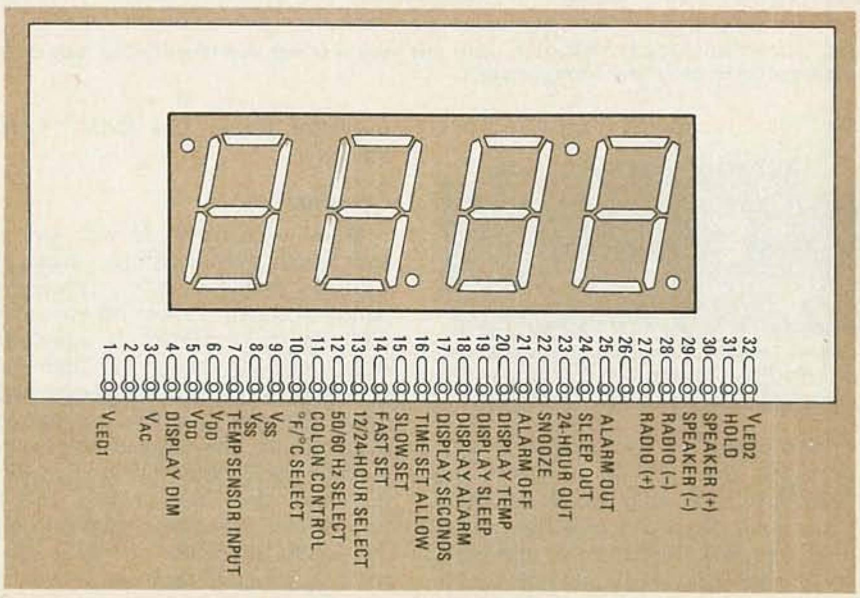


FIG. 1—THE COMPLETE PIN-OUT for the National MA1026 clock module is shown here.

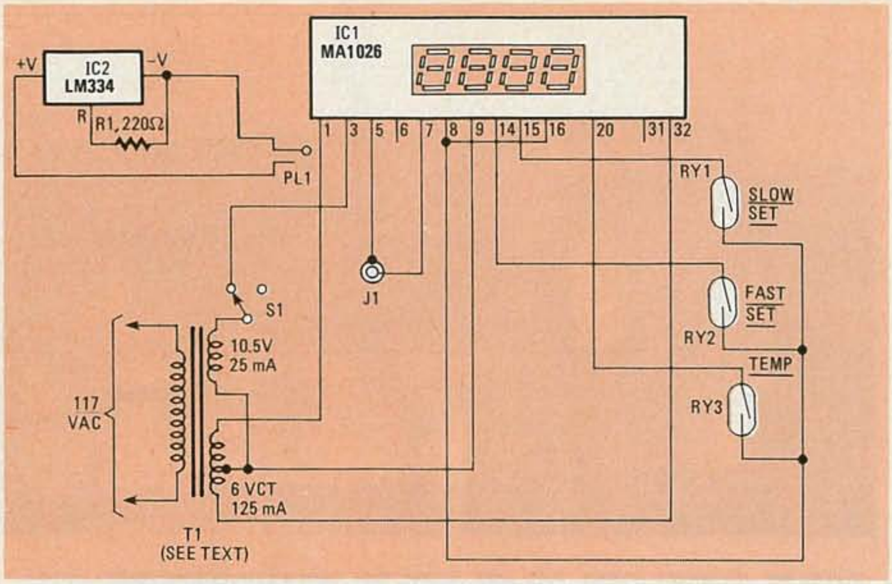


FIG. 2—SCHEMATIC DIAGRAM of the digital clock/thermometer and the temperature sensor. To make the temperature sensor, mount IC2 and R1 on a small piece of perforated construction board.

PARTS LIST

Resistors ¼ watt, 5%
R1—220 ohms, metal film or wire wound
R2—10 megohms
Capacitors
C1, C2—47 pF, ceramic disc
Semiconductors
IC1—MA 1026 clock module (National)
IC2—LM334 adjustable current source/temperature sensor
IC3—MM5369 oscillator/divider
J1—miniature phone jack, panel mount
PL1—miniature phone plug
RY1-RY3—reed switches
T1—dual secondary; 10.5 volts at 25 mA, 6 VCT at 25 mA
XTAL1—3.58 MHz crystal
Miscellaneous: acrylic case, small piece of perfboard, wire, solder, hardware, epoxy glue, etc.
NOTE: If you are unable to obtain IC1, T1, or XTAL1 from your usual dealer, they can be ordered from Digi-Key Corporation, Hiway 32 South, PO Box 677, Thief River Falls, MN 56701

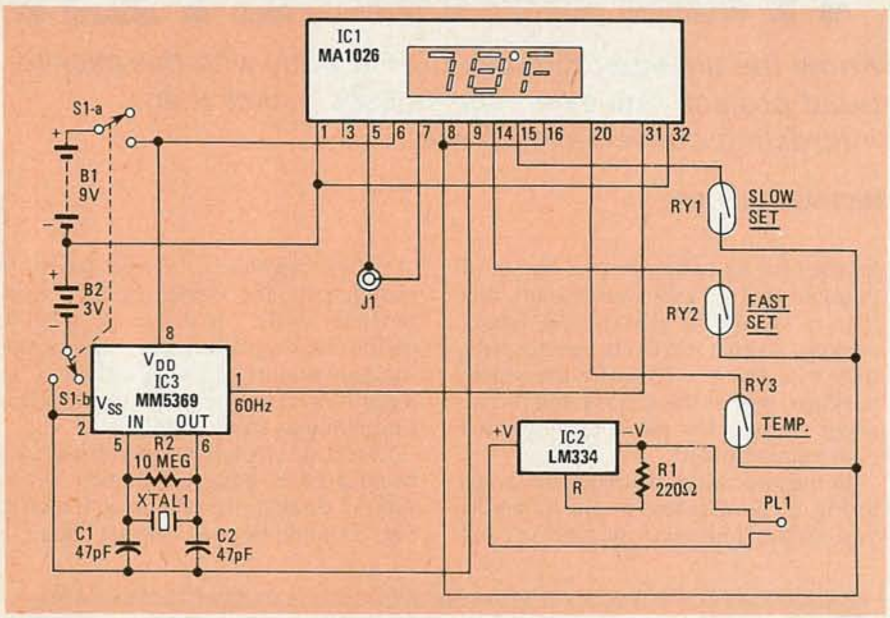


FIG. 3—FOR PORTABLE OPERATION, build this version of the clock/thermometer project. The oscillator circuit draws just 1.5 milliamperes.

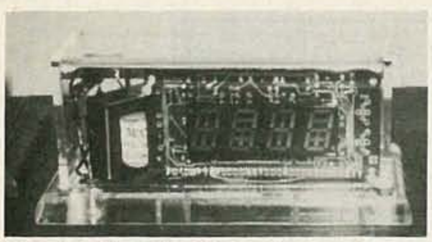


FIG. 4—THIS IS HOW the project will look when it is finished. The clear case—an acrylic butter dish—makes the clock more interesting visually.

crystal-controlled oscillator is used to drive the clock. In the oscillator, the MM5369 CMOS oscillator/divider takes the output from a 3.58-MHz crystal (that crystal is used in color television sets) and divides it using an internal 17-stage binary counter to produce an accurate 60-Hz output. Typically, the oscillator draws less than 1.5 milliamperes.

Construction

While such things as wire size and lead length are not critical, certain precautions should be taken with component placement. Traces on the module must not be shorted by the transformer case, temperature-sensor input jack, fastening bolts, or uninsulated wires. Since the reed switches are operated magnetically, they should be placed as close to the edge of the acrylic case as possible. Also keep in mind that the transformer generates a magnetic field, and could affect the operation of the reed switches if they are placed too near it.

When drilling the case, it is very easy to scratch or shatter the acrylic material unless you are careful. To make holes, place the case on a cloth and drill a "pilot" hole using a 1/16-inch bit. When you enlarge the hole, it is best to reverse the direction of the drill just before breaking through; use the friction of the moving bit to melt the remaining plastic. That technique avoids the danger of a snag and the resulting damage.

Fast-drying epoxy is clear and forms an excellent bond for mounting the module and other components to the acrylic—do not use glue on the face of the module as it will appear as a trapped drop of water. Avoid "super" glues; their fumes will create a permanent cloudiness in the clear plastic.

Before closing up the case, you will need to calibrate the module so that it reads the correct temperature. The temperature-sensor assembly should be stabilized in a known environment. To do that, prepare an ice-point bath of water and ice. Place a mercury thermometer in the bath, and watch the temperature until it drops to 32°F (or 0°C). Once that happens, the temperature of the bath should remain constant until all of the ice melts. Before then, however, place the sensor in the bath, and adjust the module potentiometer (the blue knob on back of the module) until the temperature reading is precisely 32°F (or 0°C). Once that is done, remove the sensor from the bath and close up the case. If you use epoxy, use only small drops—you might want to open up the case again someday. The completed project is shown in Fig. 4.

Options

As we mentioned earlier, the MA1026 module is loaded with features and

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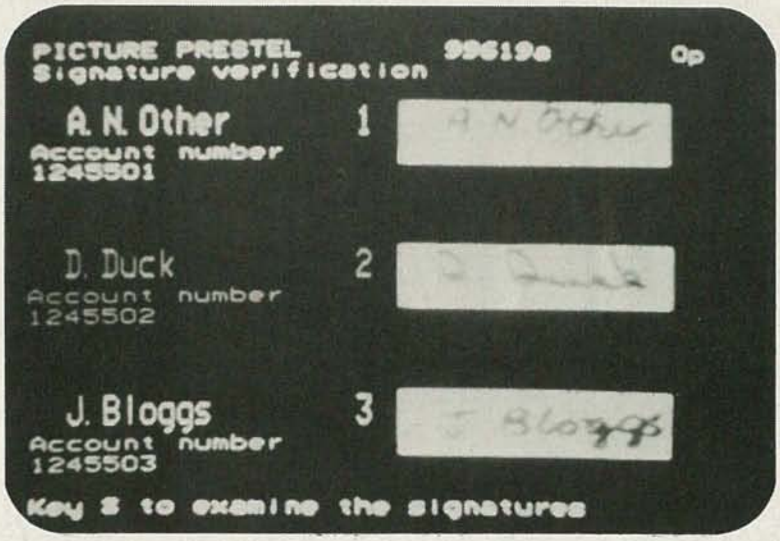
Videotex for TV—



How it works

Videotex has several levels of alphanumeric and graphics capabilities. Here's a discussion of how they work, as well as a look at videotex's future.

RICHARD LARRATT, M.A., P. Eng.*

Part 3 EARlier in this series we discussed the data that's transmitted on the vertical-blanking interval lines, preparing the videotex decoder for the video data that is to follow it, but did not talk about that information itself.

The actual display data—the alphanumerics and graphics—is placed on a video line on a "space-available" basis, in accord with the North American Broadcast Teletext Standard proposal. That's the reason for the bytes in the headers that indicate where the next information is to be found. The data contained in the headers also allows the control information to be multiplexed with the display information.

The videotex decoder separates the two and stores them in RAM. At the appropriate time, the alpha-graphic (display) information is called up by the decoder and acted upon by the control information to determine character-size, color, etc. That system is known as the parallel-attribute format.

Prestel—which has also filed with the FCC for acceptance—does it differently. As mentioned earlier, Prestel data is transmitted sequentially—the first character is sent first, and the last one last, and that's how they appear on the screen. The character-attribute data is sent along with the alpha-graphic data. That means that when an attribute (such as color), is changed, a pixel (picture element) is sacrificed and nothing is seen in the space that would otherwise be occupied by a character. Because one character or control element follows the other, the system is known as serial-attribute transmission.

(Editor's note—*This is known as Level-1 Prestel. There are a total of five levels of Prestel, each more advanced than the previous one. Level 1, while the most "primitive," is also the most common at this stage. The proposal before the FCC includes all five levels.)*

Alpha-graphics are sent using the ASCII (*A*merican *S*tandard *C*ode for *I*nformation *I*nterchange) code—the one that is used by most computers. In it, each character is represented by a 7-bit word. For example, the letter "A" is represented by the decimal value 65, and a space by the decimal value 32. Since the information is transmitted in digital form, the "A" becomes "1ØØØØØ1," and the space "Ø1ØØØØØ." Table 1 shows videotex alphanumeric characters and their ASCII values. A switchable control byte allows the same numbers to be used to obtain other characters.

In the simplest forms of videotex (see Fig. 5 in Part 1 of this series in the November 1981 issue of **Radio-Electronics**) the ASCII data is sent to a character-generator ROM. That IC contains the information needed to display all the letters and graphic symbols required by the system. When it is fed an ASCII value, it responds by outputting the dot pattern needed to form the character on the video display.

DRCS

The next step up in videotex technology calls for the use of a DRCS (*D*ynamically *R*edefinable *C*haracter *S*et). The DRCS allows the use of more graphics elements than are contained in the character-generator ROM. A videotex decoder equipped for DRCS's must contain some RAM. That memory stores the DRCS downloaded from the videotex computer over the air (or cable) and in effect acts as a secondary character-generator ROM. An example of videotex graphics using a DRCS is shown in Fig. 15.

In addition to providing enhanced graphics, DRCS's allow the use of special alphabets, such as Greek or Hebrew, to transfer mathematical data or for foreign-language captioning.

PDI's

PDI's (*P*icture *D*escription *I*nstructions) allow the supplier of videotex information even more flexibility. Table 2 shows the PDI's described in the North American Broadcast Teletext Standard proposal. Once they are downloaded into the decoder's memory, they make possible very complex graphics with very little effort. For instance, the LINE PDI could be used to instruct the decoder to draw a "...LINE from *here* to *there*...".

Once the PDI's are loaded into memory, they make possible a wide variety of high-quality graphics, such as the illustration shown in Fig. 16.

PDI's also require RAM (typically 16K) but can make a PDI-equipped decoder worth its expense when graphics are of the essence.

Alpha-photographic

An example of alpha-photographic videotex is shown in Fig. 17. Alpha-photographic videotex allows the transmission not only of text, but also of still

*President, Richard Larratt and Associates Inc.

TABLE 1

Decimal	Binary	Character	Decimal	Binary	Character	Decimal	Binary	Character
32	0100000	SPACE	96	1100000		64	1000000	@
33	0100001	!	97	1100001	a	65	1000001	A
34	0100010	"	98	1100010	b	66	1000010	B
35	0100011	#	99	1100011	c	67	1000011	C
36	0100100	$	100	1100100	d	68	1000100	D
37	0100101	%	101	1100101	e	69	1000101	E
38	0100110	&	102	1100110	f	70	1000110	F
39	0100111	'	103	1100111	g	71	1000111	G
40	0101000	(	104	1101000	h	72	1001000	H
41	0101001	)	105	1101001	i	73	1001001	I
42	0101010	*	106	1101010	j	74	1001010	J
43	0101011	+	107	1101011	k	75	1001011	K
44	0101100	,	108	1101100	l	75	1001100	L
45	0101101	–	109	1101101	m	77	1001101	M
46	0101110	.	110	1101110	n	78	1001110	N
47	0101111	/	111	1101111	o	79	1001111	O
48	0110000	0	112	1110000	p	80	1010000	P
49	0110001	1	113	1110001	q	81	1010001	Q
50	0110010	2	114	1110010	r	82	1010010	R
51	0110011	3	115	1110011	s	83	1010011	S
52	0110100	4	116	1110100	t	84	1010100	T
53	0110101	5	117	1110101	u	85	1010101	U
54	0110110	6	118	1110110	v	86	1010110	V
55	0110111	7	119	1110111	w	87	1010111	W
56	0111000	8	120	1111000	x	88	1011000	X
57	0111001	9	121	1111001	y	89	1011001	Y
58	0111010	:	122	1111010	z	90	1011010	Z
59	0111011	;	123	1111011	{	91	1011011	[
60	0111100	<	124	1111100	¦	92	1011100	\
61	0111101	=	125	1111101	}	93	1011101	]
62	0111110	>	126	1111110	~	94	1011110	Λ
63	0111111	?	127	1111111	DELETE	95	1011111	—

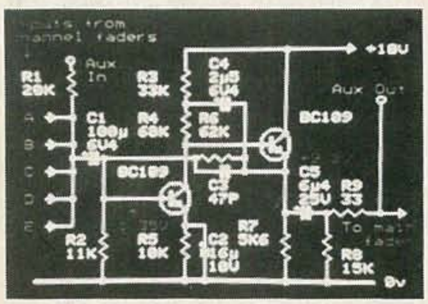


FIG. 15—A DYNAMICALLY REDEFINABLE character set (DRCS) makes the presentation of pictures such as this schematic relatively easy.

video frames—something that will be very important when shopping-by-videotex becomes widespread and the buyer wants to see not a drawing, but a real picture of the item he is interested in.

Figure 10 in the December 1981 issue of **Radio-Electronics** shows an alpha-photographic system. Several layers of RAM are overlaid, and their contents taken as a whole to provide varying brightness levels, which are not available in less sophisticated forms of videotex. As an example, let's look at bit-1 of each of the four planes of RAM shown in that figure. If we consider the four planes together, we can build values ranging from 0 to 15, depending on whether the bits are "1" or "0"'s. That means that each pixel can be assigned one of sixteen brightness levels, if the values are converted into

TABLE 2

TEXT:	Present a string (group) of characters.
POINT:	Set the position for a point and, if requested, draw it.
LINE:	Draw a line using its end-points as starting and stopping coordinates.
ARC:	Draw a circular arc using three sets of co-ordinates (any circle or part of a circle can be defined by three points).
RECTANGLE:	Draw a rectangle of a specific height and width.
POLYGON:	Draw a polygon based on the coordinates of its vertex points.
BIT:	Produce an image using bit-mapped graphics.
CONTROL:	Provide control over the modes of the drawing commands.

voltages that will control the electron beam of the video display.

Scanned sequentially, the contents of the bit-plane memory will appear as a series of brighter or darker pixels—a photograph! Even color is possible.

Of course, there is a tradeoff involved. Depending on the baud rate at which the data is sent, it can take several seconds for the picture to be completed. (Actually, that process would not be apparent to the user because the data would be loaded into RAM and not displayed until everything was present.) That's one reason why the "photograph" in Fig. 17 fills only part of the screen—a small picture requires less memory and can be transmitted and displayed more quickly (about two seconds for the one shown). Despite its apparent disadvantages, though, alpha-photographic videotex can be quite useful.

Which is best?

We've presented several levels of videotex—alpha-mosaic, alpha-geometric, and alpha-photographic. Which one is going to win out?

That's difficult to say. Eventually, of course, we'll be using the alpha-photographic mode, and every level below it. For the immediate future, however, we are faced with a conflict between a rather simple (although technically sophisticated) alpha-mosaic system, typified by Level-1 Prestel, and a more expressive but more complex—and, initially, more expensive—alpha-geometric system of the Antiope/Telidon-type.

Proponents of both systems have petitioned the FCC for acceptance of their method as the North American standard. Those backing the Prestel system claim that it is simple, inexpensive, and has a proven history.

Those in favor of the Antiope/Telidon

system say that its flexibility outweighs its apparent complexity, and that component prices will decrease rapidly once it is accepted and decoders are produced in volume.

At the moment, the decision lies with the FCC. Recent developments in FCC policy, however, indicate that the ultimate decision may be up to the user: both systems may be allowed, and the winner will be the one with the most subscribers. It's even possible that the two systems will coexist, one in some areas, and one in others.

That, however, invokes memories of "quad" sound, and the controversy and confusion that surrounded it before it more or less disappeared. Whatever the outcome, videotex—in one form or another—will be with us, and will make life a bit simpler and more rewarding.

Using videotex

Let's take a look at a not-so-hypothetical videotex system. We'll assume that the system used is that proposed to be the North American Broadcast Standard and that the videotex data is being sent over the air on two lines of the vertical-blanking interval. The equipment involved is an ordinary television receiver equipped with a videotex decoder and a small numeric keypad like a *Touch-Tone* pad. Also attached to the decoder is a modem, through which information can be sent back by telephone to the videotex computer.

A good videotex information-system will be constructed like an onion—the outside layer of information will be general. More detailed information can be obtained by requesting pages indicated by the first level. Still *more* detailed information will be available by selecting pages indicated by the second level. Also available will be an alphabetical directory—it might tell you that the page numbers for categories beginning with the letters "VAA" through "ZZZ" can be found on page number such-and-such.

Let's assume that you want to make an airline reservation from New York to San Francisco. The first thing you will do will be to find out what page carries airline information. Upon entering the page number, a directory to various airlines will appear on the screen within about 10 seconds.

When the airline you select appears on the screen, it may present a menu showing the cities served, with each city identified by a number. By keying in that number, you will find another page showing the line's flights to that city, and possibly the status of each flight ("BOOKED FULL," "STAND-BY ONLY," or even "SEATS AVAILABLE").

By keying in the number associated with the flight you want, a menu will be presented for you to "fill out" to make your reservation and, at that time, you will be instructed to set up your telephone link to transit that information to the videotex or airline computer.

FIG. 16—PDI's (*P*icture *D*escription *I*nstructions) allow very complex graphics to be generated.

FIG. 17—THE ALPHA-PHOTOGRAPHIC mode allows photographs to be included as part of the videotex material. The picture shown took about two seconds to transmit.

You'll be asked for your videotex account number, which may be reconfirmed on the screen. That not only automatically tells the airline just who is buying the ticket, but can also be used for direct-billing purposes. You'll then fill in the blanks on the screen to indicate how many people will be traveling, what class of service is desired, departure date, etc.

Finally, you will be given the option of committing yourself to that reservation, or—and sometimes more important—simply telling the computer to forget the whole matter.

Getting detailed news would also be done through a series of ever-more-detailed menus. The first page would be an index by subject ("WORLD," "NATIONAL," "SPORTS," "COMICS," etc.) and would also contain the latest headlines. By unpeeling layers of the information "onion," you could scan the items of interest to you, or read about them at length.

Who pays for it?

There's no such thing as a free lunch. Videotex equipment is not cheap, and the time that goes into programming the system also costs money. Where does the money come from?

In some instances, the company selling a service or product (such as an airline) pays out of its own pocket—it's probably less expensive than running a sales office. In other cases, such as financial reports like the Dow Jones index, a charge of 10 or 25 cents would be made to your account each time you accessed the service, or you would be billed for the time that you used.

Finally, to encourage the use of the system, some services, like news headlines or weather, might be provided without charge. After all, if you're going to use your videotex terminal for that, you'll also eventually find yourself using it for services that you (or someone else) pays for.

How we'll use it

Technically, videotex is quite an achievement. What, though, will it do for you? Some ideas were presented above; here are a few more.

Initially, interactive videotex—where the user can communicate with the service—will be limited. Broadcast videotex, using a full video-frame occupying all of a TV channel will predominate, presenting a continuously scrolling display of information. But the viewer will have no opportunity to take advantage of it, except as a non-selective information source.

At the beginning, interactive videotex will probably be available at selected public terminals (in airports, offices, and other places where its capabilities can justify the initial expense).

Our world, though, is changing. We are, more and more, becoming a "wired society." Right now that pertains primarily to telephone service—you can speak to anyone in the world for what would have been considered, a few years ago, a ridiculously low price.

Now, cable-TV is becoming a part of our lives and, if one channel were used to receive videotex information, and another to transmit multiplexed viewer response (at a relatively low-data-rate), interactive videotex over cable could easily become a reality.

In the near future we'll see two more developments that will further the interactive aspect of videotex.

The first is fiber optics. By using light, rather than RF, as a transmission medium, it will be possible to have an almost unlimited number of channels for information interchange. Fiber optics, using hair-thin transparent light-guides instead of cables, is their logical replacement. We'll be seeing a lot more of that technology soon.

The second could very well be DBS (*D*irect *B*roadcast *S*atellites). They could replace *any* wired—or light-piped—information service and, although it may take a while, they may become two-way. Not only would you be able to receive the programs or data they sent, but a relatively-low-power transmitter might transmit *your* information into the system.

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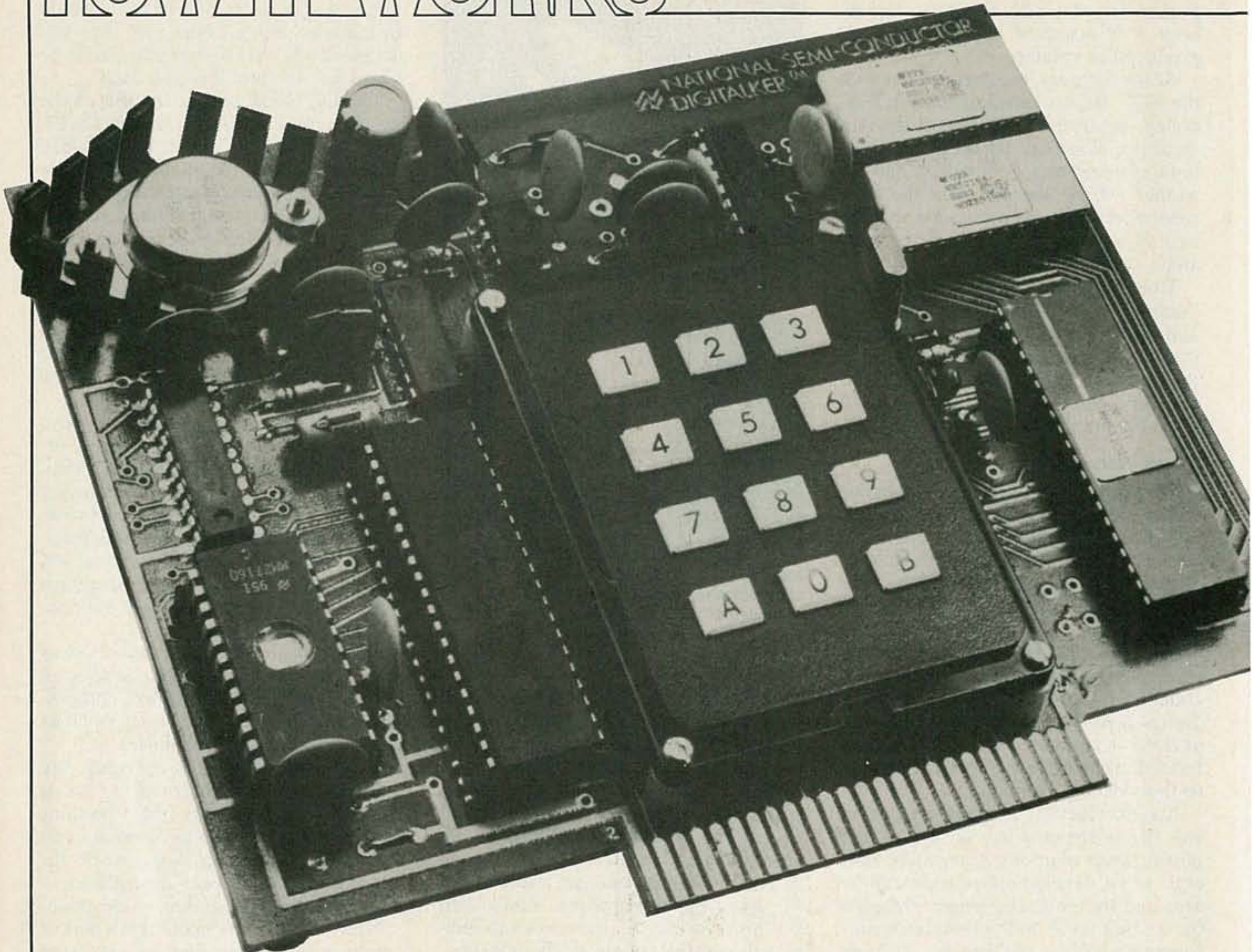

SPEECH SYNTHESIS Techniques

KARL SAVON

Electronic speech-synthesis hs come a long way from the Voder, which took seven people to operate when it was demonstrated at the 1939 N.Y. World's Fair. Now all you need are a couple of IC's.

SPEECH SYNTHESIS—THE ARTIFICIAL generation of that series of sounds known as "speech"—has advanced beyond the novelty stage to become a real alternative to the simple audible and visible indicators and displays common to so much of our society. There is very little you can do with a light or buzzer that can't be done better with a "spoken" word.

"Toys" such as Texas Instruments' *Speak & Spell* have been recognized as effective learning tools. Through the electronics mouths of those machines, children are exposed to new words in an exciting interactive way. Talking calculators and timepieces have expanded the horizons for the blind; pilots and drivers are relieved of the need to watch their meters and gauges continuously; alarms can be given with instructions as to what actions should be taken. Speech-synthesis devices are finding a myriad uses in communications, appliances, automotive applications, clocks, instrumentation, language translators, and annunicators. It is estimated that the speech-synthesis market will grow to hundreds of millions of dollars in the next five years.

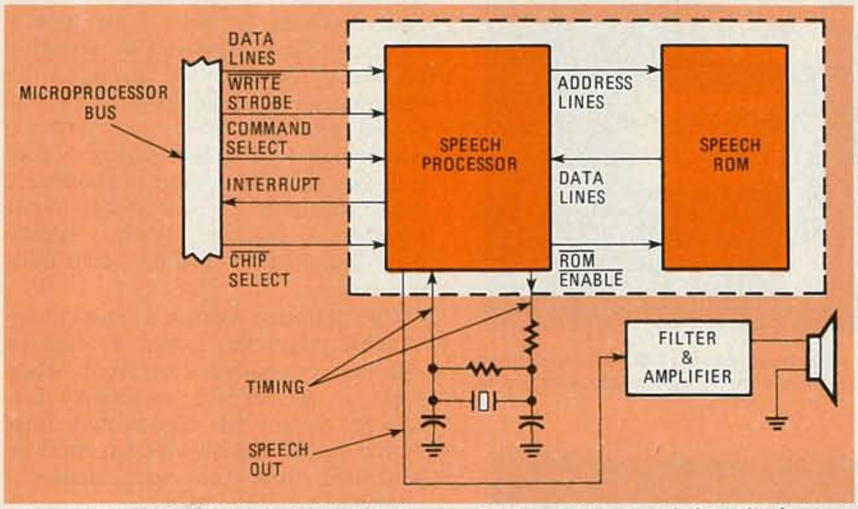

FIG. 1—A TYPICAL IC SPEECH-SYNTHESIZER uses a ROM containing speech data, circuitry to process the data and turn it into analog form, and an amplifier and speaker.

Fundamentals

Human speech begins in the cortex of the brain but, so far, that *creative* process has been imitated only crudely. The *mechanics* of speech, though, have been simulated with uncanny precision.

The human speech process begins in the lungs and proceeds through the larynx to create the noises and tones that correspond respectively to *unvoiced* and *voiced* human speech output. The wideband hissing "s", "f," and "sh" are unvoiced sounds, created by the random flow of air particles through the voice tract, but the voiced consonants like "b" and "l" are constructed of discrete narrowband frequencies; the vibrating vocal cords generate the voiced sounds. *Fricatives* like "v" and "z" combine the two types of sources and the *plosives,* such as "p," "t" and "k" are produced by the controlled release of air from the mouth.

The speech process is completed by articulation—changing the shape of the throat, and the shape and positioning of the teeth, tongue, palate and lips. Together, those parts of the mouth and respiratory system form an adaptive filter that alters the resonances of the vocal tract.

While there are more similarities than differences among the approaches to speech synthesis, they can be separated into three general groups: direct waveform-digitization, phoneme synthesis, and linear-predictive coding.

Direct waveform-digitization

Direct waveform-digitization is the process of taking a live or recorded speech-waveform and passing it through an analog-to-digital converter. The final quality of the reconstructed speech (obtained by passing the digitized data through a digital-to-analog converter) depends on several factors, including the rate at which the speech waveform is sampled (how many times each second the waveform is "looked at" and its value digitized) and the number of amplitude levels into which it is segmented. As the number of levels increases, more information must be processed and stored in memory; as the number of levels decreases the memory and processing requirements decrease —at the expense of intelligibility.

It is necessary to sample the waveform at a frequency that is at least twice as high as the highest frequency in the original waveform. If the sampling frequency is too low, *aliasing,* which causes the higher frequencies to appear falsely as lower frequencies, takes place.

Playback of the digitized signal is (in theory) a simple matter of recalling the sequences of data stored in memory and processing them with a digital-to-analog converter.

Direct waveform-digitization of human speech is highly redundant; it wastes a lot of memory storing, for example, drawn-out sounds like "ooooooh." Methods used to reduce the memory requirements and rate of processing of redundant information may actually cause this synthesis technique to be classified in one of the other simulation groups.

National Semiconductor (2900 Semiconductor Dr., Santa Clara, CA 95051) uses a direct-digitization method that reconstructs the speech using pulse-coded modulation. It calls its system the *Digitalker.* Compressed speech data is stored along with frequency and amplitude information in a read-only-memory (ROM). Figure 1 shows a typical configuration connected to a microprocessor bus complete with an output filter, amplifier, and speaker. Figure 2 shows a block diagram of the speech processor chip, referred to as the SPC.

It cannot be overemphasized that the key to the practicality of this, as well as the other systems, is *speech-compression*—coding of the signals that minimizes the redundant information. National points out that its system produces speech quality far better than the crude sound you may associate with early demonstrations of speech digitization. In terms of memory space, the result is that male voices require about 100 bits per word and female voices somewhat more. The system is more like a digital recorder that digitizes actual voices, stores, and then plays back, than the other methods which model the vocal tract.

The compression method combines three techniques. First, redundant pitch periods are removed. Then, adaptive delta-modulation, which uses the difference between two successive sampling points rather than the values *at* those points, is used to conserve memory space by storing only the difference information. Phase adjustments and half-period zeroing, remove the "direction" component of the waveform; that information is not needed for intelligibility, so can be safely done away with. Computer processing is used to accomplish the compression. National claims that its compression scheme, combined with waveform digitization, is very competitive with other systems, including linear-predictive coding.

The *Digitalker* is programmed with control information that instructs it how many times to repeat a specific waveform. A programmable frequency-generator is used to add inflection. The system is easy to use because it requires only a start pulse and an 8-bit address to trigger any message. Simple switches can be used if a microproces-

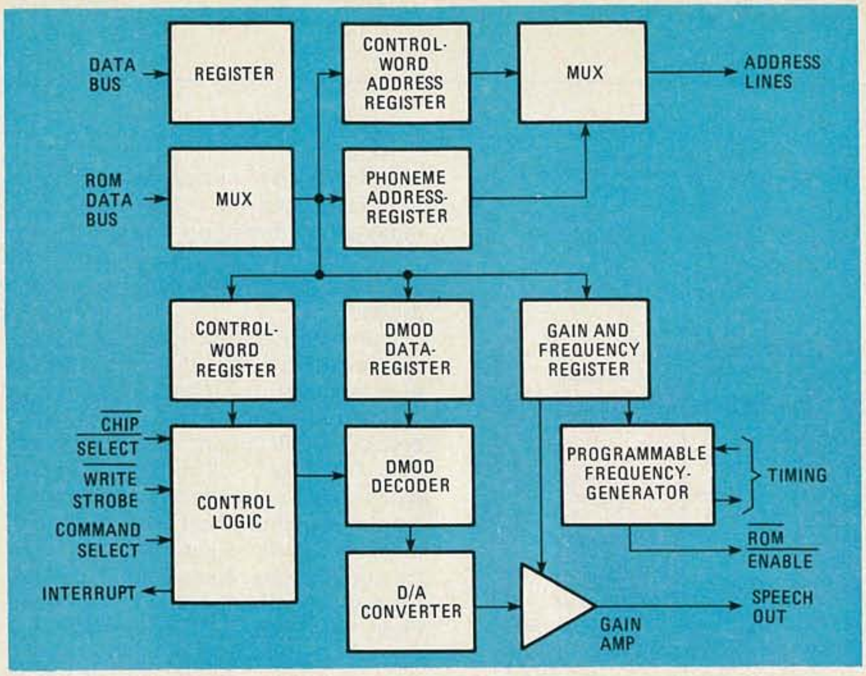

FIG. 2—NATIONAL SEMICONDUCTOR'S *DIGITALKER* has a fixed vocabulary in ROM; several different ROM's are available. Programmable frequency-generator (lower right) is used to add inflection to speech.

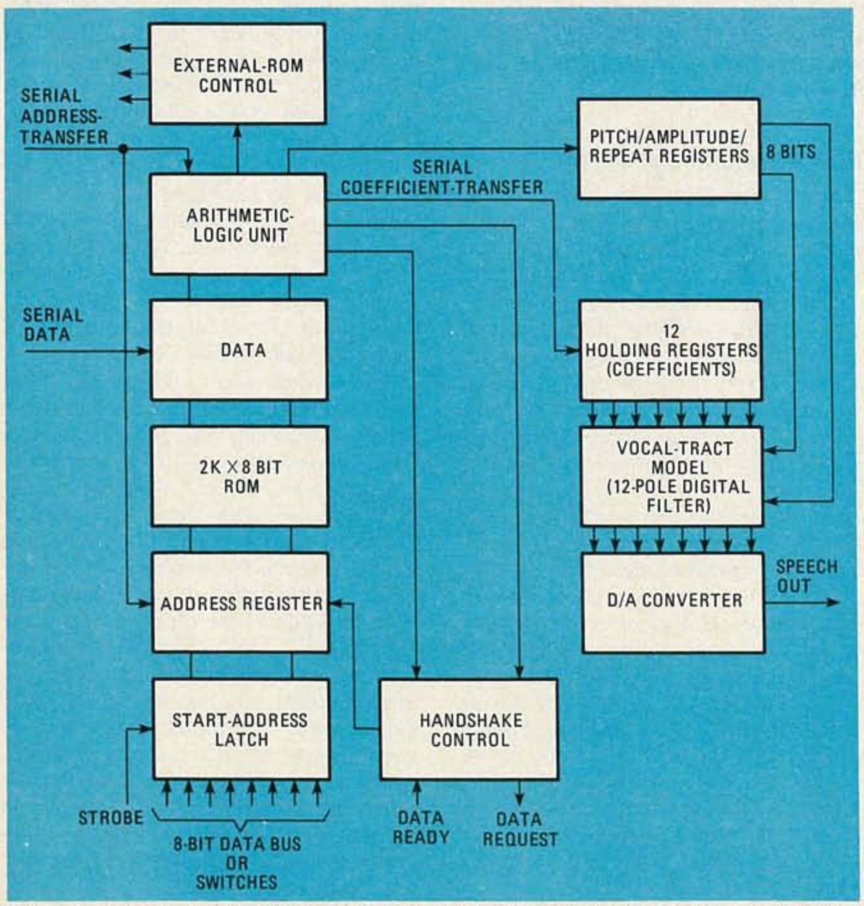

FIG. 3—A PHONEME-BASED synthesizer, such as General Instruments' SP0256, uses the sound elements that make up words to provide an almost unlimited vocabulary.

sor controller is not justified. One *Digitalker* device can produce up to 256 different messages.

An evaluation board is available which includes the NMOS speech-processor IC, two speech ROM's containing 138 words, and an erasable programmable ROM (EPROM). The *DT1000* board can be connected to an external control-system through a 22-pin edge connector. A demonstration package is available with a vocabulary aimed at several industrial markets. The 5 × 6-inch *DT1000* evaluation board is priced at $495. The *DT1050* three-piece IC set is $85. Write directly to National Semiconductor for more information.

Phoneme synthesis

Phoneme synthesis works by combining basic sound elements (phonemes) that are made up into complete words and sentences. In theory, any spoken word can be synthesized by stringing phonemes together. The quality of the resulting speech depends on the extent of the phoneme library. To cover a wide range of inflection requires a correspondingly large number of phonemes. Again, compromise is necessary to put together a practical system: redundancy-elimination coding techniques are used.

The phoneme method is particularly suitable when the extent or type of vocabulary required is not fixed: When there is no definite vocabulary list, speech cannot be constructed from stored words and phrases but must be generated from the more elemental phoneme sounds.

General Instruments (600 W. John St., Hicksville, NY 11802) has taken the approach just described, combining phoneme synthesis with a digital filter. The design is versatile enough to operate in a linear-predictive filter mode (more about that shortly). GI has released a product specification that describes the SP0256 speech-processor IC; it is an LSI n-channel metal-gate device that can synthesize up to 256 sound sequences.

Figure 3 shows a block diagram of the processor. The speech process is started by addressing the ROM location that contains the phoneme desired. Up to 256 phonemes can be stored in the 16K bits of the on-board ROM, but that can be extended to as many as 3825 phonemes (or, more usually, complete words or phrases) through the addition of up to 491K bits of ROM.

The device includes a controller and a vocal-tract model (VTM). The VTM is a digital filter similar to that used in linear-predictive coding. The system generates complex sound-sequences under the control of 15 slowly varying parameters including: repeat count, pitch period, source amplitude, and 13 digital filter-coefficients. The controller is a sequential processor that gets its instructions and data from the ROM and alters the contents of the 15 parameter-registers controlling the VTM.

One-byte inputs specify 256 entry points. The entry points in the internal ROM are spaced by 8-byte increments, meaning that each phoneme can be defined by 8 bytes (64 bits). Expanding the input format to 2 bytes increases the number of entry points to 3825, assuming that the full complement of ROM has been added. The controller has 16 executable instructions and supports one level of subroutine nesting. JMP (*JuMP*) and JSR (*J*ump to *S*ub-*R*outine) instructions are included to allow chaining of program segments and the reuse of code sequences.

External ROM interfaces to the speech-processor device through serial input and output lines. Sixteen-bit serial addresses are used for addressing. Serial-to-parallel conversion is handled internally by the SP0256. The analog output is developed by a 7-bit pulse-width modulation, digital-to-analog converter. The output is passed through a 5-kHz-cutoff low-pass filter and is then amplified externally. The single-unit price for the SP0256 is $26.70. The price will probably be even lower from a General Instruments distributor.

Votrax's phoneme system

Votrax, Div. of Federal Screw Works (500 Stephenson Highway, Troy, MI 48084) offers another phoneme-based system. Votrax uses a switched capacitor filter in its CMOS-technology SC-01 LSI integrated circuit. Phonemes require an average of 6 bits and each phoneme is 40 to 200 milliseconds long. The device has a 64-phoneme library accessed by a 6-bit code. Typical speech-data uses 70 bits per second. Votrax plans to provide a text-to-phoneme translator algorithm that will let the user do his own programming. Figure 4 shows a block diagram of the system. The price of the SC-01 is $55.00 each in quantities of five (single units may be available from distributors).

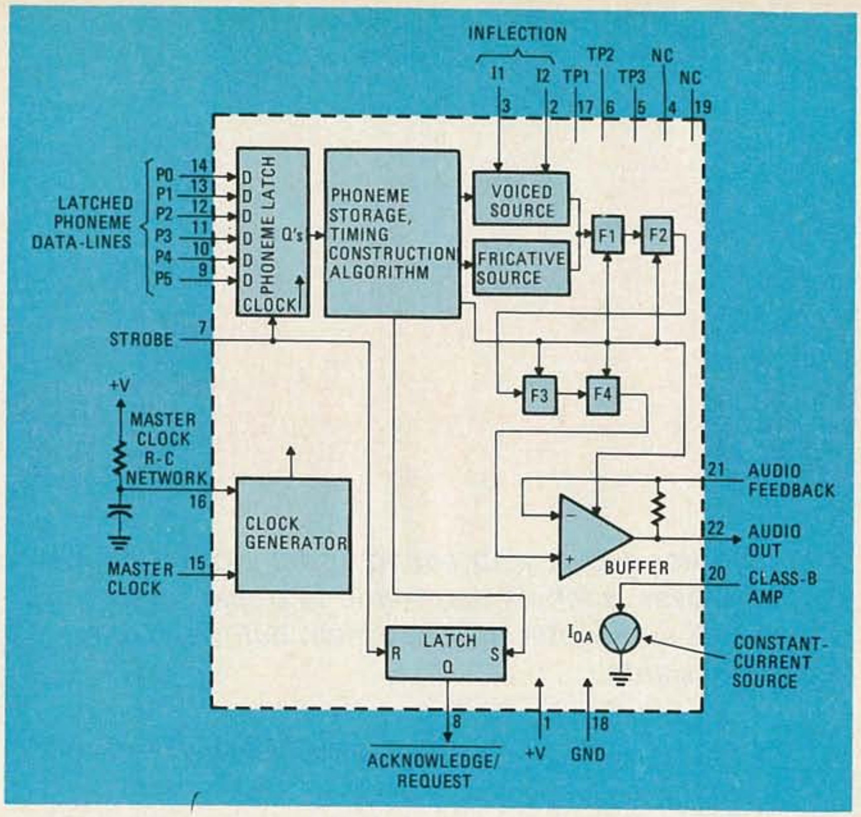

FIG. 4—VOTRAX'S SC-01 is a single-IC, phoneme-type, speech synthesizer intended for computer control.

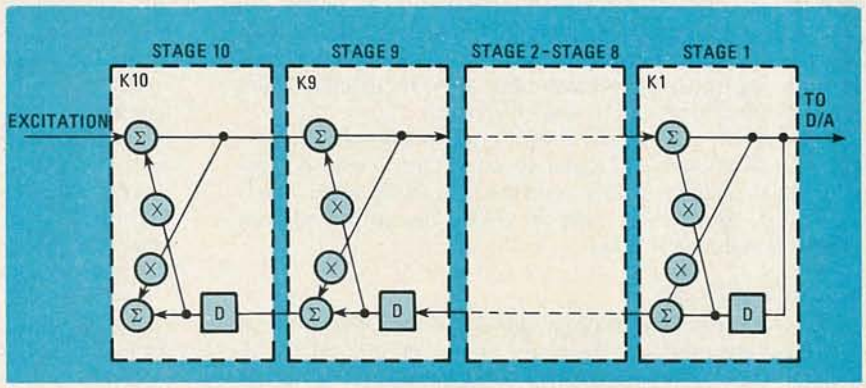

FIG. 5—TEN-STAGE LATTICE FILTER used in Texas Instruments' linear-predictive-coding synthesizer simulates the resonant effects of the mouth and nasal cavities.

Linear-predictive coding

Linear-predictive coding—used extensively by Texas Instruments (P.O. Box 225012, Dallas, TX 75265)—is a combination of techniques that model the vocal tract electronically. Noise and tonal sources generate signals that are processed by the LPC filter. The method derives its name from the fact that it predicts the parameters of the next speech sample using a linear combination of the proceding speech samples. That results in a major reduction in the amount of memory required for the storage of speech data.

Speech-synthesis techniques using that method require as few as three integrated circuits: a digital lattice-filter, a ROM, and a controller. Present systems are based on the 10-stage filter shown in Fig. 5; its output is set by pitch, amplitude, and filter coefficients.

The lattice-filter structure includes multiplication, summation, and delay blocks. Digital filters are constructed of memory-register delay components, and of summers and multipliers connected in either feedback or nonrecursive, direct path configurations. Multiplication takes longer than addition, so pipeline techniques are used to synchronize the filter's operation to the sampling rate of the system. The all-pole filter is described by the equation:

$$H_Z = \frac{G}{1 - \sum_{k=1}^{10} a_k z^{-k}}$$

The a_k terms are the ten filter-coefficients, G is a gain factor, and the z^{-k} terms represent time delays.

The voice-synthesis processor performs about 400,000 multiplications and additions each second. A frame (complete set of speech data) is supplied to it about every 25 milliseconds. Data from adjacent frames is interpolated about every 3 milliseconds to generate a smooth output. Once again a tradeoff is made among flexibility, fixed or variable vocabulary, speech quality, and cost-per-second of speech output.

A computer program is used to produce an optimal set of coefficients for the vocal tract filter, the 8-bit energy and pitch information, and to generate the one-bit repeat codes. A technician corrects any audible deficiencies.

Texas Instruments' TMS5100 speech-processing computer, which includes a 50-milliwatt power amplifier, is a key component in its speech-synthesis line. The TMS5220 is designed for easy 8-bit data bus interface. It is used in the *TI-99/4* home computer speech-synthesizer peripheral. Single-unit prices for the TMS5100 and TMS5220 are $32.00 and $48.00 respectively. **R-E**

BUILD THIS

SAFE SUB-WOOFER

A subwoofer allows your sound system to reproduce very-low bass, such as that found in organ recordings. This SAFE subwoofer may be small, but it's mighty where it counts.

GEORGE PAPPANIKOLAOU

IN THE DECEMBER 1981 ISSUE, **RADIO-ELECTRONICS** PUBLISHED plans for constructing a speaker that used the SAFE (*S*ymmetrical *A*ir *F*riction *E*nclosure) principle (U.S. patent no. 4,168,761, other patents pending) to obtain good sound from a small enclosure. This article deal with a companion subwoofer using the SAFE principle that provides extended bass response from a relatively small enclosure.

The heart of the system is an 8- or 10-inch speaker in a cabinet with a volume of under six cubic feet. It uses no special devices, such as passive radiators, to increase the effective size of the speaker, and the SAFE design provides an extremely rigid enclosure.

The SAFE principle

The SAFE principle is an outgrowth of the labyrinth-type enclosure invented by Benjamin Olney in the 1930's. A labyrinth-type enclosure is simply a long tube placed behind a speaker and into which the low-frequency back wave from the speaker is propagated. The length of the tube is used to provide "reflex action," causing the back wave to emerge from the tube in phase with the front wave. This boosts the low-frequency output of the system over a specific range of frequencies. The longer the effective length of the tube, the lower the frequencies that will be boosted.

The reason for using the term "effective length" is that friction between the air set in motion by the speaker and the internal surface of the labyrinth causes the velocity of the back wave to be decreased and making it take longer to pass through the tube than would be the case if there were no friction. The fact that it takes the sound wave longer to transverse the labyrinth than it normally would, makes it appear that the wave has traveled a longer path than it actually did.

Two methods commonly used to increase effective length of the labyrinth are to line its interior with acoustic padding such as fiberglass, or to completely fill it with the same material.

Many designs usually fold the tube (run it back and forth instead of in straight line) to keep the size of the enclosure

R-E TESTS IT

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

WE PUT AN EIGHT-INCH SAFE SUBwoofer through extensive listening tests in our laboratory and also subjected it to several measurements. We drove it using an amplifier rated at about 40-watts-per-channel and a passive crossover network.

Based on our sensitivity measurements, we would classify this speaker as being low-to-medium in efficiency (an electronic crossover would have helped). Nonetheless, we noted a fundamental output from the subwoofer down to 25 Hz. We measured relatively uniform response from the system from 30 Hz up to the 100-Hz cutoff frequency and were able to produce sound-pressure levels in excess of 100-dB SPL before any significant doubling or distortion was observed.

The unit was tested using both single-tone signals and musical material. In reproducing the music, the improvement in bass reproduction was apparent only when the program source contained a fair amount of low-bass energy. Not too many program sources do, but when you find one that *does*, the added impact of the low, low bass contributed by the subwoofer made the project decidedly worthwhile.

One word of caution. Trying to reproduce ultra-low bass in a small room can prove to be a frustrating experience. Standing waves set up in the room are responsible for that, and it is possible to move about the room and hear thunderous bass in one location while hearing virtually none in another spot, where virtually complete cancellation of bass frequencies takes place.

We used close-miking techniques in our sound-pressure measurements, placing the microphone both at the upper back-wave ports of the enclosure and at close proximity to the driver itself. Below 40 to 50 Hz, most of the energy, as might have been expected, came from the back-wave ports rather than from the front of the woofer. **R-E**

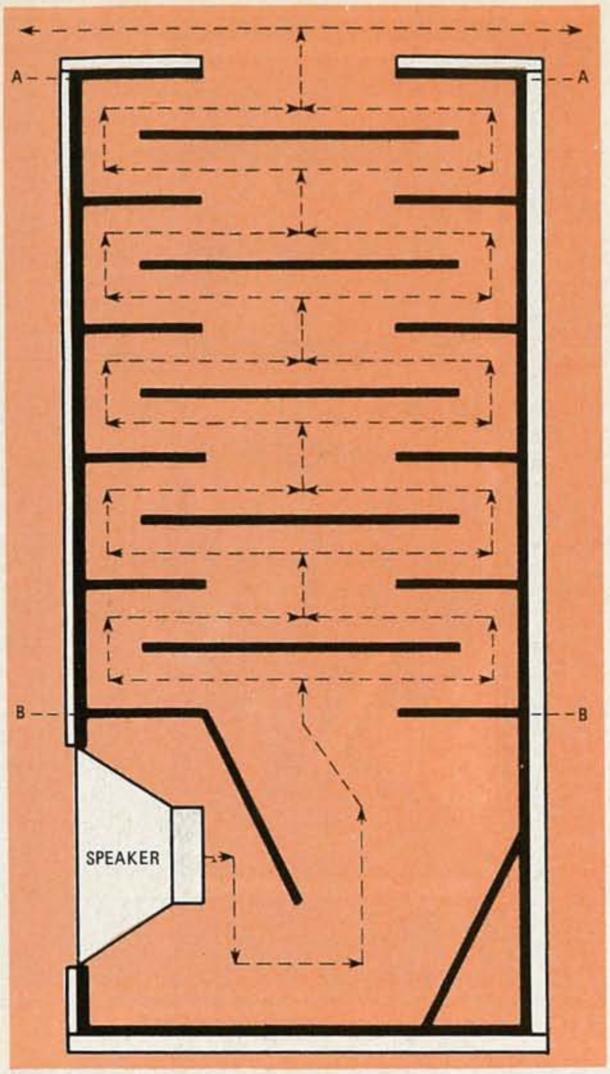

FIG. 1—SIDE VIEW OF SAFE ENCLOSURE showing speaker back-wave path. Path is symmetrical between points A and B.

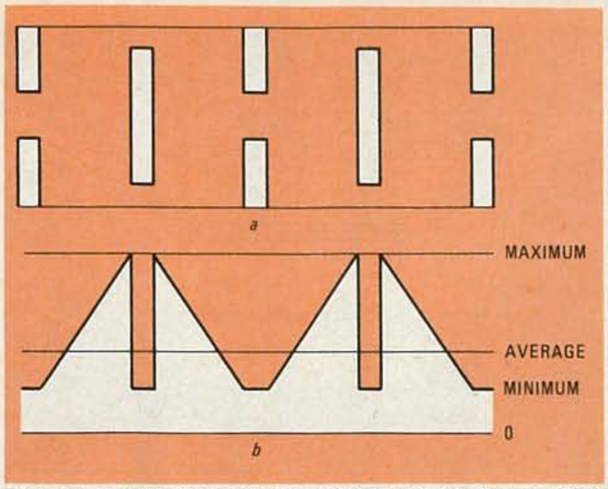

FIG. 3—PARTITIONS USED IN SAFE ENCLOSURE (*a*) affect its effective cross-sectional area (*b*).

down. Also, the effective length of the tube and the free-air resonance of the speaker are chosen so that the speaker is damped at its free-air-resonance frequency, avoiding objectionable excess output at that frequency.

There are, however, two other factors that can be used to increase air friction, and thereby the effective length of the labyrinth. These factors are what's involved in the SAFE principle. First, the internal surface area—not the length—of the tube can be increased; second, the back-wave path can be made longer by increasing the number of bends in it.

A SAFE enclosure uses a number of small chambers in series (see Fig. 1) to both increase the internal surface-area and to insert more bends in the path of the speaker back-wave. The small chambers are constructed by alternating two types of partitions within the tube as shown in Fig. 2. The first type completely blocks the tube, except for a square hole in its center. The second is smaller and is centered so that the area between it and the inside perimeter of the tube is equal to that of the hole in the first type. This forces the back-wave from the speaker to be alternately spread out and combined as it passes through the tube. (It is obvious that this design increases the internal surface-area of the tube and

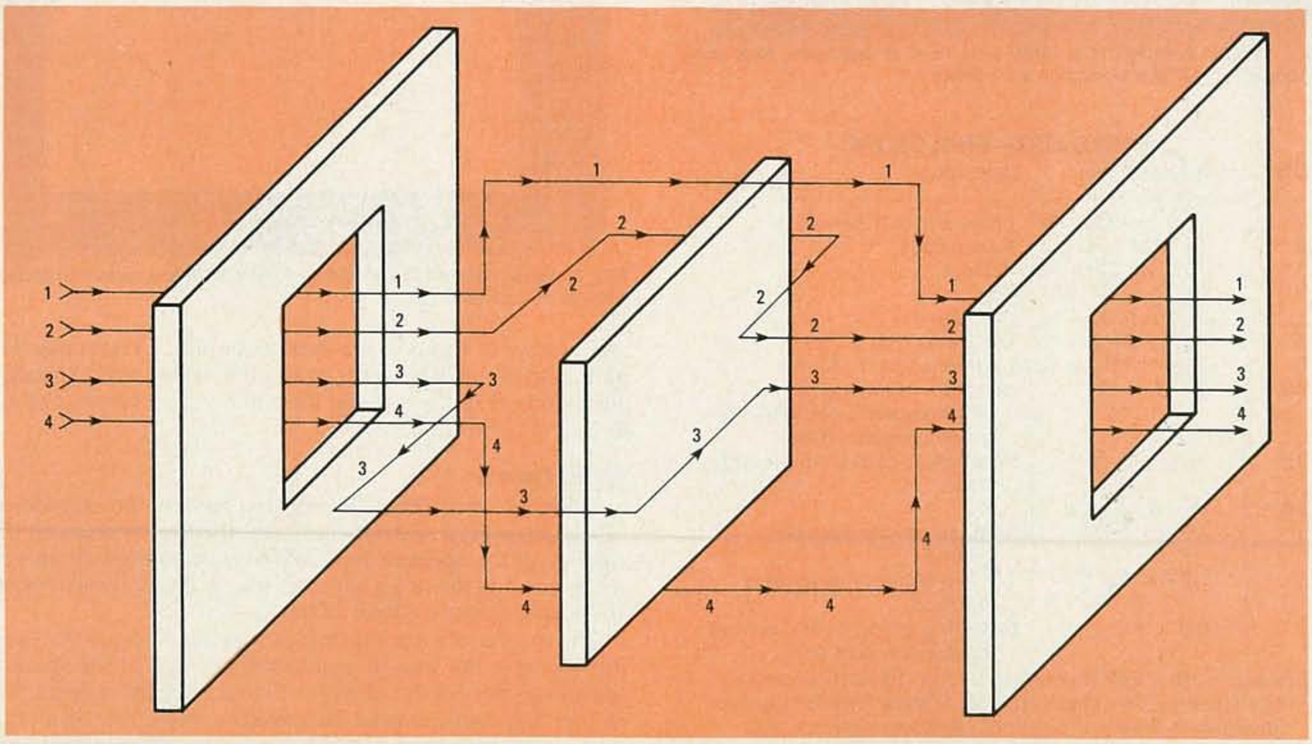

FIG. 2—SPEAKER BACK-WAVE is alternately combined and separated as it passes through and around SAFE enclosure's baffles.

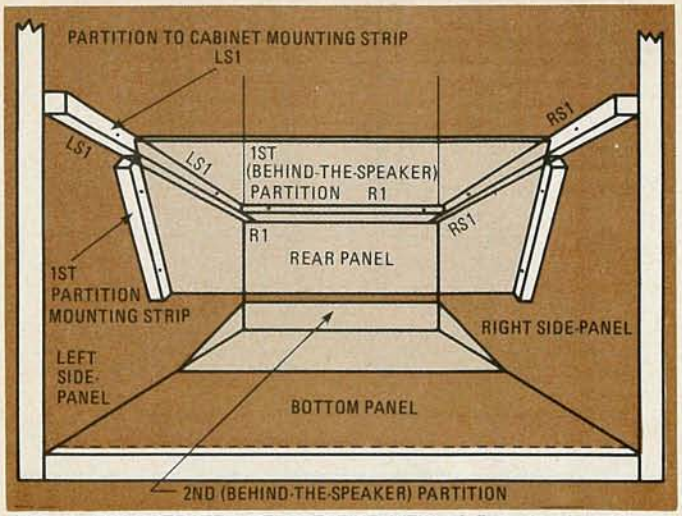

FIG. 4—EXAGGERATED PERSPECTIVE VIEW of first chamber. Note mountings of first and second behind-the-speaker partitions.

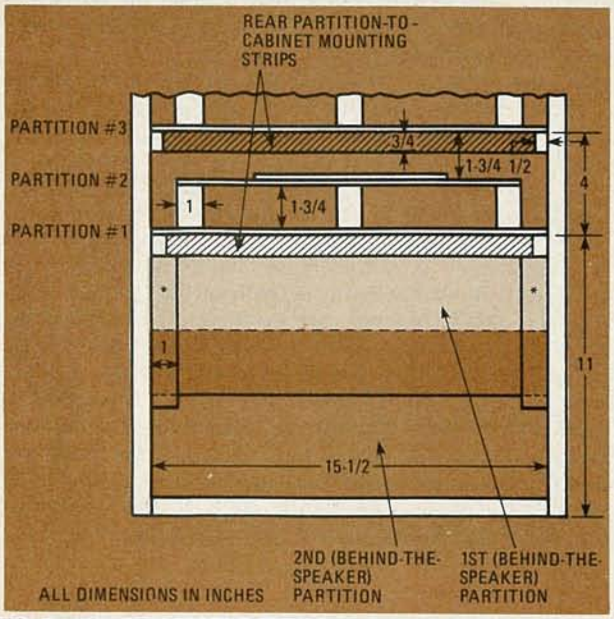

FIG. 5—NON-PERSPECTIVE VIEW from front of enclosure. Note construction of partition 1/partition 2 assembly.

PARTS LIST—ENCLOSURE

Qty.	Size (inches)	Description
2	15½ × 15½ × ¾	Front and rear panels
2	17 × 34 × ¾	Side panels
1	15½ × 15½ × ¾	Bottom
1	15½ × 17 × ¾	Top
1	15½ × 15½ × ½	Partition 11
5	15½ × 15½ × ¼	Partitions 1, 3, 5, 7, 9
5	13½ × 13½ × ¼	Partitions 2, 4, 6, 8, 10
40	1 × 1 × 1¾	Strips for mounting odd-numbered partitions to even-numbered ones
12	½ × ¾ × 15½	Partition-to-cabinet mounting strips
12	½ × ¾ × 14½	"
1	15½ × 7 × ¼	First behind-the-speaker partition
1	15½ × 8 × ¼	Second behind-the-speaker partition
2	6½ × 1 × 1	Mounting strips for first behind-the-speaker partition

Speaker—JBL *LE8T* (8-inch) or *LE10A* (10-inch) or similar
Miscellaneous: Two binding posts, screws, hot-melt glue and glue gun, acoustic insulation, crossover network, etc.

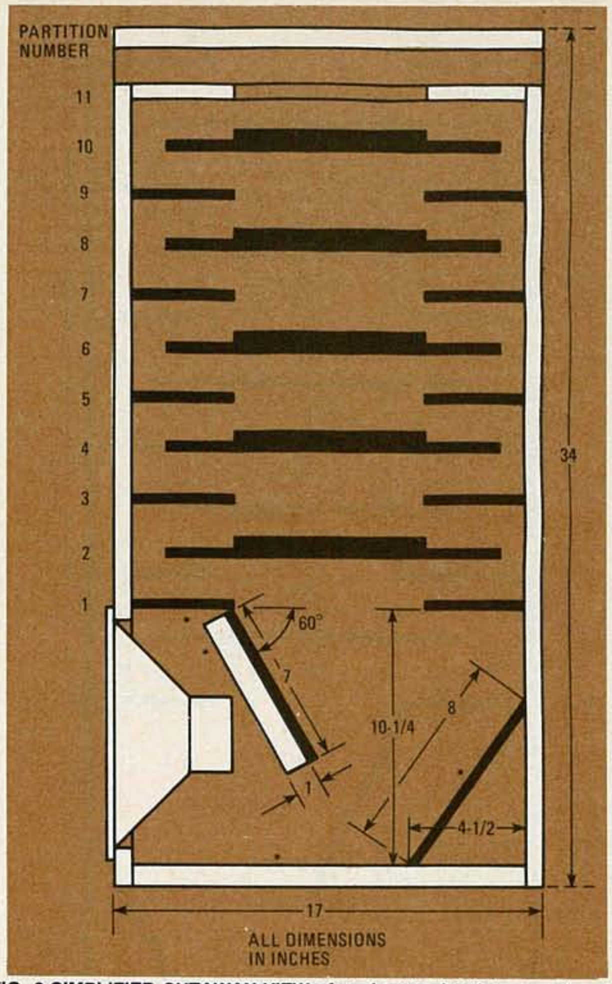

FIG. 6-SIMPLIFIED CUTAWAY VIEW of enclosure showing mounting details of first and second behind-the-speaker partitions.

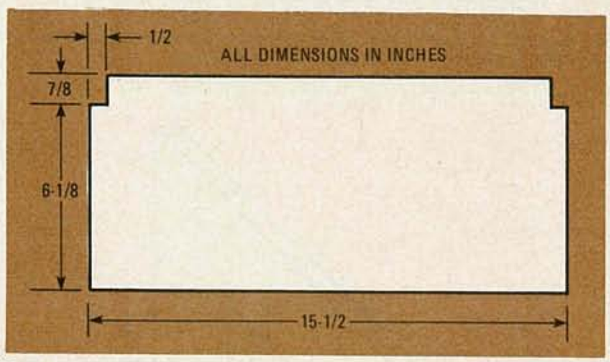

FIG. 7—FIRST BEHIND-THE-SPEAKER PARTITION has cutouts to accommodate mounting strips.

the number of bends in the back-wave path.) Traversing this path causes the back-wave to be compressed and expanded alternately (Fig. 3), slowing the wave and increasing the effective length of the tube.

Other factors

There are two other factors that have to be considered when designing a speaker enclosure: the free-air resonant frequency of the speaker used, which limits the low-frequency response, and the reflex action of the enclosure, which boosts the low-frequency output of the system.

The two factors are interrelated and an enclosure that does not increase the free-air resonant-frequency of the speaker (desirable) but doesn't provide any reflex action (undesirable), or one that does increase the speaker's free-air resonant frequency (undesirable) but does provide reflex action (de-

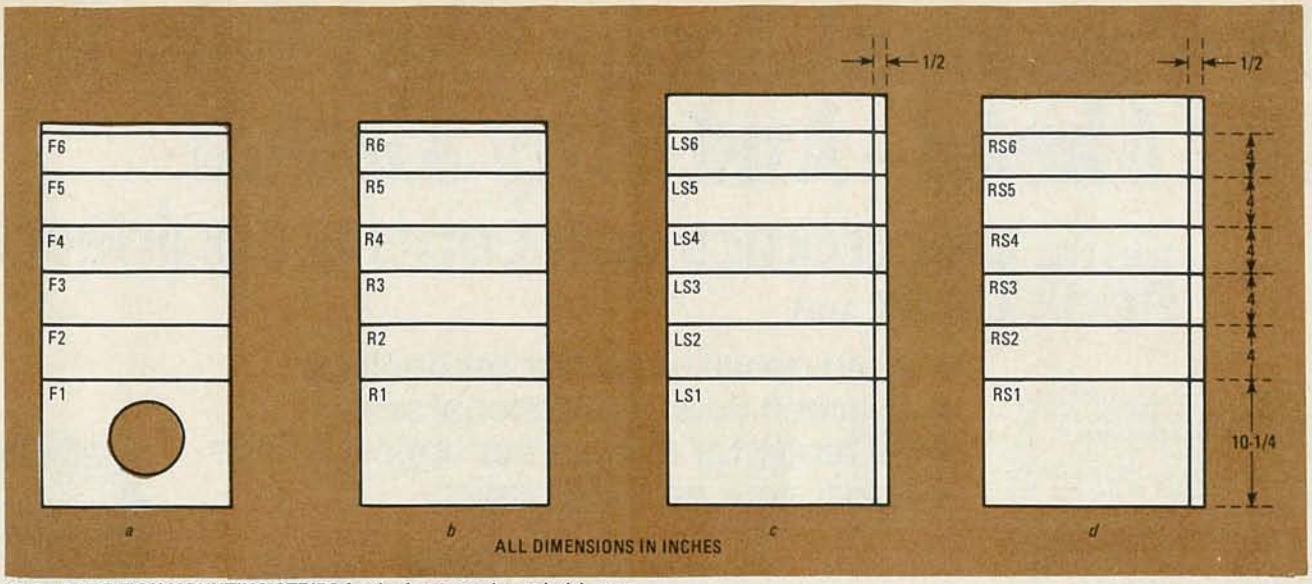

FIG. 8—PARTITION MOUNTING STRIPS for the front are shown in (*a*), rear are shown in (*b*), left side are shown in (c) and right side are shown in (*d*).

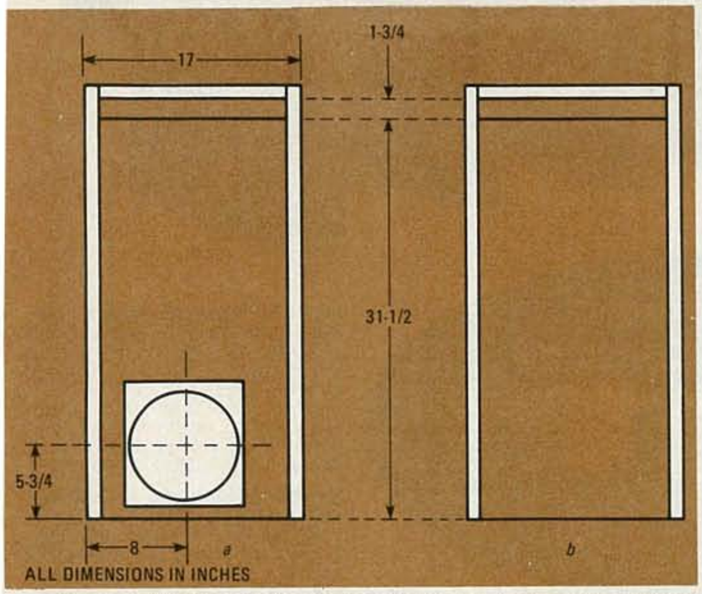

FIG. 9—SPEAKER SHOULD BE MOUNTED slightly off-center to prevent standing waves. Center figure shows distance between partition 1 and top of enclosure.

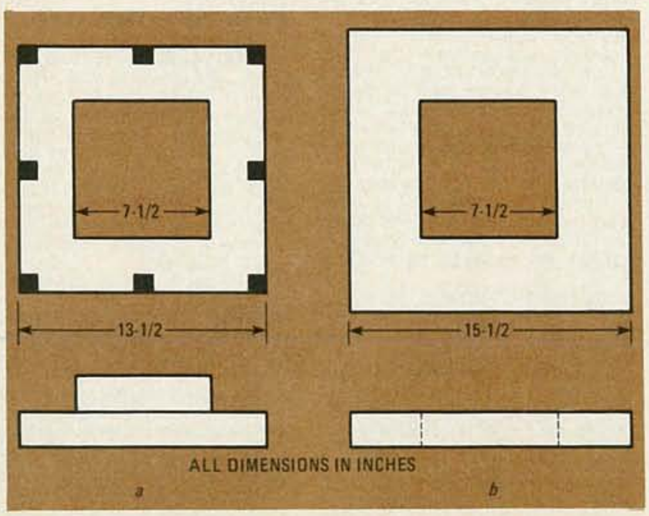

FIG. 10—EVEN-NUMBERED PARTITIONS (*a*) have "top hat" structure caused by using center piece cut out of odd-numbered partitions.

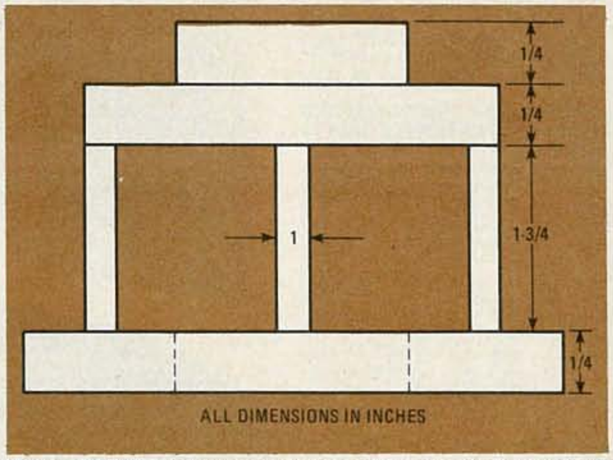

FIG. 11—SIDE VIEW of even-numbered partition mounted atop odd-numbered partition using partition mounting strips. Each strip is located as shown in Fig. 10 and measures 1 × 1 × 1¾ inches.

sirable), is not as effective as one that provides reflex action *and* does not increase the speaker's free-air resonance.

The SAFE subwoofer enclosure is designed so that it does not significantly restrict the action of an 8-inch speaker (which would increase its free-air resonant frequency) while providing good reflex action. A 10-inch speaker can also be used. A 10-inch speaker would offer the advantage of increased power-handling capacity and, perhaps, better efficiency.

Construction

The choice of a speaker is not critical. Almost any 8- or 10-inch open-frame woofer will do; an 8-inch unit should have a ceramic magnet weighing about 20 ounces. JBL's *LE8T* is a good choice for an 8-inch system; the same firm's *LE10A* should do nicely in a 10-inch one.

While detailed step-by-step instructions will not be provided, the figures and the captions accompanying them should be studied closely: they will allow you to construct the enclosure with little difficulty. (The only tricky part—the area behind the speaker—will be explained below.)

Like all subwoofers, the SAFE enclosure should be constructed from solid, heavy material, such as ¾-inch particle board, to prevent cabinet vibrations that will decrease the output of the system. The partitions can be made from ¼-inch plywood, with the exception of partition 11, which should be ½-inch thick.

Use plenty of screws and glue! The former will add mechanical integrity and the latter will make the enclosure

continued on page 106

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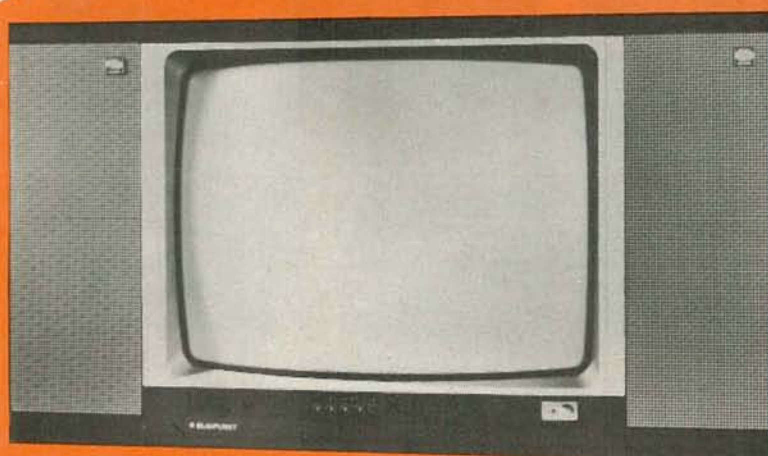
STEREO AUDIO FOR TV

Stereo and multichannel TV programming is already a reality in several countries. Here's the latest on what's happening here.

LEN FELDMAN
CONTRIBUTING EDITOR



BY THE TIME YOU READ THIS, ALL THE tests should have been completed. Even the report prepared by the Electronic Industries Association's Broadcast Transmission Standards (BTS) Committee may already be in the hands of the FCC, and we will be a step closer to having stereo audio for television broadcasts in the U.S. And, with two (or more) audio channels available, not only will stereo be able to be broadcast, but the second channel can also be used for the transmission of a second monophonic program—perhaps a soundtrack or commentary in a second language, for viewers whose native tongue is not English.

No matter how soon a multichannel audio system is adopted for U.S. TV, and no matter which system is chosen, the U.S. will still be a late starter in adopting stereo for TV. In Japan, that type of service has been available since 1978. In fact, of the three basic systems being proposed for use in the United States, one is the Japanese system that was developed and tested over a period of four years by the Technical Research Laboratories of NHK, the Japanese Broadcasting Corporation.

The two other systems currently being considered for use in this country are by Telesonics Systems, Inc. and by the Zenith Radio Corporation. The Japanese system under consideration is officially known in this country as the EIAJ system, since it is being sponsored in the U.S. by the Electronic Industries Association of Japan. Finally, a fourth system, developed—and just being introduced—in Germany, may have some influence on what method is finally adopted. (That system will be discussed in detail soon in a future issue of **Radio-Electronics**).

Further complicating the decision-making process is the fact that, in addition to the three basic transmission-systems just referred to, there are also three noise-reduction systems being proposed for use with them, making a total of nine possible combinations. The incorporation of more audio channels in the bandwidth now assigned to a single TV audio channel will degrade the audio signal-to-noise ratio, regardless of which of the three stereo systems is selected. That is what has prompted Dolby, dbx, and most recently, CBS, to propose noise-reduction encoding/decoding systems. Those, coupled with any of the proposed multichannel TV-audio systems, would reduce background noise to acceptable levels and allow broadcasters to maintain the quality of fringe-area signals.

Since multichannel TV-audio will eventually be with us, it would be a good idea to understand how the three basic transmission-systems that have been proposed work. The principles involved in audio companding are familiar to most readers of **Radio-Electronics** so we will not include a description of the three noise-reduction schemes in this discussion.

The EIAJ system

The components of the signal used by the Japanese system are shown in Fig. 1. Note that the "x" axis (horizontal) serves two purposes—it shows both the audio-frequency response of each channel and the frequency of the

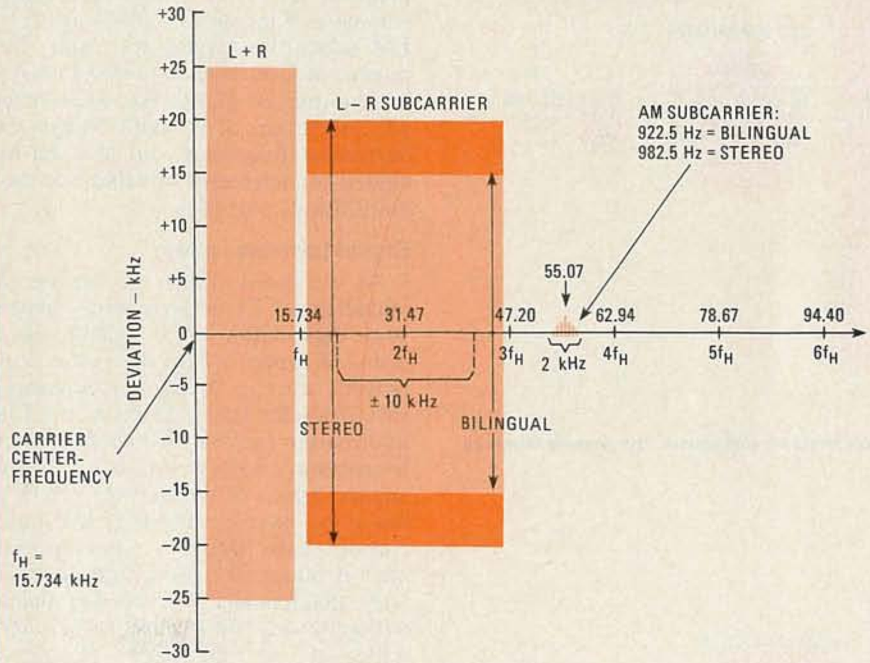


FIG. 1—ORIGINAL EIAJ SYSTEM uses a subcarrier with a deviation of ±10 kHz to transmit the L-R or second-channel audio information. Maximum frequency-response is 12 kHz.

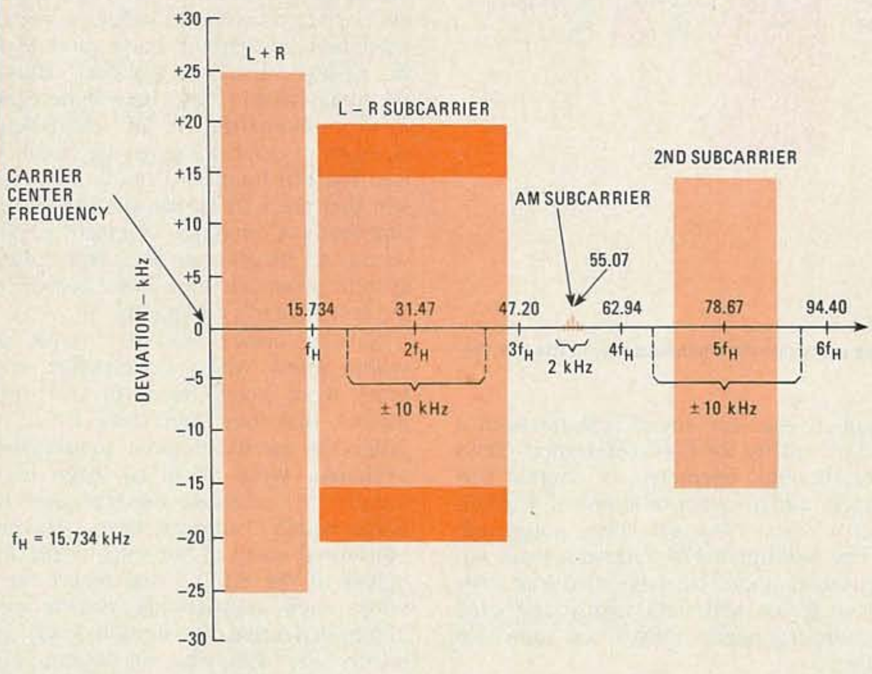


FIG. 2—U.S. VERSION of the EIAJ system extends frequency-response of the subcarrier to 15 kHz. In addition, a second subcarrier, with an 8-kHz bandwidth, is provided for.

subcarrier and pilot tone *relative* to that of the main audio carrier. The "y" axis (vertical) shows the frequency deviations of the main and sub-carriers.

The main audio carrier—used for monophonic transmissions, for one channel of multichannel transmissions, or for the L+R component of a stereo transmission—has a maximum deviation of ±25 kHz (just like the NTSC system used in the U.S.) and a frequency response from 50 Hz to 15 kHz.

The subcarrier, located at a frequency of 31.47 kHz (twice the TV horizontal line-frequency) above the main carrier, is used for the second channel of a multichannel transmission, or for the L-R component of a stereo transmission. That frequency was chosen because it minimizes interference between the video signal and the subcarrier in intercarrier-type receivers. When frequency-modulated, the subcarrier has a maximum deviation of 10 kHz on either side of the center frequency. In Japan, the frequency response of that channel is from 50 to about 12 kHz, but the system has been modified for use in the U.S. to extend the response to 15 kHz.

The subcarrier is used to modulate the main carrier—a technique known as *injection*. When stereo is being transmitted, the amount of injection is ±20 kHz, giving the main carrier a total deviation of ±45 kHz; in the multichannel mode, the amount of injection is ±15 kHz, producing a total deviation of ±40 kHz.

An amplitude-modulated control signal having a bandwidth of 2 kHz is transmitted at a frequency 55.07 kHz (3½ times the horizontal line-frequency) above the main carrier. Its purpose is to inform the decoding equipment at the receiver which mode is being used. A 982.5-Hz tone indicates that a stereo program is being transmitted; a 922.5-Hz tone indicates that a multichannel program is being broadcast. The absence of a tone means that the program material is monophonic. The control signal can also be used to activate a visual indicator to inform viewers/listeners which audio mode was being used with the video they were watching.

Tests made by the developers of the Japanese TV multiplex-system have shown that a *second* subcarrier can be added without making it necessary to change the parameters of the first subcarrier. In tests conducted by the EIA last summer in Chicago, such a system—as shown in Fig. 2—was used. The characteristics of the second subcarrier were the same as those of the first, with the exception that the audio-frequency response was restricted to an upper limit of 8 kHz. It is expected that that subcarrier would be used for services where limited frequency-response would not pose a problem.

The Telesonics system

The Telesonics system, whose arrangement is shown in Fig. 3, uses a double-sideband, suppressed-carrier, AM subcarrier similar to that used in stereo-FM broadcasting in the United

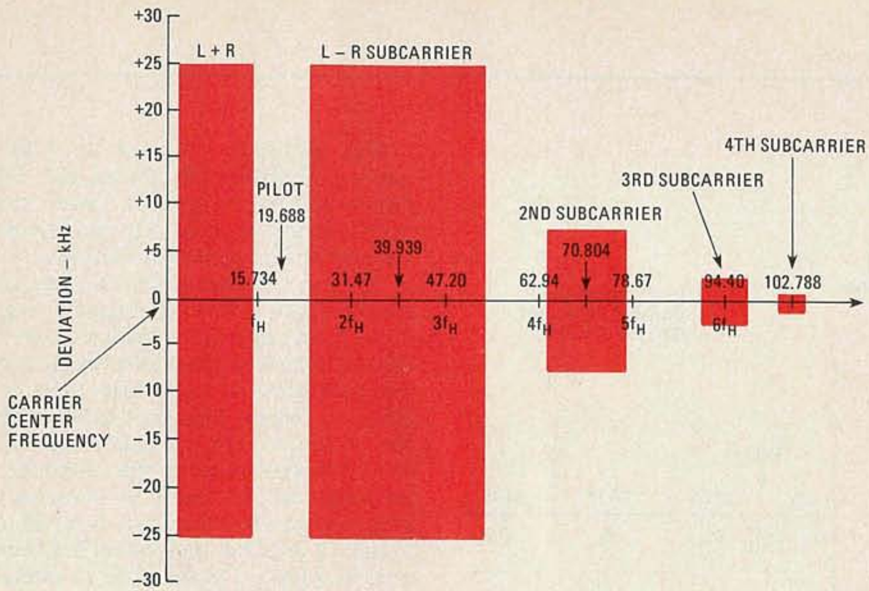


FIG. 3—TELESONICS SYSTEM uses amplitude modulation for its subcarriers. The scheme allows as many as four subcarriers.

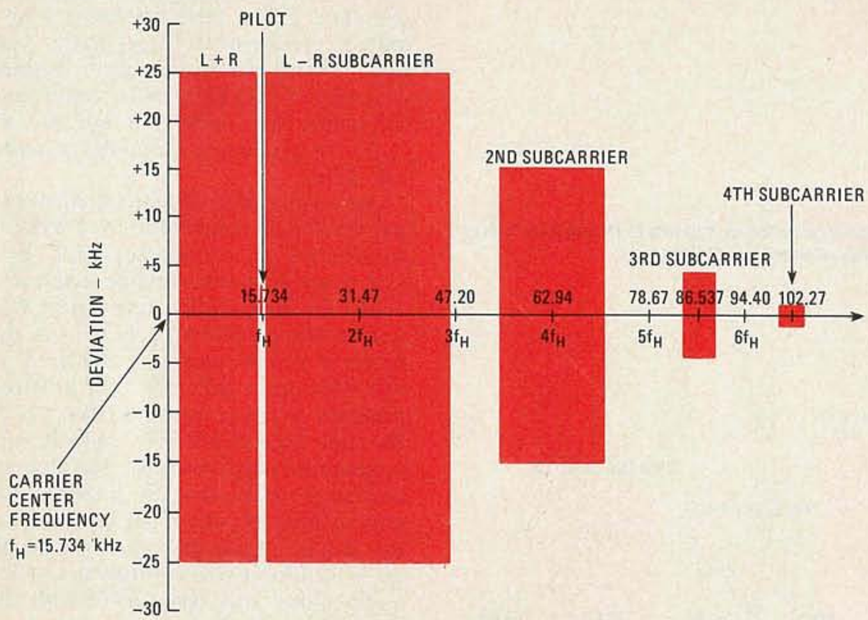


FIG. 4—ZENITH RADIO CORPORATION'S system uses the horizontal line-frequency, 15.734 kHz, for the pilot tone.

States and many other countries. (The EIAJ system, with the exception of the control signal, is all-FM.) Such an arrangement requires a pilot signal, which is used at the receiving end to restore the suppressed carrier. In the Telesonics system, the pilot signal has a frequency of 19.668 kHz, or 1.25 times the TV horizontal line-frequency. The double-sideband suppressed-carrier used for transmission of L-R information is 39.939 kHz, or 2.5 times the horizontal line-frequency, away from the audio carrier center-frequency. Tests of the system have been proposed using three different levels of deviation of the main carrier by the subcarrier: 11.25 kHz, 25 kHz, and 33.75 kHz. Tests using additional FM subcarriers at other frequencies, in order to provide a second subchannel for sound transmission; a third carrier for ENG (*E*lectronic *N*ews *G*athering), telemetry, or another service, and a fourth subcarrier for telemetry alone have also been suggested. The additional FM subcarriers are impressed upon the main carrier at very low levels and with highly restricted audio-frequency ranges, as shown in Fig. 3.

The Zenith Radio system

Frequency allocations and subcarrier arrangements used in the Zenith Radio Corporation system are shown in Fig. 4. Like the Telesonics system, the Zenith system also uses a double-sideband, suppressed-carrier AM subcarrier. Instead of using a separate pilot signal, the Zenith system uses the horizontal line-frequency itself for that purpose, with the center frequency of the suppressed subcarrier falling at twice the horizontal line-frequency, or 31.47 kHz. Provision for a separate audio program (such as a second-language summary of the news) is made using an FM subcarrier having its center frequency at four times the video horizontal-line rate, or 62.94 kHz, while other FM subcarriers at 5.5 and 6.5 times the horizontal frequency can also be included for telemetry or other telecommunications purposes.

Signal-to-noise ratios

As we noted earlier, all the stereo/multichannel TV-audio systems involve some degradation of the signal-to-noise ratio. In Japan, where the system employed uses a frequency-modulated subcarrier for transmission of the L-R information (or the second-channel information), results at station JOAX (the anchor station of the national network, based in Tokyo), using an 85 kW audio carrier, show that the signal-to-noise ratio is about 60 dB on both the main and sub-channels at receiving points within the city, fairly close to the transmitter site. In fringe areas, of course, that figure would be worse.

Experiments have already shown that the systems using AM subcarriers (Telesonics and Zenith, so far) for their difference (L-R) information or second-channel transmissions suffer a greater reduction in signal-to-noise ratio than do all-FM subcarrier systems. That's especially true in fringe areas, where the main audio-carrier is of insufficient strength to send the receiving circuitry into full FM-limiting. It is for that reason that the EIA Broadcast Television Standards Committee deemed it advisable to incorporate the companding system proposals mentioned earlier in the test recently completed.

Several critical listeners, none of whom knew which companding systems were being used (or, for that matter, that they were being asked to judge the merits of three companding systems), were asked to listen to a variety of recorded material and to judge which "sounded best." Having monitored some of the tests myself on behalf of the EIA, I can report that, while each companding system was judged effective for certain kinds of music, the difference in background noise between *all* the uncompanded transmissions and those using noise reduction was obvious, regardless of which system was used for the test. That was particularly true when "fringe area" reception conditions were simulated.

Audio enthusiasts have complained for many years about the poor quality

continued on page 102

Inside Dolby HX

Designed to provide the ideal cassette tape bias level for signals at any frequency, this new version of the Dolby HX *system overcomes the problems of the original and adds some interesting refinements.*

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

JUST ABOUT TWO AND A HALF YEARS ago, Dr. Ray Dolby, of Dolby Laboratories, introduced a new signal-processing scheme that he called *Dolby HX;* the HX stood for "headroom expansion." That circuit was Dolby Laboratories' first attempt at signal processing that had nothing to do (at least directly) with noise reduction. While Dolby noise reduction has been very widely accepted by tape-deck manufacturers, the *Dolby HX* system was not greeted with the same sort of enthusiasm.

At least one manufacturer, however, must have been fascinated by the ideas behind *Dolby HX*—enough so to have developed a version of the headroom-expansion idea that overcomes earlier objections to the HX approach, and provides benefits that were not part of Dolby's original system. That manufacturer is the Danish firm of Bang & Olufsen, and, with the unqualified blessing of Dolby, their version is called *Dolby HX Professional.*

In order to appreciate the improvements in this new version of *Dolby HX*, it will be helpful to review the concepts behind Dolby's original version of the headroom-expansion system. The underlying concept is based on the fact that there is an ideal level of tape bias for every audio frequency. As can be seen in Fig. 1, the bias level that provides the highest output level and acceptably low distortion levels for a mid-frequency tone of 333 Hz is quite different from the optimum bias level needed when recording a 10-kHz signal. Figure 1 also shows that as we attempt to record higher and higher frequencies, lower and lower levels of bias are required. Generally, most makers of cassette decks choose a bias level that, of necessity, is a compromise—one that covers reasonably well as much of the audio range as possible. Usually, that bias level is set so that it is a bit lower than optimum for best low-frequency/mid-frequency maximum output level (MOL), and for a reasonable output level at high frequencies. Since such compromise settings of bias tend to favor low and mid frequencies, the phenomenon known as high-frequency tape saturation is common in cassette decks.

The earliest version of *Dolby HX* worked on the assumption that, if the bias level of a recorder is made variable and allowed to change dynamically with changing input-signal content, it should become practical to record high-frequency signals at higher levels by reducing the bias levels when high-level, high-frequency signals dominate the program content being recorded. Furthermore, since the headroom expansion takes place entirely during the recording process, no "decoding" or correction circuitry is needed during playback to get the benefits of such a variable bias system.

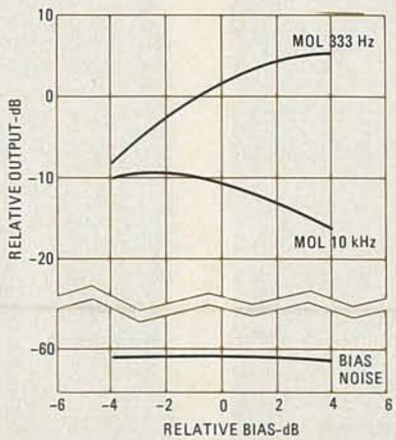


FIG. 1—THE BIAS LEVEL that provides the highest output with acceptably low distortion for a 333-kHz tone is quite different than the bias level required by a 10-kHz tone.

A block diagram of the original system is shown in Fig. 2. For the system to work, there must be a control signal that is sensitive to amplitude and frequency content. But such a control signal already exists in any *Dolby B*-equipped deck. All *Dolby B* noise-reduction circuits generate a voltage signal that depends on the strength and frequency content of the stronger of the two input channels. That voltage is used to control the amplifiers in the *Dolby B* noise-reduction circuits.

But, while the *Dolby B* control signal may be ideal for noise-reduction companding, it is less than ideal for bias level control. In *Dolby B*, the control signal is derived without regard to the recording pre-emphasis curve. That curve shapes the frequency response of the signal that, after processing for noise reduction, reaches the recording head. As the bias level changes, the frequency response of the system also changes. The problem of varying frequency response during recording was dealt with in the original *Dolby HX* system by allowing the control signal to alter pre-emphasis at the same time that it alters bias. If everything was adjusted perfectly, the bias and pre-emphasis changes were supposed to balance each other out to provide the flat response and expanded headroom for which the system was designed.

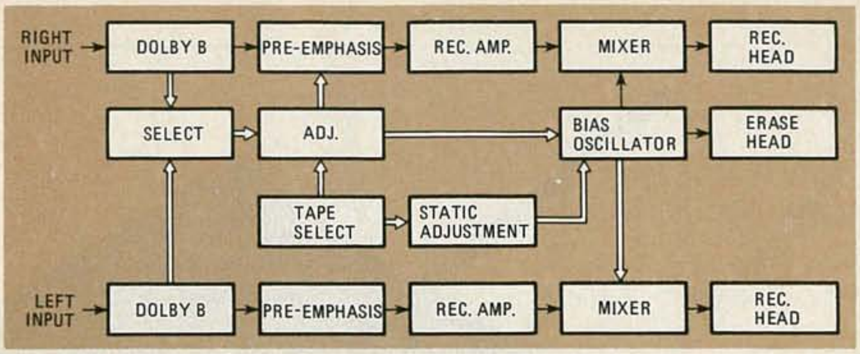


FIG. 2—THE ORIGINAL *DOLBY HX* system is shown in this block diagram. For the system to work, a control signal that is sensitive to amplitude and frequency content is required.

Self biasing and mutual biasing

While studying how *Dolby HX* works, and the dynamics of magnetic recording in general, the engineers at Bang & Olufsen noted two phenomena. They noted that any signal fed to a recording head acts as bias for the signal to be recorded, with high-frequency signals being more effective as a bias than low-frequency signals. A signal even acts as a bias for itself (self-biasing), though that effect is quite small for audio signals. Nevertheless, self bias may be a small part of the reason why high-frequency signals require a much lower bias setting than low-frequency signals.

Much more important, however, is the biasing effect of the high-frequency content of an audio signal on the low-frequency part of the same signal. While that effect is only a small part of the total bias applied to the recording head, it is enough to alter the bias conditions for low frequencies. That is shown dramatically in Figs. 3 and 4.

Figure 3 is a spectrum analysis of a single 300-Hz tone, recorded at a level of 250 nanowebers-per-meter (nWb/m). That is about 2 dB above the Dolby calibration level—not an exceptionally high level. The bias on the recorder used was adjusted to a conventional level: slightly below optimum for the best low-frequency MOL. The tall spike at the left is the 300-Hz signal. The spike at around 900 Hz is the third-order distortion component and its level is about 46 dB below that of the 300-Hz signal, which corresponds to a third-order harmonic distortion level of 1.58%. Those are not unusual values for a good-quality cassette recorder. (In Figs. 3 and 4, each vertical division is 10 dB, while the horizontal scale is logarithmic and runs from 20 Hz at the left to 20 kHz at the right; key frequency points are shown at the top of the scope display).

In Fig. 4, the 300-Hz signal has been kept at the same input level, but a pair of tones with frequencies of 9 and 10 kHz have been mixed into the signal at a level some 50 dB below that of the lower-frequency signal. You'll note that there is a dramatic reduction in third-order distortion of around 6 dB, while the recorded level of the 300-Hz signal actually rises about 2 dB. The net third-order distortion is now 8 dB lower than before (relative to the 300-Hz fundamental), or 0.63%. Both the reduced third-order distortion and the increased level of the recorded signal are caused by the additional biasing effect of the high-frequency signals; that additional biasing has raised the total *effective* bias level for the low-frequency signal to near its optimum value. The biasing of one part of an audio signal that is being recorded by another part of the same signal can be called mutual biasing.

It follows that the flat frequency-response obtained under static test conditions (using a single-tone test signal) may not be so flat when complex musical signals are recorded on tape. When such musical signals are recorded on a machine with fixed bias, the frequency response changes continuously due to mutual biasing, depending upon the instantaneous high-frequency content of the overall signal. Such dynamic changes in frequency response are present not only in cassette recorders, but in any tape recorder using high-frequency bias, such as studio tape decks and high-speed duplicating machines used to produce prerecorded tapes.

Dolby HX Professional

Dolby HX Professional was developed jointly by Bang & Olufsen and Dolby Laboratories. Although the principles of *Dolby HX* and *Dolby HX Professional* are similar, the aims of the two systems are different. In *Dolby HX*, the chief aim was to allow high-frequency signals to be recorded at higher levels on cassette tape. *Dolby HX Professional* has the more fundamental aim of keeping the active or effective bias constant, regardless of signal content. Active bias is defined here as the effective bias seen by each frequency in the audio spectrum. In keeping the active

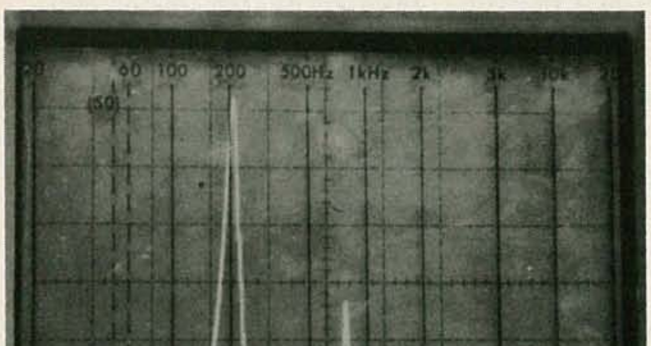


FIG. 3—SPECTRUM ANALYSIS of a single 300-Hz tone recorded at a level of 250 nanowebers-per-meter.

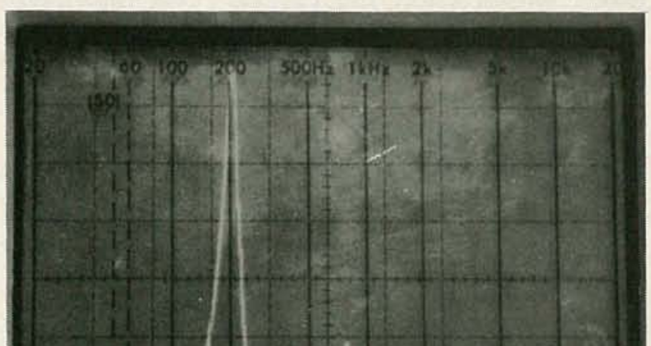


FIG. 4—MUTUAL BIASING is demonstrated here. Two low-level, higher-frequency (9 and 10 kHz) tones were mixed with the 300-Hz tone.

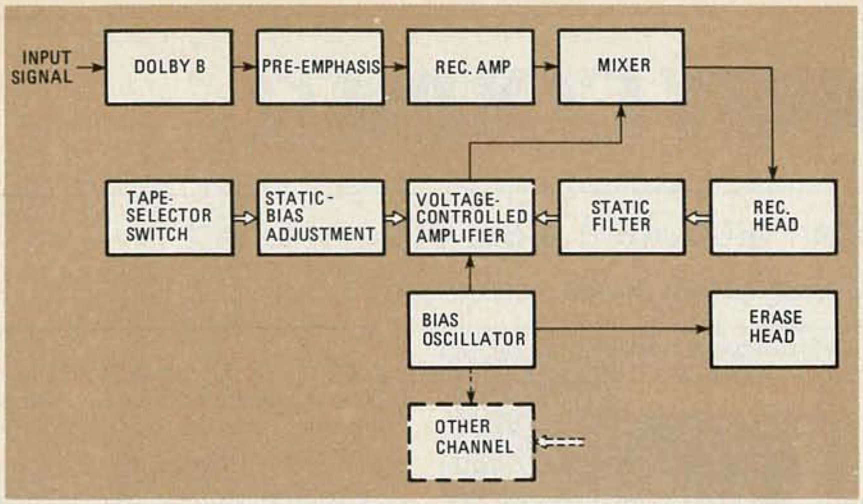


FIG. 5—BLOCK DIAGRAM of the *Dolby HX Professional* system. Unlike *Dolby HX*, this system measures the sum of the audio signal, including any preprocessing, and the bias at the record head.

bias constant, all of the recording parameters that would normally be affected by a change in bias under static conditions, will remain stable under the dynamic conditions that prevail during the recording of more complex music signals. For example, the frequency-response changes shown in Fig. 4, which were caused by mutual biasing, would not occur if active bias were kept constant for all audio frequencies.

Dolby HX Professional and *Dolby HX* are similar to the extent that both systems change the level of the bias signal dynamically, but the reason for doing it and the method used are different. As things worked out, all of the original aims of *Dolby HX* are fulfilled by *Dolby HX Professional,* but that is a secondary benefit of the latter system. *Dolby HX Professional* has other advantages over *Dolby HX*. It is a dedicated system: one that is completely independent of Dolby noise-reduction modules or other electronic circuits within the recorder. (Remember, the original *Dolby HX* system uses the same control voltage that was developed by the *Dolby B* noise-reduction circuits.) That makes the system suitable for professional applications, such as in studio recorders, as well as for use in high-quality cassette decks.

Figure 5 is a block diagram which shows how *Dolby HX Professional* works. Unlike *Dolby HX,* which only measures the audio signal to determine the bias compensation required, *Dolby HX Professional* measures the sum of the audio signal, including any preprocessing, and the bias at the tape head. The signal from the recording head is fed to a processing circuit consisting of an accurately designed static filter. Once that filter has modified the signal, the signal is rectified to form a control voltage that is an accurate replica of the *total* biasing effect of the processed audio signal, *plus* the bias at the recording head, or the "active bias." By measuring those signal components at the recording head, the system insures that the control voltage is always an accurate representation of the flux across the air gap in the recording head, regardless of signal strength or of any signal processing that may have taken place in previous stages. All processes and signals are carefully accounted for when the control voltage for bias compensation is derived from *Dolby HX Professional*. The control voltage is compared with a reference voltage that is adjusted for the static bias needed for the particular type and brand of tape being used, and a correction signal is generated. That signal is used to adjust a voltage-controlled amplifier that in turn alters the amplitude of the bias voltage supplied to the recording head. That maintains a constant active bias for the signal recorded. Once the circuit is correctly designed and installed, there is no need for any further adjustments for any tape or any signal-processing circuitry. Furthermore, since effective bias remains constant, no changes in pre-emphasis with changing bias are required; with *Dolby HX,* such changes in pre-emphasis were needed. *Dolby HX Professional* can be used with any noise-reduction circuitry currently available, or, for that matter, no noise-reduction circuitry at all.

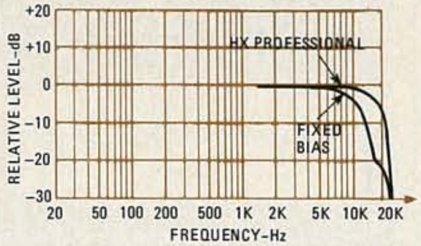


FIG. 6—HIGH-FREQUENCY CAPABILITIES of a cassette recorder equipped with *Dolby HX Professional* versus a conventional machine of the same quality.

If an audio signal having only low frequencies is fed to a recorder equipped with *Dolby HX Professional,* the circuit will "recognize" that fact and the bias level will remain fixed; since there are no high frequencies present in the signal, no bias-level change is required. If high frequencies are added, the *Dolby HX Professional* circuitry reduces the bias signal from the bias oscillator. The amount of reduction is determined by the passive filter, which monitors the entire signal applied to the tape head. That reduction in bias level will be almost exactly equal to the mutual biasing caused by the high frequencies. Thus, low frequencies see a constant bias level, but bias is reduced for high frequencies since they receive no added bias from the audio signal; low frequencies and high frequencies both see their optimum bias levels.

Should the signal consist of high frequencies only, the *Dolby HX Professional* circuit will reduce the bias from the oscillator even more; to a level that is very close to ideal for that type of signal. In that way, the original purpose of *Dolby HX*—namely, substantially increased headroom for high-frequencies —is also a characteristic of *Dolby HX Professional*. With *Dolby HX Professional,* the bias setting is adjusted to give the lowest possible distortion at low- and mid-frequencies, and the best MOL—compromises are no longer required.

Figure 6 shows the difference in high-frequency capability between a fixed-bias machine and one with *Dolby HX Professional*. The machine equipped with *Dolby HX Professional* delivered an output that was attenuated only 1.4 dB with respect to our 0-dB reference (250 nWb/m) at 13.5 kHz. A conventional machine of equal quality, on the other hand, delivered an output that was attenuated 8.6 dB at the same 13.5 kHz frequency, or fully 7.2 dB poorer response at that relatively high frequency. The same type of tape was used in both machines.

Dolby HX Professional includes another refinement. It functions totally independently on each of the two stereo channels of a tape deck. That means that bias for each channel is always optimally adjusted for the signal being applied to *that channel,* even though the signal applied to the other channel may have a completely different content, requiring a totally different bias level.

At the moment, Bang & Olufsen is the only company making use of that refinement of the *Dolby HX* circuit. The new circuitry appears in their *Beocord Model 8002* cassette recorder. If the circuit proves to be as effective as claimed, you are likely to see it used by quite a few manufacturers before too long. **R-E**

HOBBY CORNER

This little IC can produce a great deal of sound.

EARL "DOC" SAVAGE, K4SDS, HOBBY EDITOR

IT IS ALMOST UNBELIEVABLE THAT SUCH a variety of sounds can be created by one small 28-pin IC. The Texas Instruments 76477 can generate everything from simple tones to very complex sounds. Best of all is the fact that you can create any sounds you desire by just adding a few resistors and capacitors.

Before we get into how to make some of those sounds, perhaps we should mention some of the ways you can use the 76477. There are, of course, sound effects. While I can't guarantee it, I believe that this IC can produce any sound you have ever heard. Further, I know that it will produce many that you have never heard before!

The more mundane uses for the 76477 are obvious. They include such things as chimes, musical "instruments," door bells, noise generators—in fact, just about anything that requires sound. Now, let's see how to make the IC perform.

For now, we'll treat the 76477 as a "black box." To explain what actually goes on inside the IC would require a book, so we'll largely ignore the "how" and discuss the "what" of the IC.

First, there is a matter of the power supply. Texas Instruments' has made this easy by providing two ways to power the IC. A voltage regulator has been built into the 76477 so you can apply anything from 7.5- to 9-volts DC to pin 14. If you do that, you can also take 5-volts DC at up to 10 mA from pin 15 for use with external circuits! The other way to power the IC is to apply a regulated 5-volts DC to pin 15. In either method, pin 2 is the ground connection.

The next thing is the audio output. A small audio amplifier is built into the IC, but further amplification is needed to bring the signal level up to a useful level. The manufacturer suggests the simple two-transistor amp shown in Fig. 1. For a permanent installation, that will do nicely. However, I prefer a different approach for experimentation (and you will be doing a lot of experimenting to find new sounds). What I did was to use a small all-purpose amplifier such as the Radio Shack 277-1008, and connect it to the IC as shown in Fig. 2.

There is also a master switch for the IC: pin 9. If pin 9 is connected to

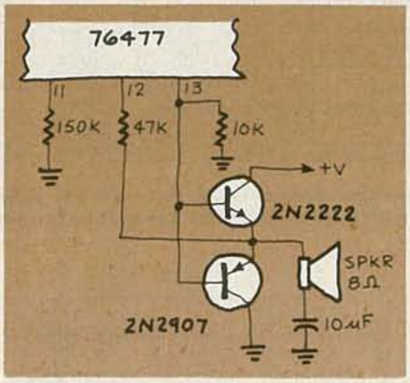


FIG. 1

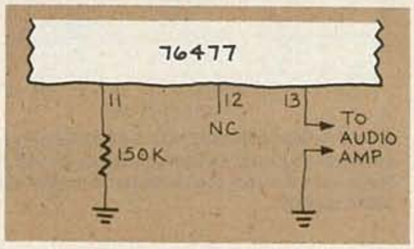


FIG. 2

ground, the IC is on; if it is connected to 5-volts DC, the IC is off.

Now that we've discussed the power, audio, and master switch pins, that leaves us with just 21 more pins. Those 21 are the ones that are used to program the sounds you want. Seldom, if ever, will you use all of them at once but you do need to know what all of them do.

To make things a little easier, we'll group those 21 pins into functions. Table 1 contains those functions and the pin numbers associated with each function. Note that most pins have an

TABLE 1

Super Low Frequency Oscillator (SLF)	
20R	7500 ohms to 1 megohm
21C	500 pF to 100μF
Voltage Controlled Oscillator (VCO)	
18R	7500 ohms to 1 megohm
17C	100pF to 1μF
19	Duty-cycle (normally +5-volts DC)
22	Switch (+5-volts DC = SLF; 0 = pin 16)
16	External (High voltage = Low frequency)
Noise	
5R	7500 ohms to 1 megohm
6C	150pF to .01μF
4R	Switch (43,000 ohms)
Mixer	
25, 26, and 27	See text
One Shot	
24R	7500 ohms to 1 megohm
23C	0.1 to 50μF
Envelope	
1 and 28	See text
Attack/Decay	
10R	Attack (7500 ohms to 1 megohm)
7R	Decay (7500 ohms to 1 megohm)
8C	Timing (.01 to 10μF)

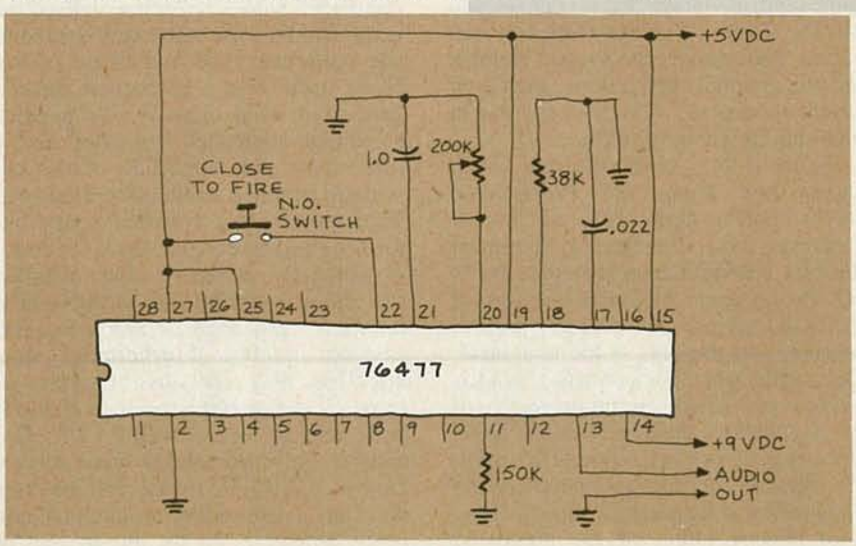


FIG. 3

appended letter (R or C) that indicates whether a resistor or capacitor is to be connected to it. In all cases, the component is connected from the indicated pin to ground. In addition, some of the pin numbers are followed by the normal range of values for the components that are to be connected to it.

The *S*uper *L*ow *F*requency oscillator (SLF) has a normal range of 0.1 to 30 Hz, but it will operate at a much higher frequency if needed. The value of the resistor and capacitor attached to the appropriate pins determines the frequency. The SLF can also be used to "modulate" other IC functions such as the VCO and/or mixer.

The *V*oltage *C*ontrolled *O*scillator (VCO) produces a tone. The basic pitch of the tone is determined by a resistor connected to pin 18 and a capacitor connected to pin 17. Remember, each of these components are connected between the pin and ground. In addition to the two components, the pitch of the tone is also determined by either the output voltage from the SLF or by a voltage applied to pin 16. Pin 22 is the switch: connecting it to +5-volts DC causes the SLF to be the controlling voltage; grounding that pin lets you control the frequency by applying a voltage to pin 16. In addition, the duty cycle of the output waveform can be controlled by a voltage applied to pin 19. Normally, pin 19 is connected to +5 volts.

The noise source is switched by pin 4. Leaving that pin unconnected keeps the noise source off; shunting pin 4 to ground through a 43,000-ohm resistor turns it on. The resistor connected to pin 5 and the capacitor connected to pin 6 determines the sound quality of the noise. An external noise source can also be input at pin 3.

The mixer does just what you would expect—it allows you to mix the generated sounds in any combination. It is programmed by a binary control signal on pins 25, 26, and 27. The three pins gives you up to eight possible combinations, ranging from binary 0 (ØØØ) to binary 7 (111). A logic high (1) is +5-volts DC and a logic low (Ø) is ground. The mixer code is as follows: ØØØ = VCO; ØØ1 = SLF; Ø1Ø = Noise; Ø11 = VCO/Noise; 1ØØ = SLF/Noise; 1Ø1 = SLF/VCO/Noise; 11Ø = SLF/VCO; and 111 = inhibit all. For example, Ø11 (a binary 3) will cause the VCO and noise source to be mixed and passed on while inhibiting the SLF.

Let's pause for a minute and take stock. The SLF can generate a frequency—even a sound—that can be fed into the VCO or the mixer. The VCO can generate a sound that can be modulated by the SLF or an external voltage and fed into the mixer. The noise generator can also be fed into the mixer.

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COMMUNICATIONS CORNER

Here's a window-mounted CB antenna that really performs.

HERB FRIEDMAN, COMMUNICATIONS EDITOR

BECAUSE OF THE MORE FREQUENT RE-strictions on the use of rooftop antennas, many hams, SWL's, and CB'ers have had to resort to the use of so-called "portable antennas;" usually an inductively loaded short antenna that is intended to clip on to a window sill or ledge. Unfortunately, if it isn't some eagle-eyed busybody who can spot No. 50 wire 100 feet in the air and run to the building's manager screaming they have found the source of all TV interference (even when there isn't any), it's the lack of ready access to a window ledge that prevents many "cliff dwellers" from using some form of "window antenna."

The past summer, however, I discovered an effective "window antenna" for CB, one that really works. While it's designed specifically for CB, any hobbyist that's reasonably handy with a soldering iron can fabricate a model for a VHF ham band.

The little gem that's the subject of this month's column is the Gold Line *Intenna*. Before I get into the details, let me tell you how I discovered it, since this will give you a better picture of what it can do.

I was standing in a CB/auto shop in a 4-block tourist town just chatting, and commented that when I pulled into a motel I can't keep in contact with the rest of the family when they take the car down the road to some stores and shops to pick up supplies. One of the customers breaks in to say that he had the same problem until he purchased a CB antenna that sticks to the window, even those that don't open, and he usually can get coverage up to one mile or so depending on what floor his room is on and which direction the window faces. You can just bet I had to try this gadget, but unfortunately, it wasn't the easiest to locate because CB is not the market it once was. But I finally did get hold of one, and it really works.

The Gold Line *Intenna* is essentially a half-wave loaded (dipole) antenna combined with a reflected power indicator of a standard VSWR meter. The main section is a lightweight metal cabinet that measures approximately 5 × 1.5 × 2 inches. On the back are two rubber suction cups that permit the box to be attached to the window.

Coming from each end of the box is a 32-inch long antenna element, which is actually a flexible wire with a suction cup on the end. On the bottom end of the box is a UHF (coaxial) connector to which the output of a CB transceiver is connected. The box is first attached to the window and then the antenna elements are stretched out and also attached to the window.

On the control box are two knobs labelled TUNE and the meter, which is arbitrarily calibrated from one to five. The knobs are actually mounted on the tuning slugs of variable inductors that are used as "loading" coils for the antenna elements.

The complete circuit is shown in Fig. 1. The dashed lines represent the metal cabinet. The two tuning coils are L1 and L2. The reflected power indicator is made up of L3, D1, R1, C1, and M1. Inductor L3 is really an RF pickup coil that takes a sample of the reflected power from the transmission line. Notice that loading coil L2 is actually between the antenna element and the metal cabinet. There might be some inclination to eliminate L2 and convert the design into a loaded ¼-wave vertical. It could be done, but the tuning would be even more critical and the antenna would not be as efficient for keeping the signal low to the ground.

Using the Intenna

To use the *Intenna*, the CB rig is first connected to the control box with a length of coax cable long enough to let you keep the rig at least 10-feet from the antenna. (If you build a similar device for some other frequency, try to keep the transmitter at least ¼-wavelength from the antenna. I realize this is impossible at the lower VHF frequencies, so all you can do is try and hope. Sometimes it will work, but other times the RF feedback will do strange things to the signal—particularly to the modulation.)

Then the top antenna element is secured to the highest point on the window using the suction cup. The wire is stretched out and the control box is secured to the window. Finally, the lower element is allowed to hang down and is then secured to the window. If the element is longer than the window, the wire is simply left hanging free or it can be taped to the wall.

The transmission line must be oriented at right angles to the antenna, or as close as possible to a right angle for at least ¼-wavelength, or whatever you can squeeze in. A few strips of masking tape will easily support the RG-58 cable on a wall.

When the antenna is in place have someone key the rig. (You could do it yourself but it might prove somewhat difficult to adjust the antenna if you're also keying the transmitter.) Adjust each of the two tuning controls for the lowest meter reading. Step away from the antenna when you check the meter

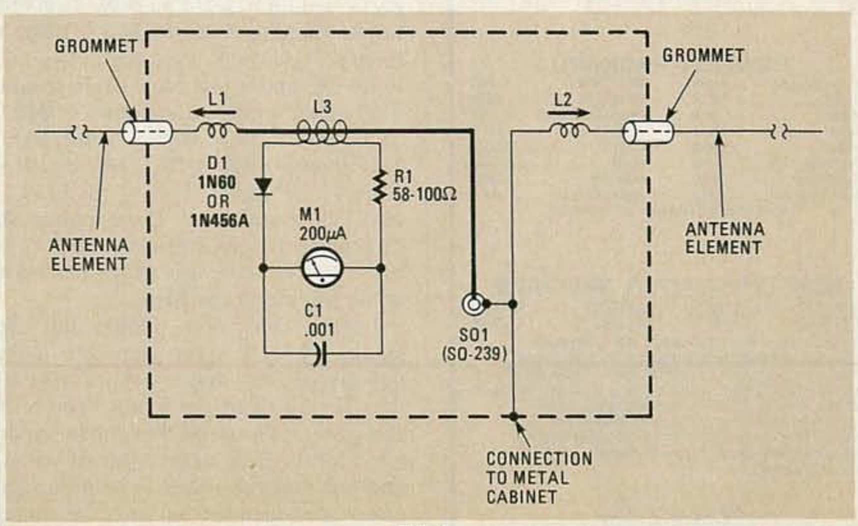

FIG. 1

reading (your body could affect the tuning). It will take a few tries to get it right, but eventually the meter will indicate near zero, or somewhere below ⅓ scale. That's it, the *Intenna* is ready for use.

As I said, CB gear isn't that easy to locate, so if you want information on pricing and availability of the *Intenna* write to Gold Line, P.O. Box 115, West Redding, CT 06896. **R-E**

HOBBY CORNER

continued from page 81

Since the output of the mixer can be any combination of those, you can see that it can produce very complex sounds. Even so, we can still process the sound further before it gets out of the 76477.

The signal from the mixer is fed to an envelope generator where it is shaped. Control of the envelope is determined by the binary signal on pins 1 and 28. Since there are only two pins, we are limited to just four control signals: ØØ = VCO; Ø1 = mixer; 1Ø = one shot; and 11 = VCO alternating. For example, 1Ø (binary 2) would cause the one shot to shape the output from the mixer. Incidently, the pulse duration of the one shot is determined by the resistor/capacitor combination on pins 23 and 24; its maximum duration is about 10 seconds.

Before the signal gets to the audio amp, there is one more opportunity to process it! You can set the speed of the leading edge (attack) and the trailing edge (decay) of the envelope by connecting resistors to pins 10 and 7 and a timing capacitor to pin 8.

Finally, the signal is fed to the built-in audio amplifier and out of the 76477. With all of those possible combinations, is it any wonder that this little IC can produce very complex sounds?

Of course, there is much more that could be said but you have enough to go on to create your own sounds using the 76477. To give you a start, the circuit in Fig. 3 can be used to generate a "laser gun" sound. **R-E**

STATE OF SOLID STATE

SCR arrays and bar-graph displays

ROBERT F. SCOTT, SEMICONDUCTOR EDITOR

LET'S BEGIN THIS MONTH WITH A LOOK at two new SCR arrays from Sprague. They are the UTN-2886B and UTN-2888A monolithic multiple-SCR arrays designed for coupling microprocessors, demultiplexers, and similar devices to high-current loads such as relays, solenoids, and lamps. The devices feature low input-current; TTL, LS-TTL, and CMOS compatibility; 35-volts minimum forward-blocking-voltage, and a 2-amp in-rush-current capability. They can be used with either full-wave or half-wave power sources.

The UTN-2886B consists of six individual SCR's and two pairs of paralleled SCR's (pins 1–16 and 8–9). Each separate SCR can handle 250 mA—the paralleled units at pins 9 and 16 handle 500 mA—at +50°C ambient temperature. Power dissipation can be increased by attaching an external heat sink. The UTN-2888A array contains eight isolated SCR's (see Fig. 1), each capable of continuous and simultaneous operation at +50°C.

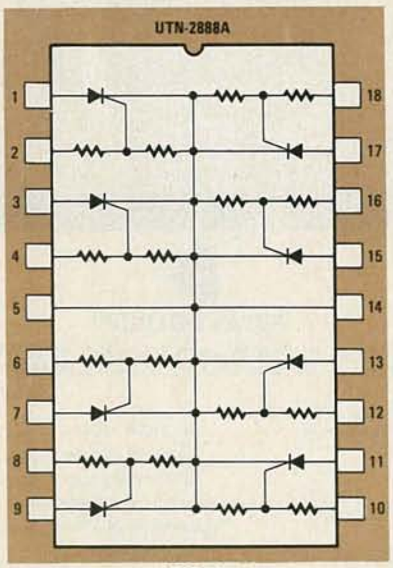

FIG. 1

Characteristics of any individual SCR (maximum limits are given unless otherwise specified) are: Forward blocking-current, 50 μA; gate-to-anode leakage, 250 μA; forward ON-voltage, 1.2 volts at +25°C and 1.15 volts at +55°C; gate trigger-voltage, 2.5 volts; gate trigger-current, 300 μA; gate OFF-current, 10 μA; holding current, 10 mA at 0°C and 5.0 mA at +55°C, and anode OFF-voltage, 400 mV minimum.

The devices operate from unfiltered DC from half-wave or full-wave-rectified sources. They cannot be used with raw AC. In operation, the SCR is triggered ON by applying a positive voltage to its gate. It continues to conduct, even though the gate voltage is removed or made slightly negative, until the anode-cathode voltage is reduced to below 400 mV.

The diagram in Fig. 2 shows a typical application, using the SCR's as lamp drivers. When using multiple SCR's and a common V_{AA} supply, gate-to-anode leakage currents (I_{GA}) can hold the supply voltage above the anode OFF voltage, $V_{AK(OFF)}$, and prevent proper turn-off. Resistor R is connected across the power supply to insure proper SCR operation.

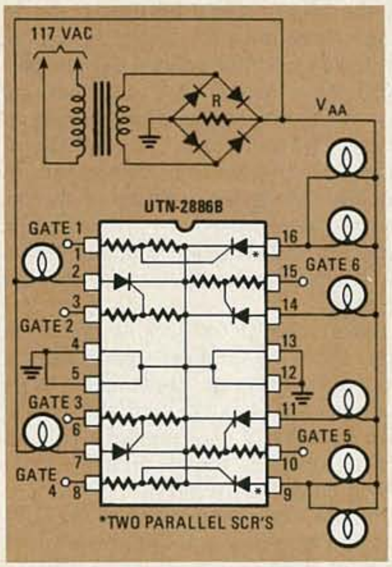

FIG. 2

The maximum value of the resistor can be calculated from the following formula:

$$\frac{400 \text{ mV}}{(n-1)\ 250\ \mu\text{A}}$$

where n is the number of SCR's being used in the system. Be sure to add 2 to the SCR count if you use the paralleled devices connected to pins 9 and 16 of the UTN-2886B.

For further information, contact Sprague Electric Co., Semiconductor Division, 155 Northeast Cutoff, Worcester, MA 01606.

Circuit of the Month

Bar-graph displays are popular as replacements for analog meters in radios, audio equipment, etc. The bar-graph circuits are simple and easily adapted for use with existing equipment. The analog signal needs little processing before being fed to the bar-graph display.

The display may consist of a number of discrete LED's, arranged in a linear array, or you can use a 10-element device such as the HDSP-4820, HDSP-4830 or HDSP-4840 series from Hewlett-Packard. In those devices, the LED's have been matched for color and brightness. A cut-away drawing of a 10-element bar-graph is shown in Fig. 3. The light from each LED element is "stretched" by diffusion and reflection to form individual elements. The array series is available in standard red (HDSP-4820), high-efficiency red

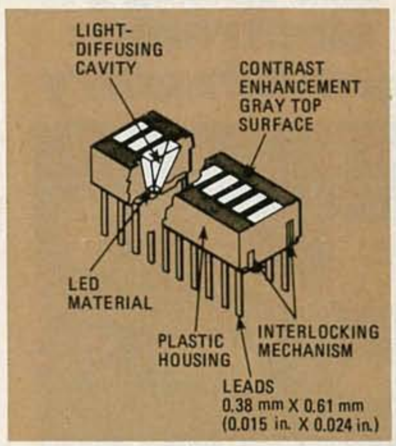

FIG. 3

(HDSP-4830), and high-efficiency yellow (HDSP-4840); the pin-outs for all three are the same.

There are a number of rather simple display-drivers for use between an analog or digital source and the LED arrays. Some display drivers or decoder/drivers provide a logarithmic display with 2- or 3-dB increments. Other drivers provide a linear display with either fixed or variable voltage increments. The drivers are made by, among others, National, Texas Instruments, Exar, Siemens, and AEG-Telefunken.

continued on page 86

CIRCLE 14 ON FREE INFORMATION CARD

STATE OF SOLID STATE

continued from page 84

A typical bar-graph decoder consists of a set of voltage comparators and a precision voltage-driver that supplies reference voltages to the individual comparators. Figure 4 shows a representative analog-input 5-stage bar-graph-display decoder. The decoder drives the display in a logarithmic or linear manner, depending on the scaling of the reference-voltage network.

Some decoders provide displays in either bar or dot-position modes. In the bar mode, the decoder lights all the LED's whose comparator voltage-thresholds are below the level of the applied input signal. In the dot-position mode, the display shows a moving dot

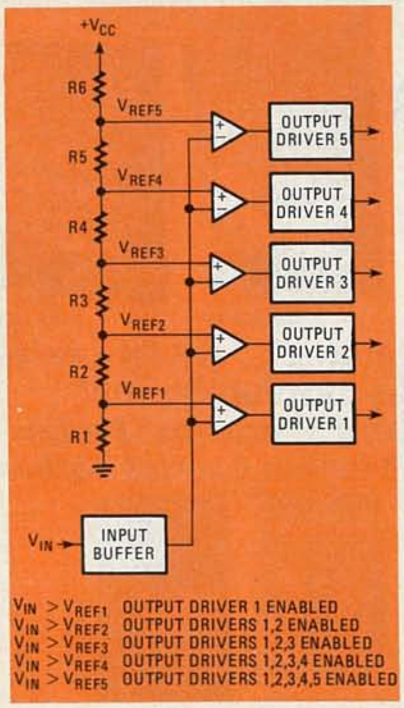

FIG. 4

whose positive is determined by the highest-threshold-voltage comparator triggered by the applied signal voltage.

Figure 5 shows a circuit that displays signal levels from zero to five volts in either a dot or bar pattern. It is based on the Hewlett-Packard 10-element bar-graph display and National Semiconductor's LM3914 dot/bar display driver. In this circuit, the display is a moving dot when the driver's MODE pin (pin 9) is tied to pin 11 and a bar graph when pin 9 is tied directly to $+V_{CC}$ at pin 3. (The National Data Book recommends leaving pin 9 floating for a dot display. Try it both ways.)

The incremental voltage-steps and thus the full-scale voltage, are determined by the voltage developed by the

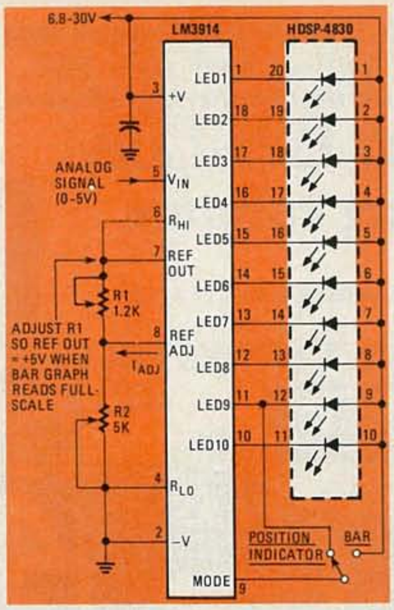

FIG. 5

internal reference source between pins 7 (REF OUT) and 8 (REF ADJ). That constant voltage forces a constant current through R1 and through an adjustable resistor, R2. Therefore the total voltage between the REF OUT pin and ground can be easily determined by using the following formula:

$V_{OUT} = V_{REF}(1 + R2/R1) + I_{ADJ}(R2)$; where V_{REF} = 1.25 volts and I_{ADJ} is 75μF typical, 150 μA maximum.

The current drawn from the voltage-reference pin determines the LED current. Approximately 10 times this current passes through each lighted LED. The LED current, and thus the brightness, can be adjusted by resistor R2. With a 7-volt supply, the LM3914 dissipates approximately 110 mW in the DOT

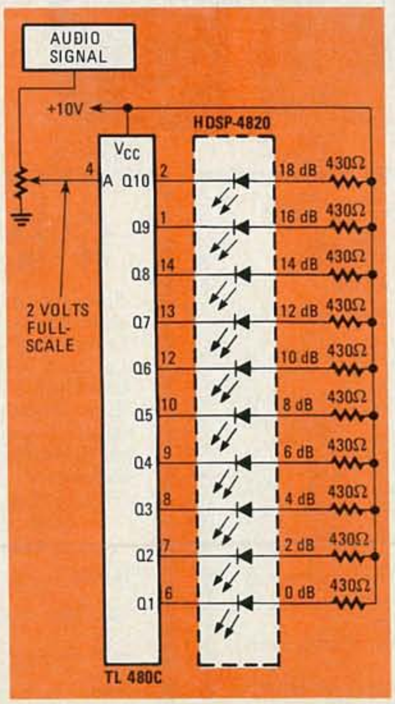

FIG. 6

mode, and around 720 mW in the BAR mode.

A low-cost VU meter is shown in Fig. 6. The bar-graph display is driven logarithmically by a Texas Instruments TL480C 10-step logarithmic analog level-detector. The device uses ten comparators to detect the level of the analog signal applied to the analog input (pin 4). Output Q1 is switched to a logic-low, turning on the 0-dB indicator LED when the input signal reaches approximately 218 mV. The comparators switch

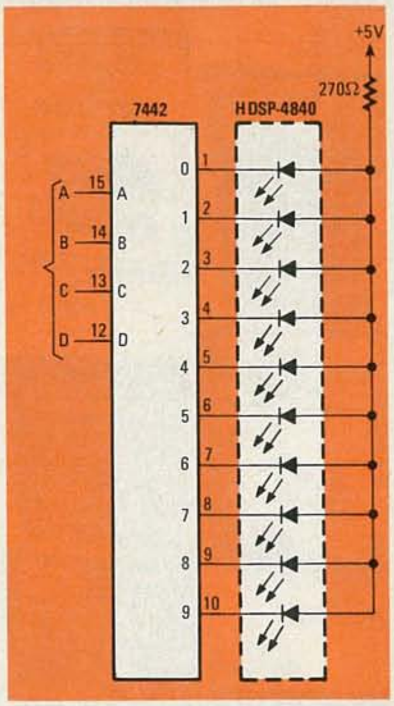

FIG. 7

in 2-dB increments until they are all low at an input value of approximately 1.732 volts.

In some systems, a BCD (*B*inary *C*oded *D*ecimal) signal is the most convenient way to drive a bar graph. Figure 7 shows a 7442 BDC-to-decimal (1 to 10) decoder connected to drive a 10-element bar-graph display in the DOT mode. In the case of that circuit, the LED's light singly to indicate the level of the BCD signal.

The material for these circuits came from National Semiconductor's *Linear Databook* and Hewlett-Packard's *Bar Graph Array Applications*. If you want to see other applications such as "chaining" for dot or bar displays of 20 or more LED elements, or interfacing to a 6800 or 8080A microprocessor, we recommend those two publications. *The Linear Databook* is available for $9.00 from National Semiconductor Corp., Literature Distribution, 2900 Semiconductor Drive, Santa Clara, CA 95051. The Hewlett-Packard literature is available from Hewlett-Packard Components, 640 Page Mill Road, Palo Alto, CA 94304; ask for *Application Note No. 1007* and the *10-Element Bar Graph* data sheet. **R-E**

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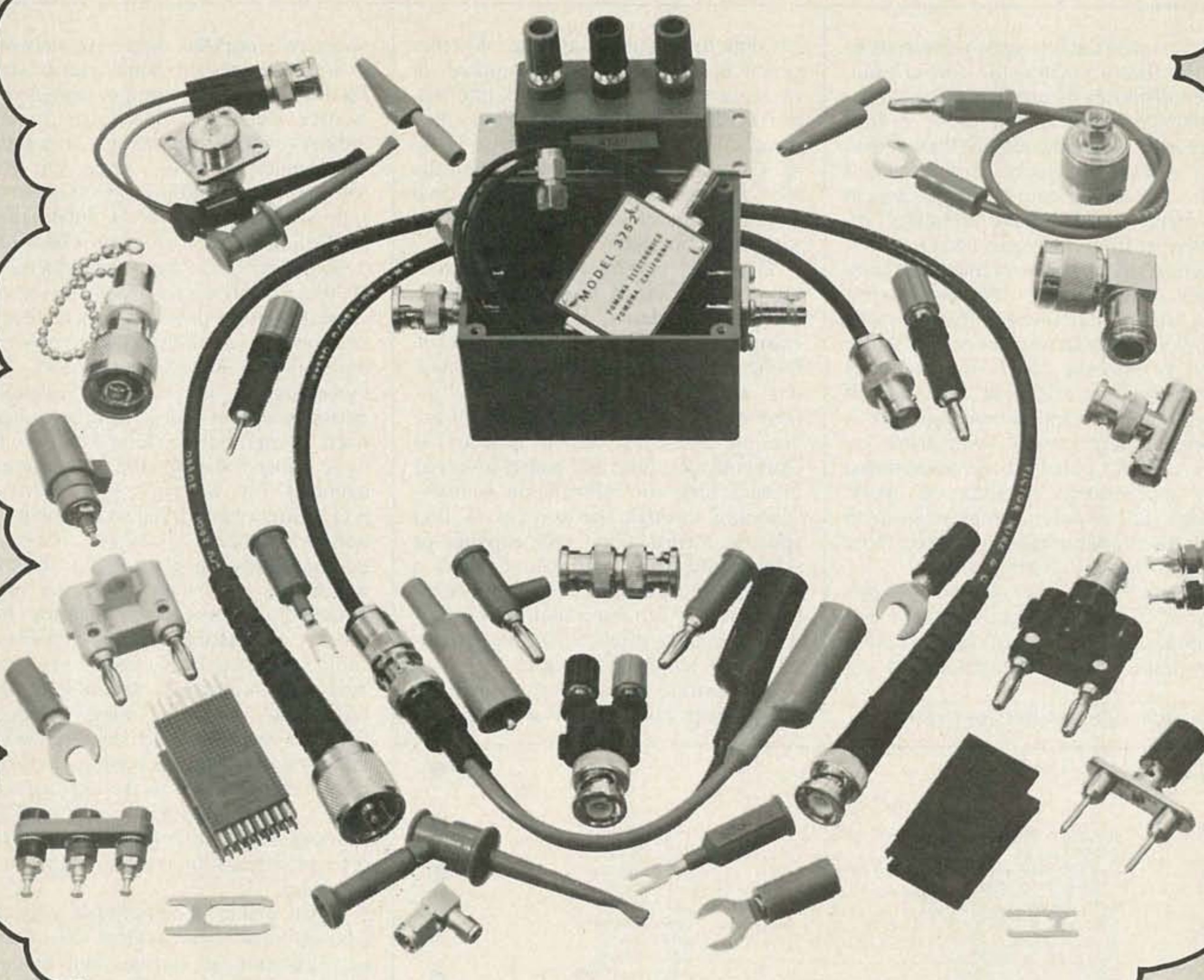

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CIRCLE 9 ON FREE INFORMATION CARD

COMPUTER CORNER

A world of information

LES SPINDLE*

WHEN A DISCUSSION ABOUT COMPUTERS of the future occurs, the conversation often discloses bizarre fears about a dehumanized society. In these cynical scenarios, students acquire their education awkwardly because they interact with a machine rather than a human teacher; patients have difficulty recovering from illnesses because their diagnosis is done by an unfeeling computer rather than a sensitive doctor, and social interaction suffers because people seldom have to leave their home for any purpose. Such predictions of doomsday are, of course, ridiculous. If anything, a computerized society is a more efficient society—with more leisure time for people to spend on social and recreational pursuits. A world linked via computer terminals has to do with more communication among more people—not social repression.

Computer data bases will provide much of the impetus for these improved communications by enabling a world of information to be instantaneously accessible to just about anyone. Whether practical or frivolous, vocational or recreational, social or clinical, information is immediately available from a data base. A computerized data base is essentially an electronic information file that is accessible to consumers that have a computer terminal and the necessary data communications peripherals.

They are currently over 600 commercial data bases in the U.S. alone, providing students, lawyers, farmers, computer hobbyists, stockbrokers, home consumers, and all types of business people with a wealth of vital information. The essential benefit of accessing data this way is obvious: it eliminates the time and hassel involved in searching for information sources, scanning through the sources to find specific information, and copying or transcribing that information. With a terminal and a data base, the desired information is retrieved and printed out within minutes after the appropriate information has been keyed in.

To illustrate how a data base can aid the average computer user, let's consider two popular data-base networks geared towards the home user or small businessman: The Source, provided by Source Telecomputing Corp. (a subsidiary of Telecomputing Corporation of America, 1616 Anderson Rd., McLean, VA 22102) and CompuServe, Inc. (formerly MicroNet), 5000 Arlington Center Blvd., Columbus, OH 43220.

Both services were introduced in 1979 and both essentially thrive on the same premise: providing sophisticated networking capabilities to the average consumer at an affordable cost. The technology is scarcely new. Computer networking and timesharing have been used as methods of doing business for large corporations and government agencies for several years. What is revolutionary about the home-computer network concept, however, is that it demonstrates the potential for a world linked up electronically in the most widespread mass-communication network conceivable. Like television, radio, the telephone, and every other mass-communication technology that has come along, the home computer will not become a true social phenomenon or booming economic industry until it is affordable by the average consumer. The computer is now affordable to a large number of consumers, but the telecommunications technology must catch up.

What makes CompuServe and the Source work is the fact that it is offered at a discount rate during hours that are not marketable for "nine-to-five" business transactions. During peak hours, the mainframe computers are heavily in demand by corporate clients. By tapping the heretofore little used evening and weekend hours, which coincide with the ideal time for consumer usage, the networks can offer the mainframe computer capabilities—and the special consumer data bases—at a much lower price.

The CompuServe network is available between 6 PM and 5 AM weekdays, all day weekends and holidays. Cost is $5 per hour. At all other times, the rate is $22.50 per hour. For The Source, a one-time registration fee of $100 is required. From 7 AM to 6 PM on Monday through Friday, the fee is $15 per hour. From 6

continued on page 92

*Associate Editor, Interface Age Magazine

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FIG. 1

COMPUTER CORNER

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PM to 12 AM on weekdays and all day on weekends, the cost is $4.25 per hour. From midnight to 7 AM daily, the cost is $2.75 per hour.

For hookup, the basic requirements for both networks include a terminal, a 300-baud modem (communications interface) and a telephone. Upon registration, the user receives an information packet including a user's manual, an index of data bases and services, an account number, and a private password. The system is accessed by dialing an assigned phone number, waiting for the tone to commence, placing the receiver in the modem, then entering the I.D. number and password. The modem translates electrical signals into sounds, and vice versa, to communicate with the host computer, or other computers plugged into the network. When a set of instructions appears, the user is told how to proceed in order to access the services or data bases he desires. Now he is ready to begin his interaction with the network.

By providing the possibility of terminal-to-terminal communication among the various subscribers, the network has the potential to achieve a communication method with mass appeal. Beyond providing a fun communication source among users in true CB-radio tradition, the network can function as a virtual electronic library and shopping center. The subscriber can browse through merchandise catalogued into specific programs, and even order the products directly through the terminal. If computer art is of interest to him, for example, he can browse through CompuServe's art-gallery listing and order a computer-generated picture for future delivery. Also available are programs on stock market data, filing capabilities for information storage, financial advice, games, educational aids, theater and movie reviews, news, weather, and sports.

The advantages of such a time-sharing network for the home user or small business are numerous and varied. As the programs and subscriber services become more diverse and useful, it is not hard to imagine that having a personal computer in every home, hooked up to major mainframe data bases, will eventually be as commonplace as a television or a telephone.

Electronic mail, for instance, is no longer a service strictly for major corporations. Exciting new directions for inexpensive mass communication at all levels of business and consumer usage are now evident. Even personal correspondance can be less expensive through a computer network than by a long distance phone call, although the personal interaction, in some cases, is obviously preferable.

The process of ordering merchandise can be streamlined. The home consumer can do tedious shopping for groceries or household goods without ever leaving the home. Such services, of course, are still somewhat limited, but expansion in this area is certainly inevitable as more homes become equipped with computer terminals.

Both CompuServe and The Source emphasize their extensive stock market services. CompuServe's *MicroQuote* includes information on over 32,000 stocks. A recent survey by The Source indicated that a large percentage of its subscribers sign up for the stock market facilities alone.

Because new data bases are constantly being added, both networks distribute a monthly news magazine to subscribers, detailing the latest services. The master index for CompuServe lists over 350 separate data bases with a wide range of subjects: adventure games, child care, want ads, tax advice, gold prices, text from various newspapers including the *Washington Post*, and photography. Among services described in the latest issue are a guide to admissions information and entrance

continued on page 102


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NEW IDEAS

Automobile ignition substitute

HERE'S A DEVICE THAT CAN HELP YOU find out what's wrong when suddenly one morning your car refuses to start. The ignition substitute described here can even be used to verify that repair work done to your engine by someone else has been done correctly.

Basically, the ignition substitute provides a constant power-source for the ignition coil. Its frequency (0.5-1.0 kHz) is that used by an 8-cylinder engine with an idling speed of 650 RPM, and the unit provides a rapid spark at a 17% duty cycle, while nonetheless staying within the power-dissipation limits of the components.

Construction is straightforward, and any method can be used. The circuit, shown in Fig. 1, consists of a 555 timer IC configured as an astable free-running multivibrator that is used to drive a high-current NPN transistor, such as a 2N6384. (That transistor should be heavily heat-sinked because it may be drawing several amps over quite a long period of time.)

The coil ballast can be from 0.68 to 6.5 ohms, depending on what's available. The 2.5-ohm, 20-watt ballast shown in Fig. 1 works well. All the other resistors can be either ¼- or ½-watt devices, and the capacitor between pins 1 and 5 of the 555 can range from 0.01 to 0.05 µF. Do not omit the 100-volt, 0.05 µF capacitor across the transistor; it prevents voltage spikes from damaging the device. Use 4-foot-long clip leads to obtain power directly from the automobile's battery; that length is suggested for convenience.

You can use either your car's own ignition coil, or a separate one. If you choose the latter, be sure to disconnect the one in the vehicle. A good coil will produce a spark between the high-tension lead and ground about ¼- to ½-inch long, and a strong bright spark across a plug with a gap smaller than 0.040-inch. That, by the way, is the first test for ignition problems.

To determine whether there's a problem with the car's distributor, supply a spark derived from the ignition substitute to the center distributor lead leading to the rotor and slowly rotate the distributor cap. Crank the engine and, at some point, the engine should catch and run. If the engine cannot be started, but seems to be trying to, the problem is probably in the timing chain, valves, camshaft, or elsewhere. If the engine doesn't even try to start, inspect the rotor, cap, wires, and plugs for damage. Once the ignition problem has been found and corrected, the normal procedure for setting the timing and dwell should be followed.

Do not attempt to adjust the distributor using the ignition substitute. That can not be done because the spark the substitute produces is slightly different from that produced under normal conditions.

Although designed for an 8-cylinder engine, this device can be used with other types. In addition, a neon bulb can be added to the circuit to verify the presence of a spark, and, in fact, can be used as a timing light if placed close to timing marks that have been painted white with fingernail polish.

—Stan K. Stephenson II

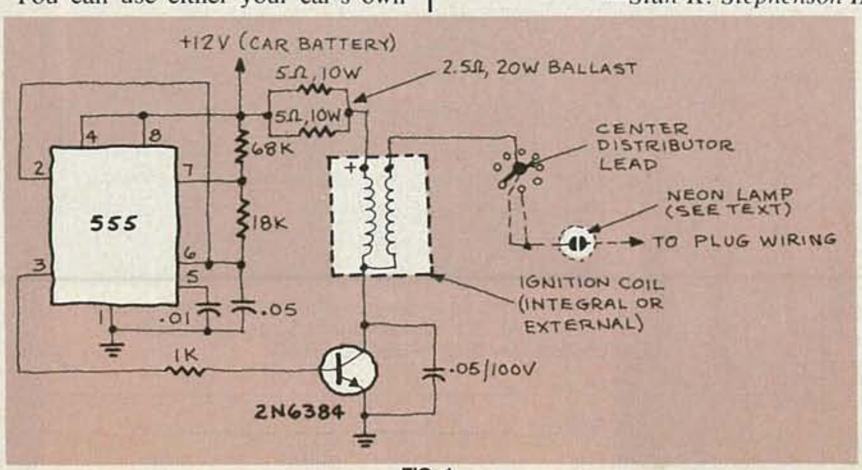

FIG. 1

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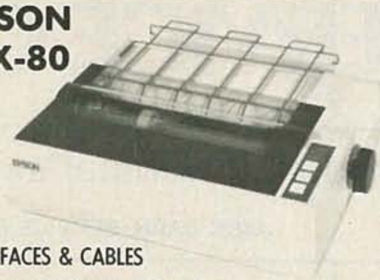

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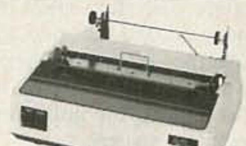

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CIRCLE 12 ON FREE INFORMATION CARD

SERVICE CLINIC

Solid-state vertical-sweep circuits

JACK DARR, SERVICE EDITOR

TUBE-TYPE VERTICAL-SWEEP STAGES ARE familiar to all the old-timers, and to most of the younger gang. They generally consisted of a high-mu triode and power pentode (often in the same "bottle"), a matching transformer, and a fairly-high-impedance yoke. The tubes were coupled by a feedback loop, so they served both as oscillators and as output stages.

Solid-state sweep stages perform the same functions, of course, but their designs may vary from manufacturer to manufacturer. Furthermore, the symptoms that they show when something goes wrong are not usually what you used to see in tube-type circuits—about the only familiar one is the thin white horizontal line indicating a total lack of vertical sweep.

A solid-state sweep circuit uses several small-signal transistors as oscillators, wave-shapers, drivers, etc. The output stage is a type familiar to anyone who has worked on audio equipment—a two-transistor "stacked totem-pole," or complementary-symmetry type. The yoke is fed from the junction of the two power transistors; it's usually a fairly-low-impedance type, driven directly through a very large electrolytic coupling capacitor.

A variation on that is used in some sets—they use a complementary-symmetry pair, with a dual-polarity power supply. Figure 1 shows a circuit of that type, used in a General Electric QB chassis. The output pair there is Q267 and Q268. Note that there is no large coupling-capacitor. The reason for that is that the junction of the two transistors is at ground potential, or very close to it.

Both circuit-types do the same thing—they deliver voltage, in the form of a square wave, to the yoke. When you feed such a square wave into an inductance (like the yoke) you get a sawtooth wave, which is what's required.

Two-transistor circuits seem to be almost universal these days. In some early sets, though, a single transistor was used, with a "loading choke" for matching and for the DC supply, and a blocking capacitor. That circuit operated in the class-A mode, like the tube types; the two-transistor circuits operate in class-B fashion, with each device amplifying one half-cycle of the driving signal.

An oscilloscope is invaluable for working with transistor sweep-circuits. Begin with the oscillator, make sure it's running—and on frequency. There may be several amplifier (and other) stages between the oscillator and the output stage, so just follow the signal through them to the yoke.

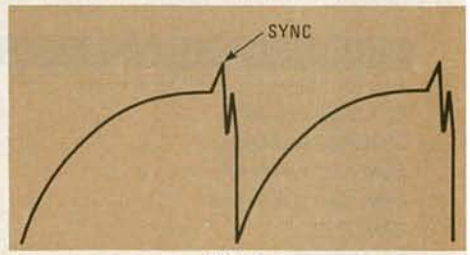


FIG. 2

You'll find one waveform at some points that you'll never see in tube-type circuits—a perfect sawtooth. With tubes, the signal on the oscillator grid (Fig. 2) shows the familiar rising curve with a spike at the top. Solid-state oscillators, on the other hand, show a

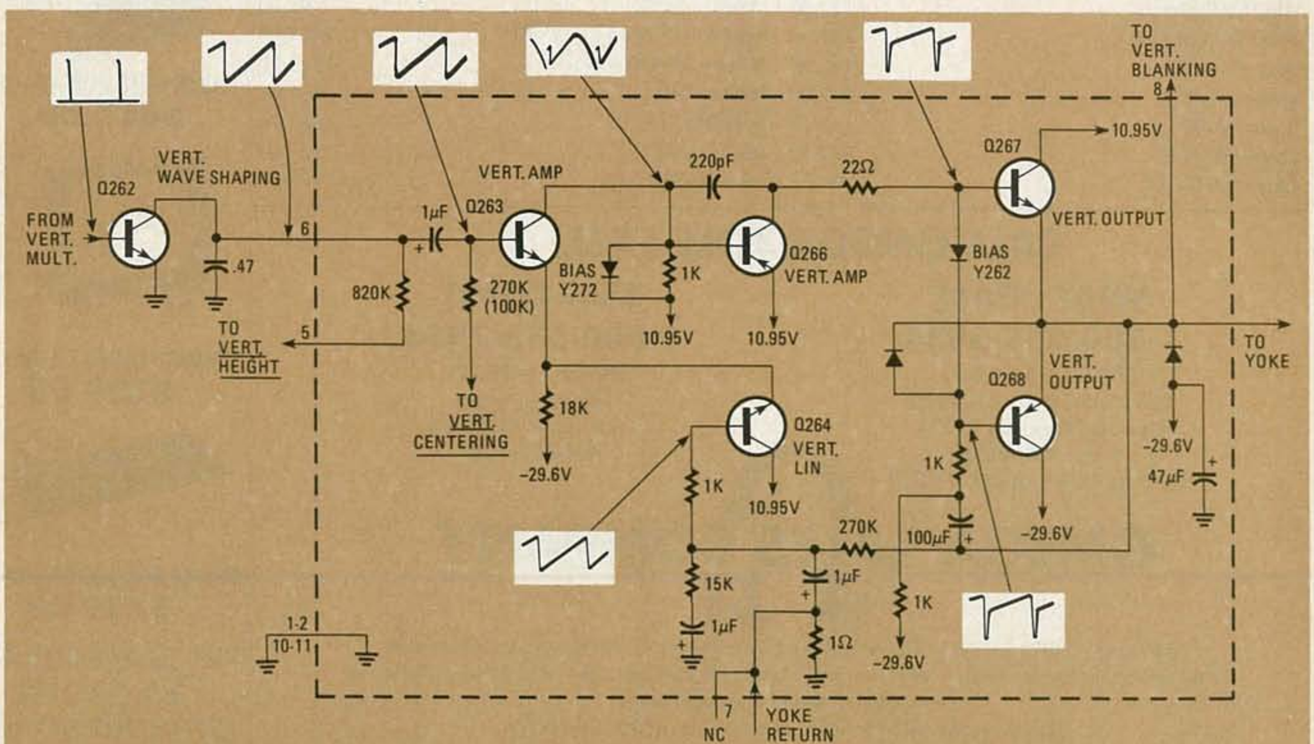


FIG. 1

series of pips, as can be seen in Fig. 1. A sawtooth wave is developed from them by a stage called a "wave shaper." The normal drive waveform on the bases of the output transistors is almost the same as in tube sets—a trapezoidal wave. In late-model sets you may find all of the stages, except for the output transistors, on a single IC. When checking this type of circuit, be sure that all the waveforms are correct, that all of the external components are OK, and that the proper DC supply-voltages are present before changing the IC.

Yoke returns

The vertical-yoke winding must return to ground, or to a level defined as a common ground. In quite a few circuits, a large blocking-capacitor is used between the bottom end of the yoke and ground. If it opens, there's no sweep, so always suspect it in such cases.

In many sets using circuits like the one in Fig. 1, you'll find the yoke return coming back to the module and running to ground through a 1-ohm resistor (R288). You must see a sawtooth waveform at the top end of that resistor; it's developed by the sawtooth current flowing through it. That current is fed to the base of a separate transistor, Q261, labelled "Vert. Lin." The reason for that is that all solid-state stages of that type are slightly non-linear! They develop a slight bend in each half of the waveform, causing what is known as "S-bending." The extra transistor and the feedback network are used to correct for that, and the end result is a perfectly linear sawtooth wave. If you run into a linearity problem, always remember to check that feedback resistor. Leakage and other defects there can cause some weird problems.

The feedback from that stage is applied to the emitter of the first vertical amp. The troubleshooting logic is clear: If the problem is linearity, go to the stage that's supposed to correct it.

Dual-polarity DC power-supplies can cause a symptom that would not be believed by a strictly tube-type technician. I know that the first time I saw it I said, "That *can't* happen!" The symptom is a perfectly good raster, but with only the top half of the picture present. That's all—there's no severe compression or other effect, as there would be in a tube set with a similar problem. The bottom half just *isn't there*.

The problem is either a loss of the DC supply to the "bottom" transistor (Q268 in Fig. 1) or the loss of the −29-volt supply to it. One other possibility exists: In the set where I first saw the problem, the vertical-sweep circuit was on a small module. The output transistors were clamped to one end of it and their leads went into individual socket-pins on the chassis. That was fine, except for the fact that the emitter lead of the "bottom" transistor was not in its socket. It was leaning on the outside of the pin, and making contact intermittently. Plugging the module (and the transistor) in properly restored things to normal. You may find that type of situation in sets with bad solder joints at one of the pins of the output transistors, so check for it.

In quite a few popular circuits, you'll find the signal passing through little low-voltage electrolytic coupling capacitors. If you're getting no signal to the output stage, check to make sure that one of them isn't open. You can do that instantly with a scope: If a signal's going in but not coming out, you've found at least part of your problem.

Here's another problem that's also common in audio circuits: If your symptoms include distortion at the center of the screen—compression or stretching of the picture—check to make sure that the bias diodes in the output stages are good. Failure of one or more of them can cause crossover distortion in audio, and also in TV sweep circuits. **R-E**

SERVICE QUESTIONS

VCR PLAYBACK PROBLEM

I have a Toshiba V-8000 VCR and an RCA CTC-25. If I record a program off the air, it will play back nicely. However, if I try to play back a pre-recorded tape, I can't get a stable picture. I had the set checked, and it's OK. Tried out the VCR with some newer sets, and it played fine. What's going on?—D.B., Memphis, TN

I've heard of that problem before. Apparently in older sets the horizontal AFC time-constant was considerably longer than the one used today, to make the set a little less susceptible to such things as airplane flutter, etc. However, the sync on pre-recorded tapes requires the shorter time constant. As a fix, try varying the size of C82/R124, or C23/R126 on the grid of the AFC tubes.

(Feedback: We tried both capacitors, and wound up taking them out completely. When we did that, the tapes played back perfectly, but we lost the sync on a broadcast signal after about five minutes. We took care of that by connecting the capacitors to a DPST switch so that they can be switched in and out of the circuit. Everything works fine now—thanks!)

COLOR BARS

This Magnanox T-982-12 makes its own color bars! The bars—blue, green, and red from left to right—divide the screen into thirds and are present all the time. When I

use a color-bar generator, all of the colors are wrong. Nothing I've tried, including purity, will get rid of the bars. Incidently, the waveforms out of the demodulator module are normal. Can you shed some light on what's going on?—M.D., Aberdeen Proving Ground, MD

I ran into something like this in a Philco. In that case half the screen was blue and the other half gold. Eventually found the source to be an open bypass-capacitor on the screen grid of the second color-bandpass amplifier. Since you've checked the DC-power supply with a scope, try checking all of the bypassed points in and around the color-amplifier stages, bandpass, etc. There should be no signal on any bypassed point, so look for a signal where it does not belong.

Since the three color-amplifier stages are separate, the cause of this should be something that is common to all. For example, check to see if there's anything odd in the video feed to those stages.

MORE ON "REDUNDANT" CAPACITORS

Here's a test that was shown to me by a technician for Hollander and Co. of St. Louis, Mo. This is for those Zenith chassis that use several parallel shunt-capacitors in the collector circuit of the horizontal-output stage. If the high voltage measures too high, one or more of those capacitors may be bad. To test, connect new capacitors in parallel with the ones already in the set. The high voltage should drop to normal, or lower. Now, disconnect the original capacitors one-by-one until you find one that has no effect on the high voltage—that's one of the bad ones. That procedure is almost as fast as using a capacitor tester, and it can be done under "normal" operating conditions.

Most of those capacitors are Zenith 22-5001's. Those are .0018 μF, 1600-volt units, but they use a special dielectric; ordinary 1600-volt units won't work. For an inexpensive replacement, use a Sprague PP16-D18. The Sprague catalog lists a lot of those; they are *Metfilm* and *Filmite* types.

DEAD SHORT

This CB is driving me crazy. It's got a dead short somewhere but I can't find it. My tests show no short to ground anywhere. Any ideas that you might have would be appreciated—W.G., Kingston, NY

We've run into something like this before. Check the "protective diode" used in the crowbar circuit; it's a Zener. It will test out OK on an ohmmeter, but when voltage is applied it becomes a "0-volt Zener!" A crowbar circuit is exactly what the name implies: If anything goes wrong, it is supposed to break down and short the DC supply to ground. That one may be getting a little bit too eager and breaking down too quickly.

FLYBACK SUBSTITUTE

I asked you about a replacement transformer for a Broadmoor 6911-C, and you said you didn't have any information on it. I wrote to Thordarson-Meissner, and they had one! (It's a FLY-677, if anyone else needs one.)—*James E. Higley, Hanover Park, IL.*

LEAN ON IT

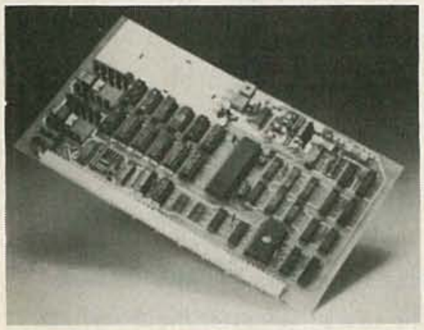
I wrote you a while ago about a Sharp TV-96P with weak audio, and thought you'd like to know that I fixed it. I tried everything I could think of, and everything *you* suggested, without any luck. Then, while checking around the second IF tube, the sound suddenly came in loud and clear.

It seems that this happened when I inadvertently leaned on the chassis, which suggested a bad solder-joint. Even though the joints looked good, I reworked about 15 of them and turned the set back on. It worked perfectly. A simple—but not immediately obvious—solution.—*L.P., Potomac, MD* **R-E**

NEW PRODUCTS

For more details use free information card inside back cover.

COLOR VDG CARD, the *ColoRAMa,* is a color video display generator/controller for SYSTEM-50 (SS-50, SS-50C) 680x computers. It permits software selection of any of 11 different display formats, including eight-color semigraphics, two- and four-color graphics, and two-color alphanumerics.



CIRCLE 111 ON FREE INFORMATION CARD

Two- and four-color displays may also be switched between primary and complementary color sets, either under software control or from the keyboard. Resolution of full-graphic displays ranges from 64 × 64 picture elements (pixels) to 256 × 192 pixels.

All of the 64 characters of the standard ASCII character subset are generated by the on-card character generator. The *ColoRAMa* is configured with one kilobyte of display RAM. One-kilobyte of RAM accommodates alphanumeric displays, eight-color semigraphic displays and two full-graphic displays modes. The *ColoRAMa* is priced at $219.95. — **Percom Data Company, Inc.,** 211 N. Kirby, Garland, TX 75042.

INTEGRATED HARDWARE/SOFTWARE SYSTEM, *Terminall (Model T1* and *Model T3),* converts the *TRS-80* microcomputer (*Model I* or *Model III*) into a state-of-the-art communications terminal. It includes all the necessary computer-interfacing, audio-demodulating, AFSK tone-generating, and transmitter-keying hardware integrated in one cabinet. That reduces equipment interconnection to a minimum and allows the operator to be on the air receiving and transmitting Morse code or RTTY in minutes.

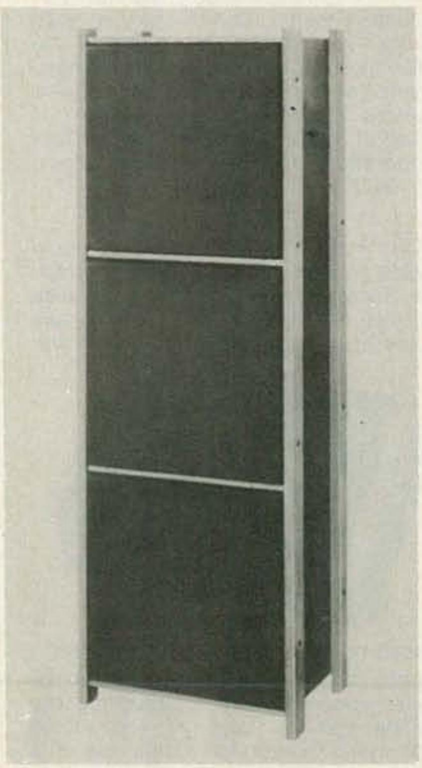
CIRCLE 112 ON FREE INFORMATION CARD

The user can plug it into the receiver headphone jack and copy Morse code, Baudot, or ASCII; plug it into the CW key jack and send Morse code, or attach a microphone connector and send Baudot or ASCII using audio tones (AFSK). In addition, the *Terminall* is expandable: disk-based (mailbox) RTTY software may be added at any time.

Terminall model T1 requires *Model I TRS-80,* 16K RAM and Level II BASIC. *Terminall model T3* requires *Model III TRS-80,* 16K RAM, and *model III* BASIC.

Terminall model T1 or *model T3* are priced at $499. — **Macrotonics,** 1125 N. Golden State Blvd., Suite G, Turlock CA 95380.

SUBWOOFER, *model AS-1320,* is designed to add bass to an existing small system, but will enhance the bass response of even 10-inch and 12-inch systems. By extending the low-frequency range of the audiophile's present system, the *model AS-1320* will reduce the bass distortion that occurs when the wing speakers try to reproduce the low-bass notes. A ported cabinet alignment uses computer-aided



CIRCLE 113 ON FREE INFORMATION CARD

design techniques to maintain an extended low-frequency response with as flat a response as possible. A six-inch tuned vent is loaded into the floor for even better response. The driver is mounted near the floor so that the first boundary cancellation is above the frequency limits of the subwoofer.

The *model AS-1320* requires either the Heathkit *model ASA-1320-1* Passive Crossover (mail-order priced at $44.95) or the Heathkit Electronic Crossover, *model AD-1702*, (mail-order priced at $194.95). A complete step-by-step instruction manual makes the subwoofer kit a one-evening project. The *model AS-1320* is mail-order priced at $299.95. — **Heath Company,** Benton Harbor, MI 49022.

DESOLDER PUMP, *model DP-1,* features all-metal construction with precision components for maximum reliability and ease of operation. Compact size facilitates comfortable, one-hand operation. Suction is precisely regulated for efficient solder removal without damage to

CIRCLE 114 ON FREE INFORMATION CARD

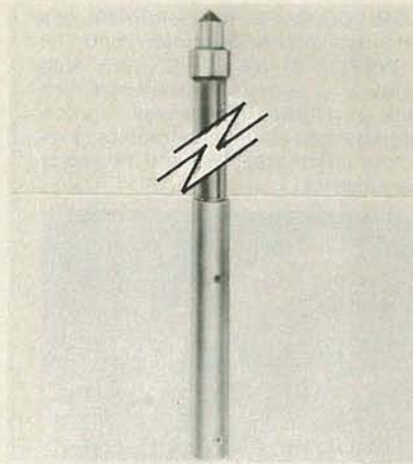
delicate circuitry. Self-cleaning at each stroke, the *model DP-1* is quickly disassembled without special tools for maintenance or repairs. The rugged Teflon tip is easily replaced. The *model DP-1* is priced at $10.95. —**OK Machine and Tool Corporation,** 3455 Conner Street, Bronx, NY 10475.

STEREO MIXER/PREAMPLIFIER, *model DM500,* has two stereo phono/line inputs; one microphone input; pro-style slide controls for fading and cueing; a talk switch that attenuates the phono/line

CIRCLE 115 ON FREE INFORMATION CARD

volume 14 dB for making smooth, professional voiceovers without touching any volume settings, and an easy-access headphone output for monitoring. The built-in, low-noise preamp handles virtually any signal source, including magnetic phono cartridges and low-impedance microphones, and is powerful enough to drive almost any power amplifier. It can also be plugged into the auxiliary input of any receiver or integrated amplifier. The *model DM500* is priced at $149.00. — **Numark Electronics Corp.,** 503 Raritan Center, PO Box 493, Edison, NJ 08817.

ANTENNA, *model PD-1610,* is a fiberglass collinear antenna of the "Super-Stationmaster" design. The frequency range is 806-896 MHz and gain is 3.0 dBd. Maximum input power is 500 watts; bandwidth, for 1.5:1 VSWR, is 60 MHz, and vertical beamwidth, ½-power points, is 36 degrees.

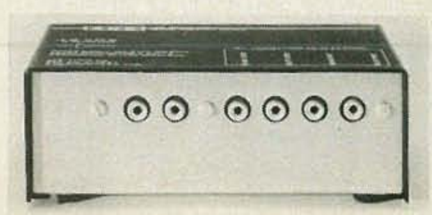


CIRCLE 116 ON FREE INFORMATION CARD

The overall length of the *model PD-1610* is 44 inches. The fiberglass housing is 1.5 inches in diameter, and the aluminum support pipe is 12 inches long and 1.66 inches in diameter. Copper alloy is used as the radiating element material. The *model PD-1610* attains a resistance to rated wind velocity of 200 miles per hour, with a lateral thrust at rated wind of 48 pounds. Bending moment 1 inch below the top of the support pipe is 47 foot pounds, and lightning protection is direct ground. Termination is direct with an 18-inch, flexible extension of RG-393/U; mounting hardware is supplied.

The *model PD-1610* is priced at $175.00. — **Phelps Dodge Communications Company,** Route 79, Marlboro, NJ 07746.

ELECTRONIC CROSSOVER, *model 6000,* is housed in a compact aluminum chassis with its own power supply, and is fully compatible with both tube- and transistor equipment. A choice of 16 different crossover frequencies is standard, with custom frequencies available at additional charges. The *model 6000* crosses-over from 200 through 10,000 Hz, contains two tweeter-level controls, and features very low distortion (.002%) and noise (−90 dB). The 12 dB/octave slope is suitable for

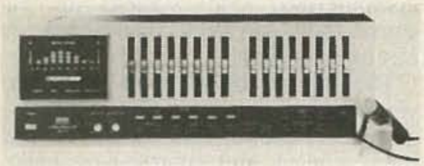


CIRCLE 117 ON FREE INFORMATION CARD

both horn and dynamic drivers.

The *model 6000* can be used either for bi-amping or tri-amping, and features a plug-in frequency module that allows changing frequencies readily. For tri-amping, a second *model 6000* is needed to provide the bandpass filter for the mid-range speakers. The *model 6000* is priced at $156.00. — **Ace Audio Co.,** 532 5th Street, East Northport, NY 11731.

GRAPHIC EQUALIZER, *model SE-9,* is a microprocessor-controlled, octave-band stereo graphic equalizer designed for either room equalization or recording. It features 4-curve memory storage, spectrum-analyzer display, and a built-in pink-noise generator; in addition, it comes supplied with an external electret condenser microphone.



CIRCLE 118 ON FREE INFORMATION CARD

A motorized fader-setting system, operating under CPU direction simplifies the digital-processing requirements; all 16 of the frequency controls are dual-slide potentiometers, one section of which can vary the boost or cut within its audio band by ±12 dB. The other section produces a varying DC voltage that is fed to comparator circuits that determine when the motors have positioned the sliders correctly. When the vertical motor has placed one slider properly, the horizontal motor shifts the adjustment mechanism to the next potentiometer, in turn. Using the automatic adjustment procedure minimizes fader-to-fader interaction, and requires only 30 seconds overall. Manually-derived settings, or factory-preselected equalizations, may also be stored in the 4-curve memory and recalled at any time.

The *model SE-9* is available in brushed aluminum and is priced at $700.00 (Also available as *model SE-9B* in matte black with rack mounting, at the same price.) — **Sansui Electronics Corp.,** 1250 Valley Brook Ave., Lyndhurst, NJ 07071.

SPEAKERS, *model 5300,* are 5-inch wedges, shaped for mounting in car doors and other surfaces. They feature a

CIRCLE 119 ON FREE INFORMATION CARD

5-inch woofer, separate 1¾-inch tweeter, 3-ounce ceramic magnet, and cloth-roll air-suspension. They have a 15-watt RMS rating, 100–15,000 Hz frequency response, and an impedance of 8 ohms.

The *model 5300* speakers are made of molded ABS plastic and are sold in kits containing two speakers and cables. The suggested retail price for the kits is $19.95 — **BP Electronics,** 855 Conklin Street, Farmingdale, NY 11735.

SOUND-ENHANCER, the *Imager 801-A,* can fit almost any size car or truck dashboard, and uses very little current. By connecting it to an auto, truck, or van's

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speaker system, the speakers' performance is improved dramatically. The sound appears to be coming from many speakers, surrounding the listener with an extra dimension of depth, clarity, and realism. It comes complete and with full instructions, so that it should not be difficult for the average do-it-yourselfer to install. The *Imager 801-A* is priced at $149.95.—**Omnisonix, Ltd.,** P.O. Box 430, Rt. 17, c/o Carrano Bldg., Northford, CT 06492. R-E

STEREO AUDIO FOR TV

continued from page 76

of TV sound. In fact, the NTSC system has always been capable of providing "high fidelity" FM sound, with response up to 15 kHz. Small-speaker TV sets, together with TV-station-owner apathy, has resulted in a vicious circle that has kept us from enjoying the kind of sound we get from FM radio and other high-fidelity program sources.

The coming of stereo-TV sound may change all that, if only for the reason that the TV tuners and adaptors needed to supply the two channels of audio will permit us to connect our stereo component-systems directly to the line outputs of those new products. In that way, we will finally be able to bypass the sound systems contained in our TV sets. When will that happen? Best estimates suggest that the FCC's decision will not come before mid-1982, and most likely, it will arrive later than that. that.

I am indebted to my friend William S. Halstead, who provided me with much of the background material used for this description of the stereo-multiplex TV systems being considered by the EIA and the FCC. **R-E**

COMPUTER CORNER

continued from page 92

procedures for various colleges, and the first magazine to distribute its monthly articles via electronic transmission: *Better Homes and Gardens*. A banking-by-home project is described in an experimental program being tried through CompuServe by the United American Bank, Knoxville, TN.

The program provides checking and savings information, financial advisory services, paying of bills, sending of messages, and bank loan applications. (The only thing it can't do, presumably, is eject dollar bills upon request, as the computerized teller stations do, because they can't be transmitted via electronic signal.)

The Source offers over 1,200 services, including the American stock exchange, etiquette, Black studies, New Mexico news and sports, ham radio, French wines, and unidentified flying objects. (A sample partial listing from the Source is shown in Fig. 1.) A recent news magazine details such added services as Legi-Slate, a listing of Congressional records and a career-placement center that matches job seekers with prospective employers.

Both networks offer computerized flea market and want-ad type services, linking consumers across the nation with the most sophisticated and comprehensive resources imaginable for trading services, selling or buying merchandise, or doing the sundry things that want ads traditionally do.

The list of consumer services goes even further: restaurant guides; travel agent transactions; receiving the latest UPI news breaks as soon as they occur. Of special interest to computer hobbyists is the ability to load and unload complete programs.

Which service is the best? The Source is, at least, the biggest, with a much larger index of services offered and access in over 300 U.S. cities. Purchased last year by the Reader's Digest Corporation and having been introduced several months earlier than CompuServe, The Source would seem to have the edge in versatility and growth potential. CompuServe, on the other hand, is not far behind, currently available in over 250 cities, with highly visible market exposure—it's sold through Radio Shack stores. Both companies have passed the 10,000 subscriber mark. Both services have their admirers and detractors. It is probably wise to request literature from each network and peruse the list of data bases offered and to study the specific hookup requirements. That way, you can decide which would be least expensive and easier for you to access. **R-E**

LETTERS
continued from page 22

Winning the DB War," in your December 1981 issue of **Radio-Electronics.**

If we are to assume that that is, indeed, the technique used by the Russians, then Mr. Leinwoll is giving them more credit than they deserve. The concept of backscatter, and its relationship to propagation, is common knowledge. It would appear that the Russians merely expanded the concept.

The sensing or sampling of the backscatter wave would be somewhat akin to over-the-horizon radar, with computer evaluation as the key to that technique.
CHARLES DERAPELIAN,
Port Neches, TX

SINGLE BOARD COMPUTER

I found Jorma Hyypia's article on "Learning About Microprocessors" (May 1981) very interesting, even though it left out the assembly-language computer that I'm using and that I think your readers might be interested in learning about, the Paccom *8085AKT.*

It uses the 8085 CPU and comes either as a kit or assembled. Memory includes 1K of RAM, 1K or PROM, and 1K of EPROM that contains the system monitor. (Two EPROM sockets are provided, and either 1K- or 2K-IC's can be used.)

This computer can be used either as a trainer or as a controller and is supported by several very good books (that come with it). It is especially good for control purposes because, of 44 lines brought out to the card edge, 36 can be wired to meet the user's specific needs.

Programming is done using a 24-key keypad and 9-digit LED display. The computer can be programmed in either octal or hexadecimal (some of us *still* prefer octal, you know).

The price of the *8085AKT* kit is $249.95 and more information on it can be obtained from: Paccom, 14905 N.E. 40th, Redmond, WA 98052.
ALLAN EGAN
New York, NY

TEMPERATURE SCALES

I wish to point out two errors in Joseph J. Carr's discussion of temperature scales in the November 1981 **Radio-Electronics.** Firstly, the absolute zero temperature is −273.15°C, relative to the freezing point of water, which is 0°C. The triple point of water, the point where gas, liquid, and solid exist in equilibrium at 1-atmosphere pressure, is defined as 273.16°K and the freezing point of water is found to be 0.01°C lower.

Second, all molecular motion does not cease at 0°K. All molecules in a potential field, such as exists in a crystal of the solid, retain a zero-point vibrational motion due to the uncertainty principle, which prevents both the particle momentum and position from being known exactly at the same time.
DAVID G. HENNINGS, Ph.D.,
Omaha, NE **R-E**

VIDEOTEX FOR TV
continued from page 61

However it works out, eventually you will be tied into the videotex network. You'll be able to do your shopping and banking, and plan your day using videotex. Even your work may be affected.

Much of the time that many people spend in the office concerns work that could just as well be done at home. That includes: phone calls, correspondence (assuming the user can type), and preparing reports. Imagine being able to do that without having to commute three hours each day to and from work!

Along other lines, farmers could request the latest weather information, or—perhaps more important—the selling price of their produce in a particular market, or find the market offering the best price. Sales could even be made using videotex.

The ability to communicate with the rest of the world—not only be voice, but by visual information—is something that we not only desire, but will *need.*

Whatever form of videotex we use, it can only stand to benefit us. **R-E**

NEW BOOKS

For more details use free information card inside back cover.

HOW TO BUILD YOUR OWN WORKING MICROCOMPUTER, by Charles K. Adams. Tab Books, Inc., Blue Ridge Summit, PA 17214. 308 pp including glossary, appendices, and index; 5⅛ × 8¼ inches; softcover; $9.95. (A hardcover edition is also available at $16.95.)

Compared to the monstrous computers of a decade or more back, the microcomputer is simple, inexpensive, and easy to use—facts well proven by its popularity and ubiquity. Microcomputers now control almost everything from toys to automobile combustion-efficiency; from games to microwave ovens, and from stop lights to numerically-controlled machines. And the microcomputer boom is just beginning.

This book is for the electronics hobbyist who would like to build and program a simple microcomputer, but doesn't know just how or where to begin. It is an easy-to-read manual, showing the way to get started...the *right* way. Whether one is a beginner or a seasoned electronics buff, building a microcomputer from scratch will give one a taste of the electronics world that can't be experienced any other way. The book shows how a computer works, and provides simple (and more advanced) programming exercises for use with a self-built computer after presenting a step-by-step outline of every aspect of construction, assembly, and testing. Diagrams and tables are presented clearly, as well as parts lists, layout, power-supply sources, keyboard and display circuits, and even plans for an EPROM programmer.

The book may be used in any one of three ways: as a general reference book; as a guide to building a computer, or as a guide to building and programming the specific computer described.

CIRCLE 151 ON FREE INFORMATION CARD

ELECTRICAL INTERFERENCE IN ELECTRONIC SYSTEMS: Its Avoidance within High-Voltage Substations and Elsewhere, by R. E. Martin, C. Eng., D.F.H., F.I.E.E., F.I.E.R.E. Consultant. Research Studies Press, PO Box 92, Forest Grove, Oregon 97116. 198 pp including references, bibliography, and appendicies—no index; 5½ × 8½ inches; hardcover; $31.00.

Semiconductors used in modern electronic equipment and in computers are very sensitive to electrical interference, and due to their low thermal inertia, they are easily destroyed by overloads lasting even one millisecond. Many such devices normally operate at microwatt or milliwatt power-levels, so that even if destruction is avoided, false operations can easily be caused by interference. Computers are one of the most difficult devices to protect against interference, because the spectrum of signals they use is extremely wide.

The pulses used by the computer may have durations of a few tens of nanoseconds and rise times of a few nanoseconds; they will thus represent frequencies extending to 100 MHz or more.

Very short interference-pulses can easily be interpreted by the comptuer as instructions, and that may corrupt a program in storage, or inhibit the running of a program.

This book is intended to be used in conjunction with other documents referenced, to aid immunity from interference by isolation, screening, filtering, and earthing—a scheme designed for use with electronic systems in electrically noisy environments. It is particularly concerned with the use of electronic equipment in high-voltage electricity substations and outlines the ways in which harmful interference may enter electronic systems within an electricity station, as well as indicating appropriate measures for controlling the effect of such interference.

Although there is no index, the table of contents, which lists nearly every page, should suffice to enable the reader to find any particular material easily. There are many clearly printed diagrams, a section on the scope of the book and on how to use it, and a glossary of terms.

CIRCLE 152 ON FREE INFORMATION CARD

MUSICAL APPLICATIONS OF MICROPROCESSORS, by Hal Chamberlin. Hayden Book Company, Inc., 50 Essex Street, Rochelle Park, NJ 07662. 661 pp including appendix, bibliography, and index; 6¼ × 9¼ inches; hardcover; $24.95.

This book covers digital-microprocessor sound and music synthesis comprehensively, featuring previously unpublished techniques that are practical only with microprocessors. Standard linear techniques for microprocessor applications are discussed and musical applications for the newer and more powerful 16-bit microprocessors are explained in non-mathematical language. All phases of waveform shaping and filtering, as applied by digital devices to music generation, are also covered.

In the first section, "Background," chapters 1 to 5 cover the fundamental material necessary for full appreciation of the sections to follow. The second section, chapters 6 through 11, deals with computer-controlled analog synthesis, and in section three, chapters 12 to 18 cover the principals of digital synthesis and sound modification.

Throughout the discussions, mathematics is kept to a minimum, and even then is limited to elementary algebra and trigonometry. Important concepts are illustrated through charts, graphs, and, at times, computer programs in BASIC.

CIRCLE 153 ON FREE INFORMATION CARD

ELECTRICAL AND ELECTRONICS DRAWING, Fourth Edition, by Charles J. Baer and John Ottaway. Gregg Division, McGraw-Hill Book Company, 1221 Avenue of the Americas, New York, NY 10020. 473 pp including appendices, glossary, and index; 6½ × 9½ inches; hardcover; $16.25.

This new Fourth Edition provides a complete course in electrical and electronics drawing that reflects the latest drafting techniques, technology, and the National Electrical Code.

Presented in a logical, easy-to-master sequence, the text is designed to expand students' knowledge of electronics functions and systems. An up-to-date picture of electrical drafting is provided with basic "how-to" information, plus coverage of electronics, automation, micro-electronics, electric power, and architectural wiring. Included are new chapters on computer-aided design (CAD), microprocessors and industrial controls, and new material on flow and logic diagrams, laying out circuits, using templates and drawing printed circuits.

The book is illustrated extensively and presents questions and problems at the end of each chapter.

CIRCLE 154 ON FREE INFORMATION CARD

SAFE SUB-WOOFER

continued from page 69

airtight. A hot-melt glue gun will make construction easier.

The rather elaborate construction of the initial chamber, behind the speaker, serves two purposes. First, it directs the back-wave from the speaker into the labyrinth. Second, it prevents standing waves from building up.

Three views of that first chamber are provided in Figs. 4, 5, and 6. It contains two *angled* partitions. The first behind-the-speaker partition, whose outline is shown in Fig. 7, is attached to mounting strips on the side panels; the second one is attached to the enclosure at all four of its edges.

The only acoustic insulating-material used in the system is in the first chamber, where indicated by asterisks in Figs. 5 and 6. It should be loosely-fluffed ¼- to ½-inch fiberglass.

Two binding posts will be needed to connect the sub-woofer to your amplifier. Locate them at the side or rear of the enclosure, and make sure that there is an airtight seal where they pass through the panel.

Prepare the front, rear, and side panels by attaching partition-to-cabinet mounting strips at the positions shown in Fig. 8, on what will become their insides. Cut out the hole for the speaker, bearing in mind that it is offset slightly from the middle of the front panel. Refer to Fig. 9 as you do this.

Prepare partitions 1-11 as shown in Fig. 10 and attach the even-numbered partitions to the odd-numbered ones as shown in Fig. 11. Now, join the sides at rear of the enclosure, leaving the front panel off for the time being. Install the first and second behind-the-speaker partitions, doing the second one first. Don't forget the acoustic installation where indicated. Attach the speaker to the front panel and connect it to the binding posts on the rear panel. Then attach the front panel to the rest of the enclosure and install partitions 1-10 on their mounting strips. Finally, add partition 11, and the top of the enclosure.

Use

The SAFE subwoofer is connected directly to your amplifier's output through a crossover network with a cutoff frequency of about 100 Hz. While an L-C-L "pi" network can be used, an electronic crossover would be better.

With much program material, the benefits of the subwoofer will not be noticeable—music just doesn't contain that much low-frequency information. When the low frequencies are present, however, you'll hear your music as you've never heard it before. **R-E**

continued from page 58

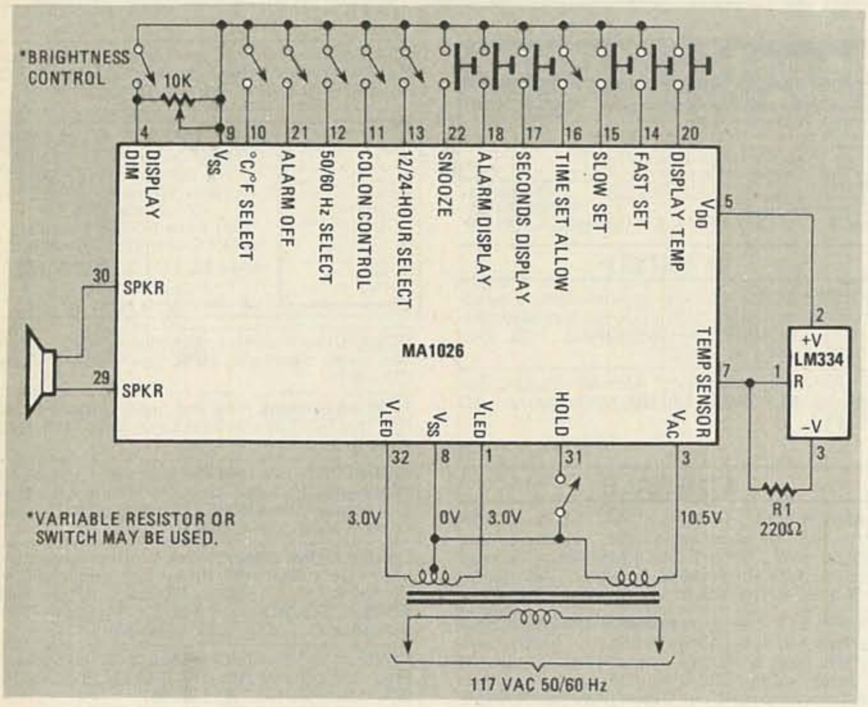

FIG. 5—EXPAND THE BASIC CLOCK/THERMOMETER project and make a full-function alarm clock with snooze alarm, using this circuit.

functions. While the clock/thermometer described in this article does not make use of some of them, there is no reason you can't expand the project to include them. For instance, with the appropriate additional circuitry you can turn the project into a full-feature alarm clock with a snooze alarm such as the one shown in Fig. 5. If you have a low-wattage soldering iron and a good eye, you might want to try accessing the traces going to individual segments of each digit. With a little ingenuity, doing that would let you build a time-of-day clock and temperature monitor for a computer. If you are interested in exploring the potential of the MA1026 further, be sure to order the data sheet and applications notes when you order the module (note that there is sometimes a small additional charge for those items). The module is simple and economical, but it has many features available to those who want to use it fully. **R-E**

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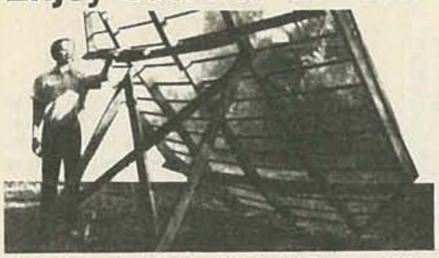

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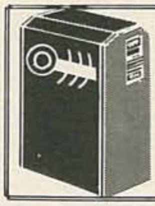
MICROPROCESSOR trainer, learn by constructing and programming a microcomputer for under $70.00. Instructions/plans $6.00. MICRO-DEVELOPMENT CORPORATION, Box 419, Edwardsburg, MI 49112



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Compact size, only 2"x1"x¾". Transmit to FM radio 88-108 MHz. Exceptional audio quality. Transmits stable signal up to 900 ft. Complete kit incl. case, battery & instructions. Only $13.95. Assembled $18.95. Add $1.55 S&H ea. Send 18¢ stamp for brochure.

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This sturdy, fully adjustable holder frees your hands for easier building and repair. Cast iron base, nickel-plated clamps. **64-2093** **7.95**

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Ready-to-use Micronta® multitester features a mirrored scale and 20,000 ohms per volt DC sensitivity. Measures 0 to 1200 volts DC in seven ranges, 0 to 1200 volts AC in five ranges. DC current, 0 to 250 milliamps in four ranges. Resistance in four ranges. Decibels, −20 to +63 in five ranges. $5\frac{1}{2} \times 3\frac{7}{8} \times \frac{1}{2}$." Requires "AA" battery. **22-202** **27.95**

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MC1350. Operates from DC to beyond 60 MHz. 8-pin DIP with specs. **276-1758** **2.19**

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MC1330. Excellent linearity. Used in many late-model TV receivers. Separate video and AFT outputs. 8-pin with specs.
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Pocket slide rule solves Ohm's law and parallel resistance problems—a real timesaver for your workbench!
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M Three mini motors
Ideal for solar displays, models and more. $1\frac{1}{2}$ to 6 VDC.
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Spring action—a "must" for testing on crowded boards. $3\frac{1}{2}$" long. One red, one black.
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74LS90	276-1923	1.09	.89
74LS123	276-1926	1.49	1.19
74LS138	276-1939	1.19	.99
74LS161	276-1931	1.39	1.09
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Q Logic probe
Indicates high, low or pulsed logic states with easy-to-read LEDs. Overload and reverse polarity protected.
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Primary: 120 VAC. Secondary: 24 VAC at 300 milliamps. Top quality. **273-1386** **3.49**

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Pushbutton release and secure contact. One red, one black.
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Simply rub strips, circles, pads on your board and etch!
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W Project cabinet
Distinctive 2-tone styling with easy-to-work end panels. $2\frac{1}{4} \times 5 \times 5\frac{1}{4}$." **270-218** . . **7.95**

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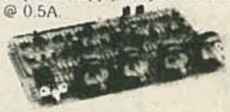
LOW TIM DC STEREO PRE-AMP KIT TA-10 20

Incorporates brand-new D.C. design that gives a frequency response from 0Hz-100KHz ± 0.5dB! Added features like tone defeat and loudness control let you tailor your own frequency supplies to eliminate power fluctuation! Specifications: • T.H.D. less than .005% • T.I.M. less than .005% • Frequency response: DC to 100KHz ± 0.5dB • RIAA deviation: ± 0.2dB • S/N ratio: better than 70dB • Sensitivity: Phono 2MV 47K/Aux. 100MV 100K • Output level: 1.3V • Max output: 15V • Tone control: bass ± 10dB @ 50Hz/treble ± 10dB @ 15Hz • Power supply: ± 24 D.C. @ 0.5A

Kit comes with regulated power supply, all you need is a 48V C.T. transformer @ 0.5A.



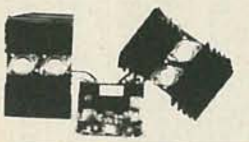
ONLY $44.50
X'former
$4.50 ea.

100W CLASS A POWER AMP KIT

Dynamic Bias Class "A" circuit design makes this unit unique in its class. Crystal clear. 100 watts power output will satisfy the most picky fans. A perfect combination with the TA-1020 low T.I.M. stereo pre-amp.

Specifications:

- Output power: 100W RMS into 8-ohm 125W RMS into 4-ohm
- Frequency response: 10Hz-100KHz
- T.H.D.: less than 0.008%
- S/N ratio: better than 80dB
- Input sensitivity: IV max.
- Power supply: ± 40V @ 5 amp
- One channel, needs two for stereo



TA-1000KIT $51.95
Power transformer $24.00 each

50 WATTS AUTO STEREO BOOSTER BY VERTRONIX

Specifications:
- 50 watts RMS total (25W + 25W)
- Frequency Response: ± 0.5dB, 20Hz ~ 20KHz
- T.H.D.: 0.2% at full rated output
- Input Impedance: 20K ohms
- Crosstalk: Better than 90dB
- Sensitivity: 1.5V for full rated output
- S/N Ratio: Greater than 95dB
- Speaker Load: 2 ~ 8 ohms
- Voltage Supply: 9 ~ 18V D.C.

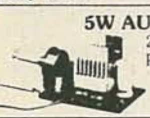
Model V-Amp 500
REG. PRICE $119.00 EACH
OUR SPECIAL PRICE $55.00 EACH

"FISHER" 30 WATT STEREO AMP

MAIN AMP (15W x 2)
Kit includes 2 pcs. Fisher PA 301 Hybrid IC all electronic parts with PC Board. Power supply ± 16V DC (not included). Power band with (KF 1% ± 3dB). Voltage gain 33dB. 20Hz-20KHz.

Super Buy Only $18.50

5W AUDIO AMP KIT



2 LM 380 with Volume Control
Power Supply 6 18V DC
ONLY $6.00 EACH

2 WATT AUDIO AMP

Pre assembled units. All you need is to hook up the speaker and the volume control. Supply voltage from 9~15V D.C. measures only 2" x 3½", making it good for portable or discrete applications. Comes with hook up data.

BUY 2 FOR $4.99

1 WATT AUDIO AMP

All parts are pre-assembled on a mini PC Board. Supply Voltage 6 ~ 9V D.C.
SPECIAL PRICE $1.95 ea.

NEW MARK III 9 Steps 4 Colors LED VU

Stereo level indicator kit with arc-shape display panel!!! This Mark III LED level indicator is a new design PC board with an arc-shape 4 colors LED display (change color from red, yellow, green and the peak output indicated by rose). The power range is very large from −30dB to +5dB. The Mark III indicator is applicable to 1 watt - 200 watts amplifier operating voltage is 3V-9V DC at max 400 MA. The circuit uses 10 LEDs per channel. It is very easy to connect to the amplifier. Just hook up with the speaker output!

IN KIT FORM $18.50

MARK IV 15 STEPS LED POWER LEVEL INDICATOR KIT

This new stereo level indicator kit consists of 36 4-color LED (15 per channel) to indicate the sound level output of your amplifier from −36dB +3dB. Comes with a well-designed silk screen printed plastic panel and has a selector switch to allow floating or gradual output indicating. Power supply is 6 12V D.C. with THG on board input sensitivity controls. This unit can work with any amplifier from 1W to 200W!

Kit includes 70 pcs. driver transistors, 38 pcs. matched 4-color LED, all other electronic components, PC board and front panel.

MARK IV KIT
$31.50

MARK V 15 STEPS LED POWER OUTPUT INDICATOR KIT

All functions same as Mark IV but this is with heavy duty aluminum front plate and case. Can be easily slot into the front panel of your auto, truck or boat. Operates on 12V DC.

$41.50 EACH KIT

SOLID STATE STEREO GRAPHIC EQUALIZER PRE AMP KIT TA-2500

Specifications:
- Total Harmonic Distortion: Less than 0.05%
- Intermodulation Distortion: (70Hz:7KHz = 4:1 SMPTE Method) Less than 0.03%
- Frequency Response: Overall 10Hz ~ 100KHz +0.5dB, −1dB
- RIAA Curve Deviation: (Phono) +0.2dB, −0.2dB (30Hz ~ 15KHz)
- Channel separation (at rated output 1KHz)
- Phono, Tuner, Aux and Tape Monitor better than 70dB.
- Input sensitivity and impedance (1KHz for rated output)

Phono: 2MV 47K ohms   Aux: 130MV 50K ohms
Tuner: 130MV 50K ohms   Tape: 130MV 50K ohms
Graphic Equalizer control: 10 Band Slide Control
Frequency Bands: 31.5Hz; G3Hz; 125Hz; 250Hz; 500Hz; 1KHz; 2KHz; 4KHz; 8KHz; 16KHz also with on panel selector for Phono, Tuner, Aux 1 and Aux 2.
Power Supply: 117 VAC
Kit comes with all electronic components, transformer, instructions and a 19" rack mount type metal cabinet.

MODEL TA-2500
$119.00 PER KIT

ELECTRONIC DUAL SPEAKER PROTECTOR

Cutt off when circuit is shorted or over load to protect your amplifier as well as your speakers. A must for OCL circuits.

KIT FORM **$8.75 EA.**

PROFESSIONAL REGULATED VARIABLE D.C. POWER SUPPLY KIT

All solid state circuitry with high efficiency power transistor 2SD388 and I.C. voltage regulator MC1733. Output voltage can be adjusted from 0-30V at 1 amp current limited or 0-15V at 2 amp current limited. Internal resistance is less than 0.005 ohm; ripple and noise less than 1 MV, dual on panel meter for voltage and amp reading, also with on board LED and audible over load indicator. Kit comes with predrilled P.C. board, instructions, all necessary electronic components, transformer and a professional look metal cabinet. The best project for school and the most useful instrument for repairman. Build one today!

MODEL TR 88A 0 ~ 15V D.C. 2 amp
MODEL TR 88B 0 ~ 30V D.C. 1 amp

$59.50 PER KIT

REGULATED DUAL VOLTAGE SUPPLY KIT

± 4 ~ 30V DC 800 MA adjustable, fully regulated by Fairchild 78MG and 79MG voltage regulator I.C. Kit includes all electronic parts, filter capacitors, I.C., heat sinks and P.C. board.

$12.50 PER KIT

POWER SUPPLY KIT

0-30V D.C. REGULATED

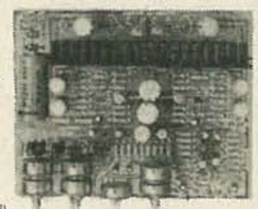
Uses UA723 and ZN3055 Power TR output can be adjusted from 0-30V, 2 AMP. Complete with PC board and all electronic parts. Tranformer for Power Supply. 2 AMP 24V x 2 **$9.50**

0-30 Power Supply
$10.50 each

TA-323 6 WATTS TOTAL 30W + 30W STEREO AMP KIT

★ SPECIAL ★

EXCELLENT PRICE!



MODEL 001-0034
Transformer (Optional)

This is a solid state all transistor circuitry with on board stereo pre-amp for most microphone or phone input. Power output employs 2 pairs matching Darlington Transistors. Driven by the popular 2N3053 Driver Transistors. Four built on board controls for; volume, balance, treble and bass. Power supplies requires 48 VET 2.5 amp transformer. T.H.D. of less than 0.1% between 100 Hz and 10KHz at full power. (30 Watts + 30 Watts loaded by 8~).

$29.50 PER KIT
$10.50 EACH

POCKET STEREO CASSETTE PLAYER WITH STEREO HEAD PHONE

This unit is a high fidelity stereo player which will give you years of listening pleasure and follow you wherever you go. Made by the same company in Japan who use the "Big Name."

Complete set comes with 1 Stereo headphone, 3 AA size alkaline batteries, 1 leather like carrying case for player and 1 carrying case for storage of 4 cassette tapes and 1 demo tape.

MODEL SWM-33
OUR DIRECT IMPORT PRICE **$67.50**

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LM 380	$2.00	Matching Transformer	$1.40
Sanyo UHF Tuner	$35.00	Tolriod Coils (Set of 4)	$3.00
Capacitors Set	$12.50		
Resistors Set	$2.00	Speaker Cabinet	$12.95
Trim Pots: Trim Caps Set	$13.50	Transformer 18V 800MA	$3.00
Pots and Knobs	$2.00		

We sell you all the above components in a package for **$125.00** and you will receive a free predrilled P.C. board and instructions at no charge!

SANYO UHF VARACTOR TUNER

For UHF CH 14 83

Tuning voltage +1V~ +28V D.C. Input impedance 75 OHM. I.F. band width 7~16 MHz. Noise figure 11.5dB MAX. Size 2⅝" x 1¼" x ¾". Supply voltage 15V D.C.

Sound I.F. = 58.0 MHz.
Video I.F. = 62.5 MHz.

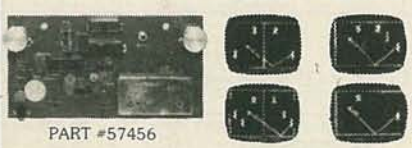
All units are brand new from Sanyo.
MODEL 115-B-405A
$35.00 EACH

Tuner is the most important part for the circuit. Don't let those $19.00 tuners fool you!

TV GAME BOARD

PLAYS 4 GAMES: TENNIS; HOCKEY; HANDBALL AND JAI-ALAI.

All boards complete with all parts ready to play. Requires 6C size batteries and a small speaker for sound effects. The boards were surplus from a famous game manufacturer. They will play on all US standard black and white or color TV sets. (Regular price for these games were $39.50 each) **OUR PRICE ONLY $6.50 EACH**



PART #57456

ELECTRONIC PIN BALL MACHINE

That sounds and plays like the real thing. All units are brand new but without the case. Functions of the game include double flipper control, kicker control, 1-4 players, 3 speed ball control, tilt switch, automatic score, extra bonus cave and many more. All solid state with LED panel, no moving parts. Requires 9V battery to operate, speaker not included.

A perfect gift for yourself or friends.

SPECIAL **$8.99** EACH SPEAKER **$1.25** EACH

ELECTRONIC MUSICAL TELEPHONE REST KIT

This telephone rest can be used as a door charm, an audible indicator and for many other sound projects. The special custom made I.C. is pre programmed with 4 musical tunes. Kit comes with a nice looking plastic case, pre-drilled P.C. board, volume control, special sound I.C. speakers and all electronic components and instructions. Ideal for home or school projects.

BUY NOW!

SPECIAL PRICE! ONLY $15.50 PER KIT

MODEL FIH-3000

DIGITAL TIMER/CLOCK

- 24 Hour preset time to turn on or off
- 12 Hour green 0.5" display for time
- operated on 12~16V A.C.

The whole timer is self contained in a compact plastic case (as seen in photo). Designed for VTR with push button switch for easy setting. Limited quantity available.

NOW ONLY $12.94 MODEL VEQ 0143

SANYO ANTENNA SIGNAL BOOSTER

This Booster is specially designed for UHF Channels (14-83). After installed this unit (between the antenna input cable and the UHF tuner) will have a minimum of 10dB gain, that is approximately 2 times better than what you are seeing now. Ideal for those who live in apartments that cannot put up an outdoor antenna. Size is so small; only 2" x 1½" x 1". Supply voltage is 15 VDC.

★ **NEW ITEM** ★

MODEL 001-0076

$12.50 EACH

13 FUNCTIONS LCD TIME MODULE

- Displays month, date and day of the week
- Displays hour, minute and second
- AM, PM Indicator
- Alarm 1 and Alarm 2 (Independent)
- 10 Hours Stop Watch
- 12 Hours presettable count down time
- Hour Charm Indicator
- Back light by touch of the switch

MODEL 001-0062
$7.94 EACH

These modules are brand new and made by LITRONIX. Designed for a man's watch. Can be used for many applications. Comes with 2 silver batteries and the ceramic round transducer.

MATCHED PAIR POWER TRANSISTORS BY MOTOROLA

MJ2955 PNP / 2N3055 NPN	150 Watts	BV=60 V, I.C.=15 A	$3.50 per pair
MJE2955 PNP / MJE3055 NPN	90 Watts	BV=60 V, I.C.=10 A	$3.00 per pair
MJ15003 NPN / MJ15004 PNP	250 Watts	BV=140 V, I.C.=20 A	$12.00 per pair

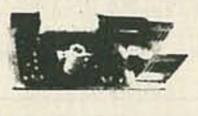
All above parts guaranteed to be prime and come with data sheets.

MUFFIN FANS FOR EQUIPMENT COOLING

These fans are pulled out from used computers. But carefully cleaned by ultrasonic cleaner. All in "like-new" condition. Size 4 11/16" x 1-1/2" x 4 11/16".
MODEL MF505
$9.50 EACH

FLUORESCENT LIGHT DRIVER KIT

12V DC POWERED



Lights up 8~15 Watt Fluorescent Light Tubes. Ideal for camper, outdoor, auto or boat. Kit includes high voltage coil, power transistor, heat sink, all other electronic parts and PC Board, light tube not included!

$6.50 Per Kit

PRESS-A-LIGHT SELF GENERATED FLASHLIGHT

EXCLUSIVE! **$3.95 ea.**

Never worry about battery, because it has none! Easy to carry in pocket and handy to use. Ideal for emergency light. It generates its own electricity by squeezing grip lever. Put one in your car, boat, camper or home. You may need it some time!

Model F-179

CRYSTAL CONTROLLED WIRELESS MICROPHONE SYSTEM

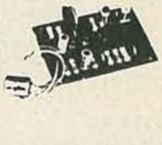
No FCC license required.
OUR PRICE $49.50
ADDITIONAL MICROPHONE (TRANSMITTER) AVAILABLE AT **$28.00** EACH

MURA WMS-49

Transmitter: FET mic for flat 30 ~18 KHz response extra controlled 49MHz AM Band for drift-free performance. 100 MW output (range approx. ¼ mile) for reliable long range transmission. Powered by a 9V radio battery (included).

Receiver: Extra controlled locks on 49MHz transmitter signal. With on panel VU meter monitors the signal strength from the microphone. Standard phone jack outlet connection to a P.A. or other phone input. 9V battery included. This professional set is ideal for on stage, in field, church, in house or outdoor use.

SUPER FM WIRELESS MIC KIT—MARK III

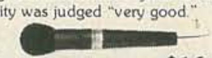


This new designed circuit uses high FEQ. FET transistors with 2 stages pre amp. Transmits FM Range (88-120 MHz) up to 2 blocks away and with the ultra sensitive condensor microphone that comes with the kit, allows you to pick up any sound within 15 ft. away! Kit includes all electronic parts, OSC coils, and P.C. Board. Power supply 9V D.C.

FMC-105 **$11.50 PER KIT**

WEM-36 FM WIRELESS MICROPHONE

TEET MODEL WEM-36 is a factory assembled FM wireless microphone powered by two AA size batteries. Transmits in the range of 88-108 MHz with 3 transistor circuits to meet with F.C.C. part 15 regulations. Element is built in a plastic tube type case with an omni-directional electret condenser microphone unit. By using a standard FM radio, signal can be heard anywhere on a one-acre lot. Sound quality was judged "very good."



MODEL WEM-36 **$16.50 EACH**

WHISTLE ACTIVATED SWITCH BOARD

All boards are pre-assembled and tested. Your whistle to its FET condenser microphone from a distance, as far as 30 feet away (sensitivity can be easily adjusted) will turn the switch on, then match your whistle to it again, then it turns off. Ideal for remote control toys, electrical appliance such as lights, coffee pots, TV, Hi-Fi, radio or other projects. Unit works on 9V D.C.

MODEL 968
$4.50 EACH

ULTRASONIC SWITCH KIT

Kit includes the Ultra Sonic Transducers, 2 PC Boards for transmitter and receiver. All electronic parts and instructions. Easy to build and a lot of uses such as remote control for TV, garage door, alarm system or counter. Unit operates by 9-12 DC. **$15.50**

ELECTRONIC SWITCH KIT

CONDENSER TYPE
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$5.50 each

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- Sailor's Hornpipe
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MAN 52	C.A.—green	.300	.99	DL728	C.C.—red	.500	1.49
MAN 54	C.C.—green	.300	.99	DL741	C.A.—red	.600	1.25
MAN 71	C.A.—red	.300	.75	DL747	C.A.—red	.600	1.49
MAN 72	C.A.—red	.300	.75	DL750	C.C.—red	.600	1.49
MAN 74	C.C.—red	.300	1.25	DLO847	C.A.—orange	.800	1.49
MAN 82	C.A.—yellow	.300	.49	DLO850	C.C.—orange	.800	1.49
MAN 84	C.C.—yellow	.300	.99	DL33B	C.C.—red	.110	.35
MAN 3620	C.A.—orange	.300	.49	FND358	C.C. ± 1	.357	.99
MAN 3630	C.A.—orange ± 1	.300	.99	FND357	C.C.	.357	.75
MAN 3640	C.C.—orange	.300	.99	FND500	C.C. (FND503)	.500	.99
MAN 4610	C.A.—orange	.400	.99	FND507	C.A. (FND510)	.500	.99
MAN 6610	C.A.—orange—DD	.560	.99	HDSP-3401	C.A.—red	.800	1.50
MAN 6630	C.A.—orange ± 1	.560	.99	HDSP-3403	C.C.—red	.800	1.50
MAN 6640	C.C.—orange—DD	.560	.99	HDSP-3406	C.C. red ±1	.800	1.50
MAN 6650	C.C.—orange ± 1	.560	.99	5082-7751	C.A., R.H.D.—red	.430	1.25
MAN 6660	C.A.—orange	.560	.99	5082-7760	C.C., R.H.D.—red	.430	1.25
MAN 6710	C.A.—red—DD	.560	.99	5082-7300	4x7 Numeric (RHD)	.600	22.00
MAN 6740	C.C.—red—DD	.560	.99	5082-7302	4x7 Numeric (LHD)	.600	22.00
MAN 6750	C.C.—red ± 1	.560	.99	5082-7340	4x7 Hxdcl. (0-9/A-F)	.600	22.50
DLO304	C.C.—orange	.300	1.25	4N28	Photo Xsistor Opto-Isol.		.69
DLO307	C.A.—orange	.300	1.25	LIT-1	Photo Xsistor Opto-Isol.		.69
DLG500	C.C.—green	.500	1.25	MOC3010	Optically Isol. Triac Driver		1.25

COMPUTER GRADE CAPACITORS

MFD	WVDC	PRICE	MFD	WVDC	PRICE	MFD	WVDC	PRICE
250	150	1.95	10,000	15	2.95	24,000	20	2.95
500	200	2.49	10,000	16	3.95	27,000	10	2.95
1,250	3	.99	11,000	19	4.95	32,500	25	4.95
1,500	25	1.95	11,000	55	5.49	40,000	25	5.95
1,500	50	2.95	11,000	60	5.95	43,000	10	5.36
2,000	10	2.95	13,000	16	2.95	50,000	20	7.95
2,250	100	3.95	14,000	13	2.95	52,000	20	5.95
2,300	33	2.95	14,000	35	3.95	55,000	15	5.95
2,500	15	2.95	18,000	10	3.95	58,000	20	5.95
3,000	25	1.95	20,000	20	2.95	65,000	10	7.95
3,600	40	3.95	20,000	55	3.95	72,000	5	7.95
4,500	50	3.95	21,000	15	3.95	80,000	15	8.95
5,500	25	4.49	23,000	7	1.95	90,000	10	8.95
6,100	40	2.49	23,000	10	2.95	160,000	10	8.95
6,600	50	4.95	23,000	20	3.95	200,000	3	12.95

OVER 200 OTHER VALUES AVAILABLE — CALL OR WRITE FOR YOUR REQUIREMENT

LOW PROFILE (TIN) SOCKETS

	1-24	25-49	50-100
8 pin LP	.17	.16	.15
14 pin LP	.20	.19	.18
16 pin LP	.22	.21	.20
18 pin LP	.29	.28	.27
20 pin LP	.34	.32	.30
22 pin LP	.37	.36	.35
24 pin LP	.38	.37	.36
28 pin LP	.45	.44	.43
36 pin LP	.60	.59	.58
40 pin LP	.63	.62	.61

SOLDERTAIL STANDARD (TIN)

	1-24	25-49	50-100
14 pin ST	.27	.25	.24
16 pin ST	.30	.27	.25
18 pin ST	.35	.32	.30
24 pin ST	.49	.45	.42
28 pin ST	.99	.90	.81
36 pin ST	1.39	1.26	1.15
40 pin ST	1.59	1.45	1.30

SOLDERTAIL (GOLD) STANDARD

	1-24	25-49	50-100
8 pin SG	.39	.35	.31
14 pin SG	.49	.45	.41
16 pin SG	.54	.49	.44
18 pin SG	.59	.53	.48
24 pin SG	.79	.75	.69
28 pin SG	1.10	1.00	.90
36 pin SG	1.65	1.40	1.26
40 pin SG	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-24	25-49	50-100
8 pin WW	.59	.54	.49
10 pin WW	.69	.63	.58
14 pin WW	.79	.73	.67
16 pin WW	.85	.77	.70
18 pin WW	.99	.90	.81
20 pin WW	1.19	1.08	.99
22 pin WW	1.49	1.35	1.23
24 pin WW	1.39	1.26	1.14
28 pin WW	1.69	1.53	1.38
36 pin WW	2.19	1.99	1.79
40 pin WW	2.29	2.09	1.89

1/4 WATT RESISTOR ASSORTMENTS – 5%

ASST. 1	5ea.	10 Ohm 12 Ohm 15 Ohm 18 Ohm 22 Ohm 27 Ohm 33 Ohm 39 Ohm 47 Ohm 56 Ohm	50pcs.	$1.95
ASST. 2	5ea.	68 Ohm 82 Ohm 100 Ohm 120 Ohm 150 Ohm 180 Ohm 220 Ohm 270 Ohm 330 Ohm 390 Ohm	50pcs.	$1.95
ASST. 3	5ea.	470 Ohm 560 Ohm 680 Ohm 820 Ohm 1K 1.2K 1.5K 1.8K 2.2K 2.7K	50pcs.	$1.95
ASST. 4	5ea.	3.3K 3.9K 4.7K 5.6K 6.8K 8.2K 10K 12K 15K 18K	50pcs.	$1.95
ASST. 5	5ea.	22K 27K 33K 39K 47K 56K 68K 82K 100K 120K	50pcs.	$1.95
ASST. 6	5ea.	150K 180K 220K 270K 330K 390K 470K 560K 680K 820K	50pcs.	$1.95
ASST. 7	5ea.	1M 1.2M 1.5M 1.8M 2.2M 2.7M 3.3M 3.9M 4.7M 5.6M	50pcs.	$1.95
ASST. 8R		Includes Resistor Assts. 1-7 (350 pcs.)		$10.95 ea.

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7045IPI	CMOS Precision Timer	14.95
7045EV/Kit*	Stopwatch Chip, XTL	24.95
7106CPL	3½ Digit A/D (LCD Drive)	16.95
7106EV/Kit*	IC, Circuit Board, Display	34.95
7107CPL	3½ Digit A/D (LED Drive)	15.95
7107EV/Kit*	IC, Circuit Board, Display	29.95
7116CPL	3½ Digit A/D LCD Dis. HLD.	18.95
7117CPL	3½ Digit A/D LED Dis. HLD.	17.95
7201IDR	Low Battery Volt Indicator	2.25
7205IPG	CMOS LED Stopwatch/Timer	12.95
7205EV/Kit*	Stopwatch Chip, XTL	19.95
7206CJPE	Tone Generator	5.15
7206CEV/Kit*	Tone Generator Chip, XTL	12.95
7207AIPD	Oscillator Controller	6.50
7207AEV/Kit*	Freq. Counter Chip, XTL	13.95
7208IPI	Seven Decade Counter	17.95
7209IPA	Clock Generator	3.95
7215IPG	4 Func. CMOS Stopwatch CKT	13.95
7215EV/Kit*	4 Func. Stopwatch Chip, XTL	19.95
7216AIJI	8-Digit Univ. Counter C.A.	32.00
7216CIJI	8-Digit Freq. Counter C.A.	26.95
7216DIPI	8-Digit Freq. Counter C.C.	21.95
7217IJI	4-Digit LED Up/Down Counter	12.95
7218CIJI	8-Digit Univ. LED Drive	10.95
7224IPL	LCD 4½ Digit Up Counter DRI	11.25
7226AIJL	8-Digit Univ. Counter	31.95
7226AEV/Kit*	5 Function Counter Chip, XTL	74.95
7240IJE	CMOS Bin Prog. Timer/Counter	4.95
7242IJA	CMOS Divide-by-256 RC Timer	2.05
7250IJE	CMOS BCD Prog. Timer/Counter	6.00
7260IJE	CMOS BCD Prog. Timer/Counter	5.25
7555IPA	CMOS 555 Timer (8 pin)	1.45
7556IPD	CMOS 556 Timer (14 pin)	2.20
7611BCPA	CMOS Op Amp Comparator 5MV	2.25
7612BCPA	CMOS Op Amp Ext. Cmvr. 5MV	2.95
7621BCPA	CMOS Dual Op Amp Comp. 5MV	3.95
7631CCPE	CMOS Tri Op Amp Comp. 10MV	5.35
7641CCPD	CMOS Quad Op Amp Comp. 10MV	7.50
7642CCPD	CMOS Quad Op Amp Comp. 10MV	7.50
7660CPA	Voltage Converter	2.95
8038CCPD	Waveform Generator	4.95
8048CCPE	Monolithic Logarithmic Amp	21.60
8069CCQ	50ppm Band—GAP Volt Ref. Diode	2.50
8211CPA	Volt Ref/Indicator	2.95
8212CPA	Volt Ref/Indicator	2.95

74C

74C00	.39	74C95	1.59	74C221	1.95
74C02	.39	74C107	1.89	74C240	2.25
74C04	.39	74C151	2.95	74C244	2.25
74C08	.39	74C154	3.95	74C373	2.49
74C10	.39	74C157	2.25	74C374	2.59
74C14	.75	74C160	1.69	74C901	.69
74C20	.39	74C161	1.60	74C903	.69
74C30	.39	74C162	1.49	74C911	10.95
74C42	1.39	74C163	1.69	74C912	10.95
74C48	1.95	74C164	1.59	74C915	1.69
74C73	.79	74C173	1.39	74C917	10.95
74C74	.79	74C174	1.39	74C922	5.49
74C85	1.95	74C175	1.19	74C923	5.75
74C86	.99	74C192	1.69	74C925	7.50
74C89	6.95	74C193	1.69	74C926	7.50
74C90	1.29	74C195	1.59	80C95	.79
74C93	1.29			80C97	.79

LINEAR

LH0002CN	6.85	LM340T-5	1.25	LM702H	.79
LM10CLH	4.50	LM340T-12	1.25	LM703CN	.89
LM11CLH	4.75	LM340T-15	1.25	LM709N	.29
LH0070-OH	4.95	LM341P-5	.75	LM710N	.79
TL071CP	.79	LM341P-12	.75	LM711N	.79
TL072CP	1.39	LM341P-15	.75	LM723N	.69
TL074CN	2.49	LM342P-5	.69	LM733N	1.00
LH0082CD	35.80	LM342P-12	.69	LM739N	1.19
TL082CP	1.19	LM342P-15	.69	LM741CN	.35
TL084CN	2.19	LM348N	1.25	MC1741SCG	3.00
LH0094CD	36.80	LM350K	5.75	LM747N	.79
LM300H	.99	LF351N	.60	LM748N	.59
LM301CN	.35	LF353N	1.00	LM1014N	2.75
LM302H	1.95	LF355N	1.10	LM1310N	1.95
LM304H	1.95	LF356N	1.10	LM1458CN	.59
LM305H	.99	LM358N	1.00	LM1488N	1.25
LM307CN	.45	LM359N	1.79	LM1489N	1.25
LM308CN	1.00	LM370N	4.49	LM1496N	1.95
LM309H	1.95	LM373N	3.25	LM1556V	1.75
LM309K	1.25	LM377N	2.95	LM1800N	2.95
LM310CN	1.75	LM380N	1.25	LM1871N	5.49
LM311/CN	.90	LM381N	1.95	LM1872N	5.49
LM312H	2.49	LM382N	1.79	LM1877N-9	3.25
LM317MP	1.15	LM384N	1.95	LM1889N	3.20
LM317T	1.75	LM386N-3	1.29	LM1896N	1.75
LM317K	3.95	LM387N	1.45	LM2002T	1.49
LM318CN	1.95	LM389N	1.35	LM2877P	2.05
LM319N	1.95	LM392N	.69	LM2878P	2.25
LM320K-5	1.35	LF398N	4.00	LM2896P-1	2.25
LM320K-12	1.35	LM399H	5.00	LM3189N	2.95
LM320K-15	1.35	TL494CN	4.49	LM3900N	.69
LM320T-5	1.25	TL496CP	1.75	LM3905CN	1.25
LM320T-12	1.25	NE510A	6.00	LM3909N	1.15
LM320T-15	1.25	NE529A	4.95	LM3914N	3.95
LM323K	5.95	NE531H	3.95	LM3915N	3.95
LM324N	.99	NE536H	6.00	LM3916N	3.95
LM329DZ	.65	NE540H	6.00	RC4136N	1.25
LM331N	3.95	NE544N	4.95	RC4151NB	3.95
LM334Z	1.30	NE550A	1.30	RC4194TK	6.95
LM335Z	1.40	NE555V	.39	RC4195TK	5.49
LM336Z	1.75	LM556N	.99	LM4500A	3.25
LM337T	1.95	NE564N	3.95	ICL8038B	4.95
LM337MP	1.15	LM565N	1.25	LM13080N	1.29
LM338K	6.95	LM566CN	1.95	LM13600N	1.49
LM339N	.99	LM567V	1.25	75138N	1.95
LM340K-5	1.35	NE570N	4.95	75450N	.89
LM340K-12	1.35			75451CN	.39
LM340K-15	1.35			75492	.89

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

Value	1-9	10-99	100+	Value	1-9	10-99	100+
10 pf	.08	.06	.05	.001µF	.08	.06	.05
22 pf	.08	.06	.05	.0047µF	.08	.06	.05
47 pf	.08	.06	.05	.01µF	.08	.06	.05
100 pf	.08	.06	.05	.022µF	.09	.07	.06
220 pf	.08	.06	.05	.047µF	.09	.07	.06
470 pf	.08	.06	.05	.1µF	.15	.12	.10

100 VOLT MYLAR FILM CAPACITORS

.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022mf	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	.22mf	.33	.27	.22

+20% DIPPED TANTALUMS (Solid) CAPACITORS

.1/35V	.39	.34	.29	1.5/35V	.41	.37	.29
.15/35V	.39	.34	.29	2.2/35V	.51	.45	.34
.22/35V	.39	.34	.29	3.3/25V	.53	.47	.37
.33/35V	.39	.34	.29	4.7/25V	.63	.56	.45
.47/35V	.39	.34	.29	6.8/25V	.79	.69	.55
.68/35V	.39	.34	.29	15/25V	1.39	1.25	.95
1.0/35V	.39	.34	.29	22/6V	.79	.69	.55

MINI. ALUMINUM ELECTROLYTIC CAPACITORS

Axial	1-99	100-499	500+	Radial	1-99	100-499	500+
.47/50V	.16	.14	.10	.47/25V	.15	.13	.12
1.0/50V	.19	.16	.12	.47/50V	.16	.14	.13
3.3/50V	.17	.15	.11	1.0/16V	.15	.13	.12
4.7/25V	.18	.15	.11	1.0/25V	.16	.14	.13
10/25V	.18	.15	.11	1.0/50V	.17	.15	.14
10/50V	.19	.16	.12	4.7/16V	.15	.13	.12
22/25V	.19	.16	.12	4.7/25V	.16	.14	.13
22/50V	.24	.20	.18	4.7/50V	.17	.15	.14
47/25V	.25	.21	.19	10/16V	.15	.13	.12
47/50V	.29	.25	.23	10/25V	.16	.14	.13
100/25V	.28	.24	.22	10/50V	.17	.15	.14
100/50V	.41	.37	.34	47/50V	.25	.21	.19
220/25V	.39	.34	.33	100/16V	.21	.17	.14
220/50V	.49	.45	.41	100/25V	.25	.23	.21
470/25V	.54	.49	.45	100/50V	.37	.34	.31
1000/16V	.79	.69	.61	220/16V	.25	.21	.19
2200/16V	.89	.79	.69	470/25V	.35	.31	.27

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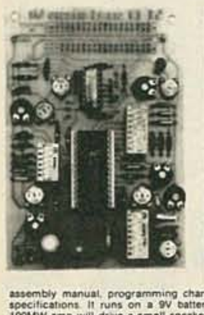

The SE-01 is a complete kit that contains all the parts to build a programmable sound effects generator. Designed around the new **Texas Instruments SN76477 Sound Chip**, the board provides banks of MINI DIP switches and pots to program the various combinations of the SLF Oscillator, VCO, Noise, One Shot, and Envelope Controls. A Quad Op Amp IC is used to implement an Adjustable Pulse Generator, Level Comparator and Multiplex Oscillator for even more versatility. The 3¼" x 5" PC Board features a prototype area to allow for user added circuitry. Easily programmed to duplicate **Explosions, Phasor Guns, Steam Trains,** or almost an infinite number of **other sounds**. The unit has a multiple of applications. The low price includes all parts, assembly manual, programming charts, and detailed 76477 chip specifications. It runs on a 9V battery (not included). On board 100MW amp will drive a small speaker directly, or the unit can be connected to your stereo with incredible results! (Speaker not included). **76477 is included.** Available separately for **$3.15** each.

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- Battery backup
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REVISION 2

$24.95

(Basic Kit)

Does not include speaker switches or 2708 ROM.

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- ★ Envelope control gives decay to notes.
- ★ On board inverter allows single voltage (+12) operation.

OPTIONAL ACCESSORIES

DIP Switches (One 8 pos., One 5 pos.) (Can be **directly soldered** to PC Bd. to access tunes)	2.00/set
Rotary Switches Two 5 position (For **remote wiring** to PC Bd. to access tunes)	2.50/set
Attractive Tan Plastic Case	6.50
Wallplug Transformer (For operation on 117VAC house voltage)	3.00

SPECIAL WINTER PRICES

1. Super Music Maker with case and two 5-position rotary switches — $32.00
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2304 MHZ DOWN CONVERTERS. TUNES IN ON CHANNELS 2 TO 7 ON YOUR OWN HOME T.V. HAS FREQUENCY RANGE FROM 2000 MHZ TO 2500 MHZ. EASY TO CONSTRUCT AND COMES COMPLETE WITH ALL PARTS INCLUDING A DIE-CAST ALUM CASE AND COAX FITTINGS, REQUIRE A VARIABLE POWER SUPPLY AND ANTENNA (Antenna can be a dish type or coffee can type depending on the signal strength in your area.)

2304 MOD 1 (Basic Kit) (Less case & fittings)	$49.95
2304 MOD 2 (Basic / Pre-amp) (Includes case & fittings)	$59.95
2304 MOD 3 (Hi-Gain Pre-amp) (Includes case & fittings)	$69.95

POWER SUPPLY FOR EITHER MODEL ABOVE IS AVAILABLE. COMES COMPLETE WITH ALL PARTS, CASE, TRANSFORMER, ANTENNA SWITCH AND CONNECTORS (Kit) $24.95
Assembled $34.95
Slotted Microwave Antenna For Above Downverters $39.95

****

PREAMPLIFIERS

HAL PA-19—1.5 mhz to 150 mhz. 19db gain operates on 8 to 18 volts at 10ma. Complete unit $8.95.
HAL PA-1.4—3 mhz to 1.4 ghz. 10 to 12 db gain operates on 8 to 18 volts at 10ma. Complete unit $12.95.
(The above units are ideal for receivers, counters, etc.)

****

16 LINE TOUCH TONE DECODER KIT WITH P.C. BOARD AND PARTS $69.95

12 LINE TOUCH TONE DECODER KIT WITH P.C. BOARD AND PARTS $39.95

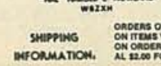
16 LINE ENCODER KIT, COMPLETE WITH CASE, PAD AND COMPONENTS $39.95

12 LINE ENCODER KIT, COMPLETE WITH CASE, PAD AND COMPONENTS $29.95

****

MANY, MANY OTHER KITS AVAILABLE

Send 20 cents stamp or S.A.S.E. for information and flyer on other HAL-TRONIX products. To order by phone: 1-313-285-1782.



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HAL-TRONIX
P.O. Box 1101
Southgate, MI 48195

SHIPPING INFORMATION: ORDERS OVER $25.00 WILL BE SHIPPED POSTPAID EXCEPT ON ITEMS WHERE ADDITIONAL CHARGES ARE REQUESTED. ON ORDERS LESS THAN $25.00 PLEASE INCLUDE ADDITIONAL $2.00 FOR HANDLING AND MAILING CHARGES.

CIRCLE 76 ON FREE INFORMATION CARD

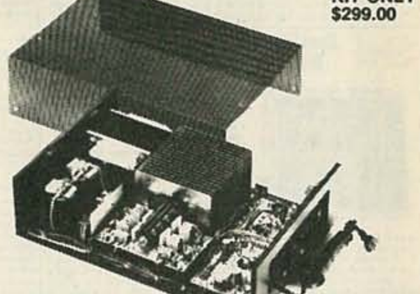
FUJITECH AUDIO KITS

LATEST AUDIO TECHNOLOGY FROM JAPAN

Model A501 Power Amp

- Pure Class A 25W + 25W
- Switchable to Class AB 100W + 100W
- Switchable to Bridge Class A 100W mono
- Switchable to Bridge Class AB 300W mono
- Frequency Response 5-200KHz (-1dB)
- Signal-to-Noise Ratio 120dB
- Non-magnetic Chassis
- "Out-board" comprehensive protection circuitry
- DC circuitry with limited use of NFB
- High Efficiency Fluid Convection Cooling
- THD under 0.007%

KIT ONLY $299.00



$299.00

Model A502 DC Stereo Control Center

- Direct DC coupling from Input to Output
- DC servo circuitry
- **Cascade FET Input in all stages**
- Separate Moving Coil RIAA amplifier
- Distortion below 0.005% (3V)
- Max Output 15V
- Frequency Response 20Hz-20KHz ±0.2 dB
- Maximum Phono Input
  MC = 16mv RMS (1KHz)
  MM = 270mv RMS (1KHz)
- Built-in Headphone amplifier
- Relay Output Muting

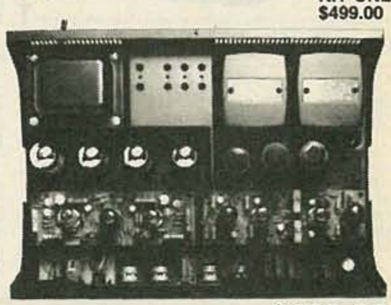
KIT ONLY $349.00

$349.00

Model A1033 Integrated Tube Amplifier

- Latest Japanese Design
- Distortionless Output Transformer using special winding techniques
- Most circuitry on PCB for easy assembly and humfree performance
- Output 30W × 2 Ultra Linear (Switchable to Triode) 15W × 2 Triode Output (near class A performance)
- THD under 0.4%
- Frequency Response 30~30,000 Hz (-1dB)
- Separate Pre-Out and Main-In

KIT ONLY $499.00



$499.00

Send $5.00 for each assembly manual, refundable with order.

Monarchy Engineering, Inc.
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South San Francisco, CA 94080
Visa or Mastercharge acceptable.

VIDEO

36 Channel Up Converter for TV & VTR cable VHF to UHF

1-3 pieces
$29.95 ea.
4 pieces & up
$24.95 ea. **Model V5736**

- Allows complete programming of VTR
- Watch or record any combination of standard or Pay-TV programs
- Receives Midband and Superband channels on UHF
- For Beta/VHS type recorders

BRUCE 37- Channel Wireless Remote Control TV Tuner

Commander 500

1-5 pcs.
$109.95 ea.
6 pcs. & up
$99.95 ea. Reg. $199.95

- For all channels; for all TV's
- Red LED channel readout 1-99
- Master power switch and fine tune controls on remote
- Easy to install
- Scan channels up and down

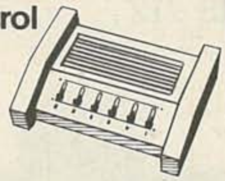
TEKNIKA Wireless Remote Control TV Tuner

$109.95 ea.
Reg. $169.95
Model 6301

- Easy to install; just 4 wires
- Electronic channel selection and indication. VHF: 2-12, UHF: 14-83,
- Ultra-Infrared Beam Control
- Master power switch

Video Control Center

Model VTS-157
$59.95



- No need to change cable to access input to TV set.
- One output; 4 inputs
- No AC power required to operate.
- Auxillary input and output.

CATV 30-Channel Remote Control

Model RSC- 8C **$79.95**

Consists of 2 units: remote control channel selector with fine tuning, ON/OFF switch; and converter body.

TV Accessories

7002 2 Set VHF/FM Amplifier **$ 9.95** ea.
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Coax Accessories

DCS-A/B CATV/MATV Switch **$9.00** ea.

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PPF-1. *PHASOR PAIN FIELD* — Is being tested by Gov't for riot control. Soon to come under weapons restrictions as an infernal machine. Easily hand-held. Hazardous — Use with discretion. SOLD ONLY FOR ANIMAL CONTROL.
PPF-1 .... PLANS **$15.00**

IPG-3. *INVISIBLE PAIN FIELD GENERATOR* — Produces directional field of moderately intense pain to lower back of head up to 50 ft. Cigarette pack sized enclosure is easily hidden.
IPG-3 .... PLANS .... **$7.00** **IPG-3K** .... KIT **$39.50**
IPG-30 .... ASSEMBLED FOR ANIMAL CONTROL **$49.50**

HUG-1. *HIGH POWERED ULTRASONIC GUN* — Produces directional 130 dbs of sound pressure energy at 20-24 kHz. Hand-held, intended for lab use.
HUG-1 .... PLANS **$10.00**

LASERS

PARTICLE BEAM WEAPON .... PLANS **$15.00**

LHP-2. *BEGINNER VISIBLE RED NON-HAZARDOUS OPTICAL DEVICE*. Adjustable pulse.
LHP-2 .... PLANS .... **$7.00** **LHP-2K** .... KIT **$39.50**

LP-3/LRG-3. *LASER PISTOL AND RIFLE COMBINATION* — 7-24 watts of infrared energy.
LP-3/LRG-3 .... PLANS **$10.00**

LGU-1. *VISIBLE RED LASER GUN* for holography, special effects, cloud writing, etc.
LGU-1 .... PLANS **$10.00**

LC-1. *BURNING/CUTTING CO2 LASER* — 10-40 watts continuous.
LC-1 .... PLANS **$15.00**

RUB-1. *WELDING/DRILLING RUBY/YAG LASER*, intense red.
RUB-1 .... PLANS **$15.00**

HPS-1. *HIGH POWERED PORTABLE ENERGY SOURCE FOR LASERS & MAGNETIC WEAPONS* exploding wires, shock waves, etc.
HPS-1 .... PLANS .... **$8.00** **HPS-1K** .... KIT **$49.50**

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INF-1. *INFINITY TRANSMITTER* — Uses telephone lines for selective home or office listening while away on business or vacation.
INF-1 .... PLANS **$15.00**

SD-4. *SEE IN THE DARK* — Device, long range. **SD-4** ... PLANS ... **$10.00**

VWPM-5. *WIRELESS TELEPHONE TRANSMITTER* — Long range.
VWPM-5 .... PLANS .... **$10.00** **VWPM-5K** .... KIT **$34.50**

FBT-7. *WIRELESS MICROPHONE* — Extended range.
FBT-7 .... PLANS .... **$7.00** **FBT-7K** .... KIT **$34.50**

HOD-1/TT-6. *ELECTRONIC TRACKING AND HOMING DEVICE* —
HOD-1/TT-6 ... PLANS ... **$6.00** **HOD-1K/TT-6K** ... KIT ... **$39.50**

TAT-2. *TALK AND TELL* — Device records telephone when in use.
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PSW-3. *PHASOR STUN WAND* — Produces energy capable of burning flesh. Intended as a last resort personnel defense weapon.
PSW-3 .... PLANS .... **$8.00** **PSW-3K** .... KIT **$59.50**

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CIRCLE 78 ON FREE INFORMATION CARD

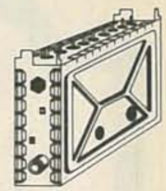
SIMPLE SIMON ELECTRONIC KITS, Inc.

7 + 11 SWD PARTS KITS

MITSUMI VARACTOR UHF TUNER

Model UES-A56F

$34.95

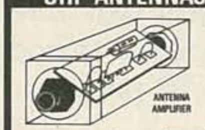


Freq. Range UHF470 - 889MHz
Antenna Input 75 ohms
Channels 14-83 Output Channel 3

KIT NO	PART NO	DESCRIPTION	PRICE
1	VT1-SW	Varactor UHF Tuner, Model UES-A56F	$34.95
2	CB1-SW	Printed Circuit Board, Pre-Drilled	18.95
3	TP7-SW	P.C.B. Potentiometers, 1-20K, 1-1K, and 5-10K ohms, 7-pieces	5.95
4	FR35-SW	Resistor Kit, ¼ Watt, 5% Carbon Film, 32-pieces	4.95
5	PT1-SW	Power Transformer, PRI-117VAC, SEC-24VAC, 250ma	6.95
6	PP2-SW	Panel Mount Potentiometers and Knobs, 1-1KBT and 1-5KAT w/Switch	5.95
7	SS14-SW	IC's 7-pcs, Diodes 4-pcs, Regulators 2-pcs Heat Sink 1-piece	29.95
8	CE9-SW	Electrolytic Capacitor Kit, 9-pieces	5.95
9	CC33-SW	Ceramic Disk Capacitor Kit, 50 W.V., 33-pieces	7.95
10	CT-SW	Varible Ceramic Trimmer Capacitor Kit, 5-65pfd, 6-pieces	5.95
11	L4-SW	Coil Kit, 18mhs 2-pieces, .22µhs 1-piece (prewound inductors) and 1 T37-12 Ferrite Torroid Core with 3 ft. of #26 wire	5.00
12	ICS-SW	I.C. Sockets, Tin inlay, 8-pin 5-pieces and 14-pin 2-pieces	1.95
13	SR-SW	Speaker, 4x6" Oval and Prepunched Wood Enclosure	14.95
14	MISC-SW	Misc. Parts Kit Includes Hardware, (6/32, 8/32 Nuts, & Bolts), Hookup Wire, Ant. Terms, DPDT Ant. Switch, Fuse, Fuseholder, etc.	9.95

When Ordering All Items, (1 thru 14), Total Price 139.95

UHF ANTENNAS and ACCESSORIES



ZYZZX

VHF-UHF WIDEBAND ANTENNA AMPLIFIER

MODEL ALL-1
50 MHz — 900 MHz
12 dB GAIN ± 0.5dB

A Revolutionary New One Stage HYBRID IC Broadband Amplifier

This unit is not available anywhere else in the world. One unit serves many purposes and is available in Kit or Assembled form. Ideal for outdoor or indoor use. Input-output impedance is 75 ohms. Amplifier includes separate co-ax feed power supply. Easily assembled in 25 minutes. No coils, capacitors etc. to tune or adjust.

ALL-1 Complete Kit plus Power Supply **$24.95**
ALL-1 Assembled / Tested plus Power Supply **$34.95**

INTRODUCING OUR NEW 14 ELEMENT — 14.5 dB GAIN YAGI ANTENNA

STVA-3 Yagi Antenna, 14.5 dB, 75 ohm, Chan. 60-68 ... **$19.95**
STVA-4 Yagi Antenna, 14.5 dB, 75 ohm, Chan. 44-52 ... **$19.95**

STVA-1 Yagi Antenna, 11.5 dB, 75 ohm, Chan. 42-54 .... **$9.95**
STVA-2 Yagi Antenna, 11.5 dB, 75 ohm, Chan. 20-28 .... **$9.95**

RG-59/U	75 ohm Low Loss Coax Cable	$ .12 p/ft
F-59	Coaxial Connectors, ea.	.39
MT-1	Special UHF 75-300 ohm Matching Transformer, ea.	1.45
ALL-1	HYBRID IC Wideband VHF-UHF-FM Antenna Amplifier Kit	24.95
ALL-1	HYBRID IC Wideband VHF-UHF-FM Ant. Amp. **Assembled**	34.95

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7408	2/.89	74123	.99
7410	2/.85	74150	1.95
7414	.99	74154	1.95
7417	2/1.10	74157	.99
7420	2/.85	74161	1.19
7447	1.19	74164	1.59
7474	.69	74174	1.59
7475	.79	74175	1.49
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7485	1.19	74193	1.19
7486	2/1.19	74367	.99
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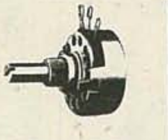
POTENTIOMETERS



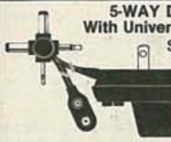
2 Watt @ 70°C
7/8" Slotted Shaft
Linear Taper
1K, 5K, 10K, 25K, 50K, 100K, 1 Meg

CMU $2.95

3/4 Watt @ 70°C
15 Turn Pot.
Linear Taper
100 Ohm, 500 Ohm, 1K, 5K, 10K, 50K, 100K, 500K, 1Meg

830P $1.79

5-WAY DC VOLTAGE ADAPTER
With Universal Plug & 9V Battery Snap



Selective voltage: 6,9,12VDC. Pol. selection (+/-). 6' line — adapter to plugs. 6" line — adapter to batt. snap. 120V/60Hz. 300mA.

DC6912.......$9.95

CMOS

4000	.55	4030	.75
4001	.55	4040	1.79
4002	.59	4044	1.39
4006	1.49	4046	1.95
4009	.79	4047	2.75
4010	.79	4049	.79
4011	.55	4050	.89
4013	.79	4051	1.59
4016	.79	4066	.95
4017	1.39	4069	.69
4018	1.39	4070	.75
4020	1.39	4071	.69
4023	.49	4081	.59
4024	1.19	4093	1.19
4027	.79	4511	1.95

CONNECTORS

DB25P	D-Subminiature Plug	3.95
DB25S	D-Subminiature Socket	4.95
DB51226	Cover for DB25P/S	2.25
22/44SE	P.C. Edge	2.95
UG88/U	BNC Plug	2.19
UG89/U	BNC Jack	3.95
UG175/U	UHF Adapter	.59
SO239	UHF Panel Recp.	1.49
PL258	UHF Adapter	1.95
PL259	UHF Plug	1.95
UG260/U	BNC Plug	2.39
UG1094/U	BNC Bulkhead Recp.	1.49

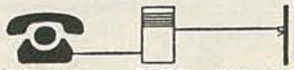
LINEAR

LM301N	.59	LM7805T	1.75
LM305H	1.39	LM7812T	1.75
LM307N	.75	LM7815T	1.75
LM308N	1.19	LM380N	1.49
LM309K	2.25	LM384N	2.49
LM310N	2.69	LM555N	.69
LM311N	1.49	LM556N	1.49
LM317T	2.29	LM565N	1.95
LM318N	2.95	LM566N	1.95
LM319N	2.95	LM567N	1.79
LM320K-5	2.25	LM723N	.79
LM7905T	1.75	LM741N	.65
LM7912T	1.75	LM1310N	2.95
LM7915T	1.75	LM1458N	.99
LM323K	5.95	LM1488N	1.59
LM324N	1.29	LM1489N	1.59
LM337T	2.29	LM1800N	4.49
LM339N	1.29	76477N	3.95

Phone Tunes

REPLACES THE TELEPHONE RINGER BELL WITH A SELECTION OF 30 FAMILIAR TUNES

NEW! NEW!



Telephone PT030 Wall Jack

FEATURES

Replaces monotonous telephone ringer bell. Easily connects to any standard phone. Use alongside regular phone or replace remote ringer elsewhere in building or outside. FCC approved. Use on any phone system — worldwide. Use different tune to identify extension phones. Microprocessor controlled. Adjust. vol. control and variable tune speed control. Operates on 2-9V batteries or AC Adapter (not incl.).

PT030 Phone Tunes $49.95
AD30 AC Adapter $8.95

NEW! JE215 Adjustable Dual Power Supply

General Description: The JE215 is a Dual Power Supply with independent adjustable positive and negative output voltages. A separate adjustment for each of the supplies provides the user unlimited applications for IC current voltage requirements. The supply can also be used as a general all-purpose variable power supply.

FEATURES:
- Adjustable regulated power supplies, pos. and neg. 1.2VDC to 15VDC.
- Power Output (each supply): 5VDC @ 500mA, 10VDC @ 750mA, 12VDC @ 500mA, and 15VDC @ 175mA.
- Two, 3-terminal adj. IC regulators with thermal overload protection.
- Heat sink regulator cooling
- LED "on" indicator
- Printed Board Construction
- 120VAC input
- Size: 3-1/2"w x 5-1/16"L x 2"H

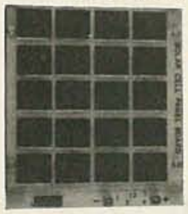
JE215 Adj. Dual Power Supply Kit (as shown) . . $24.95

(Picture not shown but similar in construction to above)
JE200 Reg. Power Supply Kit (5VDC, 1 amp) . . $14.95
JE205 Adapter Brd. (to JE200) ±5,±9 & ±12V. . $12.95
JE210 Var. Pwr. Sply. Kit, 5-15VDC, to 1.5amp. . $19.95

DESK TOP ENCLOSURES

DTE-8 (Pictured).....................$31.95
DTE-11 (Pictured).....................34.95
DTE-14 (Pictured).....................36.95
DTE-HK (Case for JE600)..............47.95
DTE-AK (Case for JE610)..............52.95

NEW! *Sun Power Your Electronics!*
SOLAR CELL PANEL KIT



- Output: 10VDC, to 100mA in Series 5VDC, to 200mA in Parallel
- Panel may be easily connected for Series or Parallel out
- Over 11 square inches of active cell surface
- Voltage line tap @ 0.5V increments
- Provision for charging batteries
- Overall panel size: 4¾"L x 4½"H x ½"D

The JE305 Solar Cell Panel Kit contains 20 ea. solar cells. On the panel board are power line taps which allow the user to select voltages (1 voltage at a time) from 0.5VDC to 10VDC. The applications of each panel can be further expanded by coupling additional panels in series for more voltage or in parallel for more current. The premium grade solar cells provide the current necessary for the operation of most portable transistor radios, small battery powered cassette tape players & unlimited experimental solar projects.

JE305 ....$39.95

LS Schottky

74LS00	.55	74LS109	.75
74LS02	.55	74LS123	1.49
74LS04	.69	74LS138	1.29
74LS08	.55	74LS139	1.29
74LS10	.55	74LS154	1.95
74LS14	1.09	74LS157	1.19
74LS30	.55	74LS161	1.29
74LS32	.69	74LS174	1.19
74LS38	.69	74LS175	1.19
74LS42	1.29	74LS192	1.49
74LS47	1.29	74LS193	1.49
74LS48	1.79	74LS221	1.49
74LS73	.75	74LS244	1.89
74LS74	.69	74LS245	3.49
74LS75	.75	74LS367	.89
74LS85	1.49	74LS374	1.95
74LS90	.89	81LS97	2.29

SOCKETS

Low Profile		Wire Wrap	
8 pin LP	2/.59	14 pin WW tin	.75
14 pin LP	2/.69	14 pin WW gold	1.09
16 pin LP	2/.79	16 pin WW tin	.79
18 pin LP	2/.89	16 pin WW gold	1.19
20 pin LP	2/.99	24 pin WW gold	1.69
22 pin LP	2/1.09	40 pin WW gold	2.75
24 pin LP	.79	14 p. plug/cover	1.29
28 pin LP	.82	16 p. plug/cover	1.39
36 pin LP	.99	24 p. plug/cover	1.95
40 pin LP	1.19	Also, The Molex Line	

DIODES & TRANSISTORS

IN751	2/.59	2N2219A	2/1.19
IN757	2/.59	2N2222A	2/.89
IN1188	2.69	2N2907A	2/.89
IN3600	5/.99	2N3055	.99
IN4001	4/.59	2N3772	2.25
IN4004	4/.69	2N3904	2/.69
IN4007	4/.79	2N3906	2/.69
IN4148	10/.99	2N4401	2/.79
IN4733	2/.69	2N4403	2/.79
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IN4735	2/.69	2N5139	2/.69
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IN4744	2/.69	2N5951	2/1.29

CAPACITORS

Dipped Tantalum		ELECTROLYTIC	
.1mfd@35V	2/.89	1mfd@50V	3/.69
.47mfd@35V	2/.89	4.7mfd@50V	2/.59
1mfd@35V	2/.89	10mfd@50V	2/.69
2.2mfd@25V	2/1.09	22mfd@50V	2/.79
3.3mfd@25V	2/1.19	47mfd@50V	2/.89
4.7mfd@25V	2/1.39	100mfd@50V	.59
10mfd@25V	1.19	220mfd@50V	.69
33mfd@25V	3.95	1000mfd@25V	1.19
		2200mfd@16V	1.39
100V MYLAR		**50V CERAMIC**	
.001-.01mfd	4/.79	10pf-.022mfd	4/.59
.022mfd	4/.89	.047mfd	4/.69
.047mfd	4/.99	.1mfd	4/.79
.1mfd	4/1.19		
.22mfd	4/1.29		

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Z80A	CPU (4MHz)	13.95
MC6800	8 Bit MPU	8.95
8080A	CPU	6.95
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8216	Bi-Directional Bus Driver	4.49
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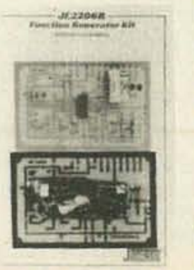
8T97	Tri-State Hex Buffer	2.25
AY-5-1013	30K Baud UART	6.95
AY-5-2376	88-Key Keyboard Encoder	11.95
2114-2	4K Static RAM (200ns)	3.95
MK4116	16K Dynamic RAM (250ns)	3.95
2708	8K EPROM	5.95
2716	16K EPROM (+5V)	9.95

Function Generator Kit



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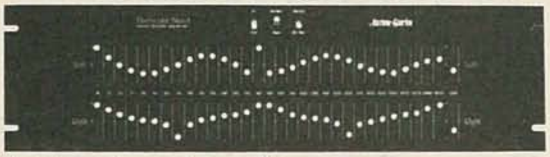
COMPARE! 31 BANDS



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11 Band Mono EQ	☐ $ 75.84	☐ $151.57
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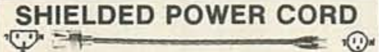
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THE LAST WORD IN 8" FLOPPY-DISK ENCLOSURES

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9602	Card Cage	75.00
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9612	Buffered Utility Proto Board	49.00
9616	32K EPROM/RAM Module	250.00
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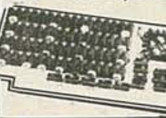

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21L02 450ns	1.30	1.25	.99
21L02 250ns	1.59	1.55	1.15
2111	3.75	3.65	3.55
2112-1	2.95	2.85	2.65
2101-1	2.90	2.70	2.55
2114N (450 NS.)	3.75	3.50	3.25
2114L 250ns (4045)	6.50	5.95	5.50
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4044 250 ns	8.95	7.50	6.90
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EMM4200A	9.75	8.75	7.95
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4060 4K x 1 (16 Pin) ... 4.95
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14	19	36	59
16	20	38	62
18	24	59	84
20	29	69	99
22	24	79	1.10
24	28	85	1.20
28	43	1.10	1.49
36	58	1.25	1.69
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FND357	357	Red	Comm. Cathode	99
FND500	500	Red	Comm. Cathode (+1)	99
FND503 (500)	500	Red	Comm. Cathode	99
FND507 (510)	500	Red	Comm. Anode	99
FND508	500	Red	Comm. Anode (+1)	99
FND530	500	Red	Comm. Cathode	99
FND550	500	Green	Comm. Cathode	149
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FND807 (810)	800	Red	Comm. Anode	175
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TIL309	270	Red	Numerical Display	9.95
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XAN3051	300	Green	Comm. Anode Right DP	125
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XAN3053	300	Green	Overflow, CA, Left DP	125
XAN3054	300	Green	Comm. Cathode Right DP	125
XAN3061	300	Green	Comm. Anode Right DP	199
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525-10	10 Hole Hard NS, Apple, etc.	$29.95
525-16	16 Hole Hard Micropolis	$29.95

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577-10	10 Hole Hard NS, Apple, etc.	32.25
577-16	16 Hole Hard Micropolis	32.25

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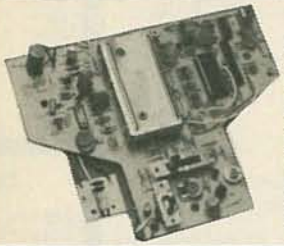

"TANK BATTLE" TV GAME

In just a short time and with a few minor parts, the most novice hobbiest can complete this exciting Tank Battle game. Create a fun-filled evening for the whole family. Two independent tanks rumble thru land mine fields, shoot shells and fragment when hit. Four distinct engine sounds are produced for the different speeds. Sounds of gunfire, shell bursts and tank explosions are realistic. Automatic on-screen scoring. Supplied with schematic drawing.

SOLD AS IS
$9.95 ea.

C.B. SPECIAL

CONVERT THESE TO 10 METER FM

New HY-GAIN printed circuit board assembly with PLL02A chip and 3 crystals. (Squelch pot, volume control and channel switch not included.) Boards sold as is, the way we bought them from the manufacturer. Board dimensions 6″x 6½″

1-9 **$7.50** 50-99 **$6.00**
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(Double Side)
Size 9.25 x 10.75
Thickness .062
$2.00 ea.

TRIMMER CAP

1.5-20pF
(ARCO PC-402)
50¢ ea.

E. F. JOHNSON "S" METER

Edge Meter 250 UA, fits in ⅝″x 1⅜″ hole. Black background.
Scale 1-20 Top, 0-5 Bottom.
$1.25 ea. **5/$5.00**

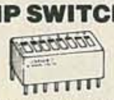
COMPUTER GRADE ELECTROLYTICS

VALUE/MFD	VOLTS	DIAM./LGTH.	PRICE
63,000	@ 15V	3″ x 5½″	$4.00 ea.
10,000	@ 20V	1½″ x 5¾″	$3.00 ea.
2,700	@ 25V	1¼″ x 2¼″	$2.00 ea.
2,900	@ 25V	1¼″ x 2″	$2.00 ea.
100,000	@ 30V	3″ x 5½″	$6.00 ea.
39,000	@ 30V	1″ x 5¾″	$4.00 ea.
34,800	@ 50V	3″ x 5½″	$3.00 ea.
450	@ 75V	1¼″ x 2¼″	$2.00 ea.
500	@ 100V	1½″ x 3¼″	$2.00 ea.
50	@ 450V	1¼″ x 2″	$2.00 ea.

SUB-MINI 10K POT

with On-Off
¼″ hole mount,
⅛″ D shaft,
¾″ thread section.
5/$1.00

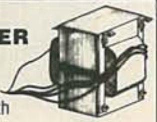
DIP SWITCH



5 POSITION **$1.00** ea.
8 POSITION **$1.50** ea.
10 POSITION **$2.00** ea.
12 POSITION **$2.50** ea.

POWER TRANSFORMER

$14.95 ea.



Primary – 115 vac
Secondary – 32 v with 24 v tap at 15 amps
Dim. 4½″ h X 3¾″ w X 4″ deep

AMP METERS

2¼″ square, no shunt required. Easy-to-read dial.
Movements: 0-6, 0-10, 0-17
$2.50 ea.

TELEPHONE & TTY INTERFACE MODEM

MFG by Anderson Jacobson
DAA Modem Model DC 230 with A-36 Telephone Coupler

$69.95

Rated 300 Baud, half or full duplex. DAA level adjustable 0 to −3, −4 to −6, −7 to −10. TTY and DAA outputs brought out to 15 pin Molex connectors. FSK oscillator sends 1070 Hz space and 1270 Hz mark. Receives 2025 Hz space and 2225 Hz mark. Telephone coupler has 4-ft. cord and plug. Size 4¼″ W x 15 L x 3″ Dp. designed to be recessed in desk or panel. Electronics in case, 6⅞ W x 12 x 2¾″ Dp. with 8-ft., 3-wire U-ground cord and plug. Operates on 115 vac, 50/60 Hz, ⅛ Amp. Supplied with connection sheet. Removed from equipment, excellent condition, guaranteed.

9 VOLT NiCd RECHARGEABLE BATTERY

NEW. Replaces the popular 9V Transistor Battery.
$4.75 ea.

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MFG By Rotron Inc.
3 Blades 4¾″ Square
USED
110 VAC **$5.95** ea.
NEW
230 VAC Model MU3A1
$12.00 ea.

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6 volt @ 8 a.h. with Charger

$14.95

Elpower EP 680 may be charged constant voltage or constant current. Battery is self-contained and requires no maintenance. Connections made with quick connect lugs. All plastic case size 5½ h x 2¾ w x 4½ l, weight 4 lbs.

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4⅝″ w x 7⅜″ l x ¾″ to 1½″ h
Has a lip for recessed face plate and a felt bottom

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3″ Diam.,
8 OHM,
5 Watts.
$2.00 ea.

TEXAS INSTRUMENT KEYBOARD

Has 3 slide switches, 26 different keys, key pad removable by 4 screws
$1.95 ea. 5/**$8.00**

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2 uF @	15V	12/$1.00
10 uF @	15V	12/$1.00
20 uF @	15V	12/$1.00
50 uF @	15V	12/$1.00
2.2 uF @	25V	12/$1.00
3.3 uF @	25V	12/$1.00
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2 uF @	150V	12/$1.00
25 uF @	25V	15/$2.00
3 uF @	50V	15/$2.00
5 uF @	50V	15/$2.00
10 uF @	50V	15/$2.00
250 uF @	25V	10/$2.00
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Mfg. by Rotron Inc., Model SU2A5.
115v AC. 19 amps.
(Impedance protected.)
3¼″x 3¼″x 1¾″
$12.00 ea.

POWER SUPPLY

+ 12 vdc .1 amps
+ 5 vdc .4 amps
$3.95 ea.

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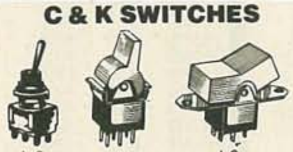
UG-175 RG-58 Adapt	$ .20
UG-176 RG-59 Adapt	$ .20
UG-1094 BNC-F/Panel	$1.00
S0239	50c
PL259	60c

COAXIAL CABLE

50 OHM-RG 174
$4.95/100′ $3.00/50′

C & K SWITCHES



L-3 J-60 J-3

Part #		Movement
J-60	7101	SPDT
L-3	7108	SPDT (momentary)
J-3	7201	DPDT (special large rocker)

$1.00 ea. **6/$5.00**

7′ POWER CORD

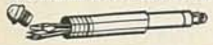
HEWLETT PACKARD TYPE

Molded 3 Prong Plug with molded receptacle
Belden 16 AWG
$3.00 ea.

IC SOCKETS GOLD-PLATED WIRE WRAP

14 pin **40c** ea.
16 pin **45c** ea.

SCREW DRIVER KIT



Handle stores four blades
2 single slot 5/32″ & 3/32″
1 phillips 1 scratch awl
6″ long with one blade inserted
$1.00 ea.

MODEM CABLE ASSEMBLIES

$5.50 ea.

Conn & Hood	22 AWG # Cond	Length
25 P	14	15′
25 S	10	17′

24-Volt POWER SUPPLY 5.4 AMPS

MFG by ACDC Electronics Inc.
Model OEM 24N5.4-1
$45.00

Input 105-125 vac 50/60 Hz. Has volt adj and O.L. adj. Output terminals contain + out, + sen, − sen, − out, ac neut, ac line and GND. 13 LBS.
10″ l x 5″ h x 5″ w

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ALL MERCHANDISE 100% GUARANTEED!

CALL US FOR VOLUME QUOTES

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2716	2048 x 8	(5V) (450ns)	5.50	4.95
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TMS2532	4096 x 8	(5V) (450ns)	12.95	11.95
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4116-300	16,384 x 1	(300ns)	8/14.95	1.75
4164	64,536 x 1	(200ns)		CALL

STATIC RAMS

				100 pcs
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2102-1	1024 x 1	(450ns)	.89	.85
21L02-4	1024 x 1	(LP) (450ns)	1.29	1.15
21L02-2	1024 x 1	(LP) (250ns)	1.69	1.55
2111	256 x 4	(450ns)	2.99	2.49
2112	256 x 4	(450ns)	2.99	2.79
2114	1024 x 4	(450ns)	8/16.95	1.95
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LP = LOW POWER

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5.0	3.95
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5.185	3.95
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6.5536	3.95
8.0	3.95
10.0	3.95
14.31818	3.95
18.0	3.95
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20.0	3.95
22.1184	3.95
32.0	3.95

February Specials

Z-80A-CPU	6.00
Z-80A-PIO	6.00
8214	2.95
8216	1.50
6800	4.95
6810	3.95

TMS 40L44-20
4096 x 1 low power 200ns RAMS

By Texas Instruments - not equivalent part number made by another manufacturer as sold by others:

4.49 each 125.00/32 pcs.

Specials end February 28, 1982
Please state "February Specials" when ordering

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6502	6.9
6502-A	12.9
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6505	8.9
6507	9.9
6520	4.3
6522	9.9
6532	14.9
6551	11.8

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Z80-CPU	8.9
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Z80A-P10	6.0
Z80-CTC	5.9
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Z80A-S10/1	28.9
Z80-S10/2	23.9
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				74LS166	2.40	74LS293	1.85
74LS00	.25	74LS85	1.15	74LS168	1.75	74LS295	1.05
74LS01	.25	74LS86	.40	74LS169	1.75	74LS298	1.20
74LS02	.25	74LS90	.65	74LS170	1.75	74LS324	1.75
74LS03	.25	74LS91	.89	74LS173	.80	74LS352	1.55
74LS04	.25	74LS92	.70	74LS174	.95	74LS353	1.55
74LS05	.25	74LS93	.65	74LS175	.95	74LS363	1.35
74LS08	.35	74LS95	.85	74LS181	2.15	74LS364	1.95
74LS10	.25	74LS96	.95	74LS189	9.95	74LS365	.95
74LS11	.35	74LS107	.40	74LS190	1.00	74LS366	.95
74LS12	.35	74LS109	.40	74LS191	1.00	74LS367	.70
74LS13	.45	74LS112	.45	74LS192	.85	74LS368	.70
74LS14	1.00	74LS113	.45	74LS193	.95	74LS373	.99
74LS15	.35	74LS114	.50	74LS194	1.00	74LS374	1.75
74LS20	.25	74LS122	.45	74LS195	.95	74LS377	1.45
74LS21	.35	74LS123	.95	74LS196	.85	74LS378	1.18
74LS22	.25	74LS124	2.99	74LS197	.85	74LS379	1.35
74LS26	.35	74LS125	.95	74LS221	1.20	74LS385	1.90
74LS27	.35	74LS126	.85	74LS240	.99	74LS386	.65
74LS28	.35	74LS132	.75	74LS241	.99	74LS390	1.90
74LS30	.25	74LS136	.55	74LS242	1.85	74LS393	1.90
74LS32	.35	74LS137	.99	74LS243	1.85	74LS395	1.65
74LS33	.55	74LS138	.75	74LS244	.99	74LS399	1.70
74LS37	.55	74LS139	.75	74LS245	1.90	74LS424	2.95
74LS38	.35	74LS145	1.20	74LS247	.76	74LS447	.37
74LS40	.35	74LS147	2.49	74LS248	1.25	74LS490	1.95
74LS42	.55	74LS148	1.35	74LS249	.99	74LS668	1.69
74LS47	.75	74LS151	.75	74LS251	1.30	74LS669	1.89
74LS48	.75	74LS153	.75	74LS253	.85	74LS670	2.20
74LS49	.75	74LS154	2.35	74LS257	.85	74LS674	9.65
74LS51	.25	74LS155	1.15	74LS258	.85	74LS682	3.20
74LS54	.35	74LS156	.95	74LS259	2.85	74LS683	2.30
74LS55	.35	74LS157	.75	74LS260	.65	74LS684	2.40
74LS63	1.25	74LS158	.75	74LS266	.55	74LS685	2.40
74LS73	.40	74LS160	.90	74LS273	1.65	74LS688	2.40
74LS74	.45	74LS161	.95	74LS275	3.35	74LS689	2.40
74LS75	.50	74LS162	.95	74LS279	.55	81LS95	1.69
74LS76	.40	74LS163	.95	74LS280	1.98	81LS96	1.69
74LS78	.50	74LS164	.95	74LS283	1.00	81LS97	1.69
74LS83	.75	74LS165	.95	74LS290	1.25	81LS98	1.69

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74C02	.35	74C901	.80	4020	.95	4099	1.9
74C04	.35	74C902	.85	4021	.95	14409	12.9
74C08	.35	74C903	.85	4022	1.15	14410	12.9
74C10	.35	74C905	10.95	4023	.35	14411	11.9
74C14	1.50	74C906	.95	4024	.75	14412	12.9
74C20	.35	74C907	1.00	4025	.35	14419	4.9
74C30	.35	74C908	2.00	4026	1.65	4502	.9
74C32	.50	74C909	2.75	4027	.65	4503	.6
74C42	1.75	74C910	9.95	4028	.80	4508	1.9
74C48	2.10	74C911	10.00	4029	.95	4510	.9
74C73	.65	74C912	10.00	4030	.45	4511	.9
74C74	.85	74C914	1.95	4034	2.95	4512	.9
74C76	.80	74C915	2.00	4035	.85	4514	1.2
74C83	1.95	74C918	2.75	4040	.95	4515	2.2
74C85	1.95	74C920	17.95	4041	1.25	4516	1.5
74C86	.95	74C921	15.95	4042	.75	4518	1.2
74C89	4.50	74C922	5.95	4043	.85	4519	1.2
74C90	1.75	74C923	5.95	4044	.85	4520	1.2
74C93	1.75	74C925	6.75	4046	.95	4522	1.2
74C95	1.75	74C926	7.95	4047	.95	4526	1.2
74C107	1.00	74C927	7.95	4049	.55	4527	1.9
74C150	5.75	74C928	7.95	4050	.55	4528	1.2
74C151	2.25	74C929	19.95	4051	.95	4531	.9
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74C160	2.00	4001	.35	4066	.75	4539	1.9
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74C174	2.25	4011	.35	4075	.30	4585	.95
74C175	2.25	4012	.25	4076	.95	4702	12.95
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74C193	2.25	4014	.95	4081	.30	80C07	.95
74C195	2.25	4015	.95	4082	.30	80C95	.85
74C200	5.75	4016	.45	4085	.95	80C96	.95
74C221	2.25	4017	1.15	4086	.95	80C97	.95
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22 pin ST	.30	.27
24 pin ST	.30	.27
28 pin ST	.40	.32
40 pin ST	.49	.39
ST = SOLDERTAIL		
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75452V	.39
75453V	.39

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74S03	.48	74S86	1.44	74S169	5.44	74S260	1.83
74S04	.79	74S112	1.59	74S174	1.09	74S274	19.95
74S05	.79	74S113	1.98	74S175	1.09	74S275	19.95
74S08	.48	74S114	1.50	74S181	4.47	74S280	2.90
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7403	.19	7460	.23	74143	2.95	74192	.79
7404	.19	7470	.35	74144	2.95	74193	.79
7405	.22	7472	.29	74145	.60	74194	.85
7406	.22	7473	.34	74147	1.75	74195	.85
7407	.22	7474	.35	74148	1.20	74196	.79
7408	.24	7475	.49	74150	1.35	74197	.75
7409	.19	7476	.35	74151	.65	74198	1.35
7410	.19	7480	.59	74152	.65	74199	1.35
7411	.25	7481	1.10	74153	.55	74221	1.35
7412	.30	7482	.95	74154	1.40	74246	1.35
7413	.35	7483	.50	74155	.75	74247	1.25
7414	.55	7485	.65	74156	.65	74248	1.85
7416	.25	7486	.35	74157	.55	74249	1.95
7417	.25	7489	4.95	74159	1.65	74251	.75
7420	.19	7490	.35	74160	.85	74259	2.25
7421	.35	7491	.40	74161	.70	74265	1.35
7422	.29	7492	.50	74162	.85	74273	1.95
7423	.29	7493	.49	74163	.85	74276	1.25
7425	.29	7494	.65	74164	.85	74279	.75
7426	.29	7495	.55	74165	.85	74283	2.00
7427	.29	7496	.70	74166	1.00	74284	3.75
7428	.45	7497	2.75	74167	2.95	74285	3.75
7430	.19	74100	1.00	74170	1.65	74290	.95
7432	.29	74107	.30	74172	5.95	74293	.75
7433	.45	74109	.45	74173	.75	74298	.85
7437	.29	74110	.45	74174	.89	74351	2.25
7438	.29	74111	.55	74175	.89	74365	.65
7440	.19	74116	1.55	74176	.89	74366	.65
7442	.49	74120	1.20	74177	.75	74367	.65
7443	.65	74121	.29	74178	1.15	74368	.65
7444	.69	74122	.45	74179	1.75	74376	2.20
7445	.69	74123	.55	74180	.75	74390	1.75
7446	.59	74125	.45	74181	2.25	74393	1.35
7447	.69	74126	.45	74182	.75	74425	3.15
7448	.69	74128	.55	74184	2.00	74426	.85
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74S04	.40	74S112	.85	74S175	1.40
74S05	.45	74S133	1.40	74S194	1.10
74S08	.40	74S135	1.50	74S257	1.50
74S10	.30	74S138	1.25	74S258	1.40
74S11	.35	74S139	1.10	74S260	1.50
74S15	.40	74S140	1.00	74S280	1.50
74S20	.40	74S153	1.10	74S373	2.25
74S30	.40	74S151	1.25		
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2N3820 P FET .... $ .45
2N 5457 N FET .... $ .45
2N2646 UJT .... $ .45
ER 900 TRIGGER DIODES .... 4/$1.00
2N 6028 PROG. UJT .... $ .65

DISC CAPACITORS
.1UF 16V .... 10/$1.00 .... 100/$8.00
.01UF 35V .... 16/$1.00 .... 100/$5.00

IN4148 (IN914) 15/1.00

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.47UF 35V	5/$1.00	10UF 35V	— $ .40
.68UF 35V	5/$1.00	22UF 10V	— $ .30
1UF 35V	5/$1.00	15UF 16V	3/$1.00
2.2UF 20V	5/$1.00	30UF 6V	5/$1.00
3.3UF 20V	4/$1.00	33UF 20V	$ .60
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		200UF 20V	$1.75

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Si 1020 G 20 WATTS .$12.50
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200 PRV 1A LASCR .95

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DB 25P male $2.75
DB 25S female 3.75
HOODS 1.50

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4001	.20	4027	.40	4081	.20	74C74	.50
4002	.20	4028	.56	4082	.20	74C76	.70
4006	.65	4029	.75	4093	.60	74C83	1.30
4007	.27	4030	.35	4099	1.75	74C85	1.40
4008	.65	4034	2.25	4501	.95	74C86	.50
4009	.45	4035	.75	4510	.65	74C90	.90
4010	.45	4040	.65	4511	.65	74C93	.95
4011	.20	4042	.55	4514	1.40	74C151	1.75
4012	.20	4043	.65	4515	1.50	74C157	1.75
4013	.30	4044	.55	4516	.75	74C160	1.20
4014	.55	4046	.90	4518	1.25	74C161	1.15
4015	.55	4047	.90	4520	.70	74C163	1.15
4016	.30	4048	.40	4553	2.75	74C165	1.25
4017	.60	4050	.40	74C00	.27	74C173	1.30
4018	.50	4051	.80	74C02	.27	74C174	1.30
4019	.45	4052	.75	74C08	.30	74C175	1.20
4020	.70	4053	.75	74C10	.27	74C192	1.30
4021	.55	4066	.50	74C14	1.20	74C901	.50
4022	.80	4069	.20	74C20	.27	74C914	1.75
4023	.20	4071	.25	74C32	.45		
4024	.45	4072	.20	74C73	.75		
4025	.25	4076	.65				
		4077	.35				

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200	.70	.80	1.90	9.00
400	1.20	1.40	2.60	12.00
600		1.80	3.60	15.00

TRIAC's

PRV	1A	10A	25A
100	.45	.80	1.55
200	.84	1.30	2.10
400	1.30	1.90	3.10
600	2.00	2.75	4.30

L1411-IR DETECTOR .... 3/$1.00
FP 100 PHOTO TRANS .... $ .50
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IL-5 OPTO ISOLATOR .... $ .45
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20KV 250MA DIODE $1.90

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200	.07	.20	.40	1.30	5.25	9.00
400	.09	.25	.65	1.50	6.50	12.00
600	.11	.30	.80	2.00	8.50	15.00
800	.15	.35	1.00	2.50	10.50	18.00
1000	.20	.45	1.25	3.00	12.50	26.00

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7404	.24	7483	.50	74174	.65
7405	.24	7485	.65	74175	.60
7406	.33	7486	.42	74176	.75
7407	.35	7490	.45	74177	.75
7408	.27	7491	.45	74180	.75
7409	.24	7492	.45	74181	1.90
7410	.17	7493	.45	74182	.45
7411	.22	7494	.60	74190	.70
7413	.42	7495	.60	74191	.75
7414	.50	7496	.60	74192	.70
7416	.33	74107	.35	74193	.79
7417	.37	74121	.35	74194	.85
7420	.17	74122	.39	74195	.45
7425	.30	74123	.42	74196	.75
7426	.33	74125	.45	74197	.75
7427	.30	74126	.45	74273	.85
7430	.17	74145	.75	74279	.60
7432	.27	74148	1.25	74365	.65
7437	.27	74150	1.10	74367	.65
7438	.27	74151	.50	74368	.65
7440	.17	74153	.40	74390	.90
7442	.45	75154	1.10	75492	1.05
7445	.70	74155	.50	8T31	2.00
7446	.75	74157	.50	8T32	2.75
7447	.65	74160	.85	8T98	1.20
7450	.17	74161	.65	9312	.60
7472	.35	74162	.60	9601	.75
7473	.35	74163	.60	9602	.75
		74164	.60	DS0056H	1.50

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74LS03	.22	74LS109	.38	74LS240	.89
74LS04	.22	74LS112	.38	74LS241	.89
74LS05	.22	74LS113	.45	74LS242	.89
74LS08	.20	74LS114	.55	74LS243	.89
74LS09	.22	74LS123	.59	74LS244	.89
74LS10	.20	74LS124	1.25	74LS245	1.50
74LS11	.22	74LS125	.45	74LS247	.75
74LS12	.22	74LS126	.45	74LS248	1.10
74LS13	.45	74LS132	.50	74LS251	.55
74LS14	.40	74LS136	.45	74LS253	.55
74LS15	.35	74LS138	.48	74LS257	.55
74LS20	.18	74LS139	.48	74LS258	.55
74LS21	.18	74LS151	.40	74LS266	.60
74LS22	.25	74LS153	.40	74LS273	1.15
74LS26	.35	74LS155	.60	74LS279	.48
74LS27	.28	74LS156	.70	74LS280	1.80
74LS28	.45	74LS157	.48	74LS283	.75
74LS30	.18	74LS158	.48	74LS290	.72
74LS32	.35	74LS161	.58	74LS365	.52
74LS37	.30	74LS162	.70	74LS366	.52
74LS38	.30	74LS163	.58	74LS367	.52
74LS40	.40	74LS164	.58	74LS368	.52
74LS42	.44	74LS165	.75	74LS373	1.25
74LS47	.65	74LS169	1.75	74LS374	1.25
74LS51	.20	74LS170	1.50	74LS377	1.25
74LS54	.20	74LS173	.59	74LS386	.50
74LS73	.35	74LS174	.45	74LS390	.98
74LS74	.35	74LS175	.40	74LS393	.98
74LS75	.35	74LS181	1.95	74LS670	1.60
74LS76	.45	74LS190	.72	81LS97	1.10
74LS83	.75	74LS191	.72	81LS98	1.10
74LS85	.85	74LS192	.65		
74LS86	.40	74LS193	.60		
74LS90	.39	74LS194	1.10		
74LS92	.45	74LS195	.90		

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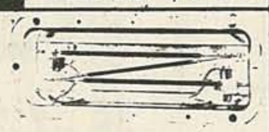

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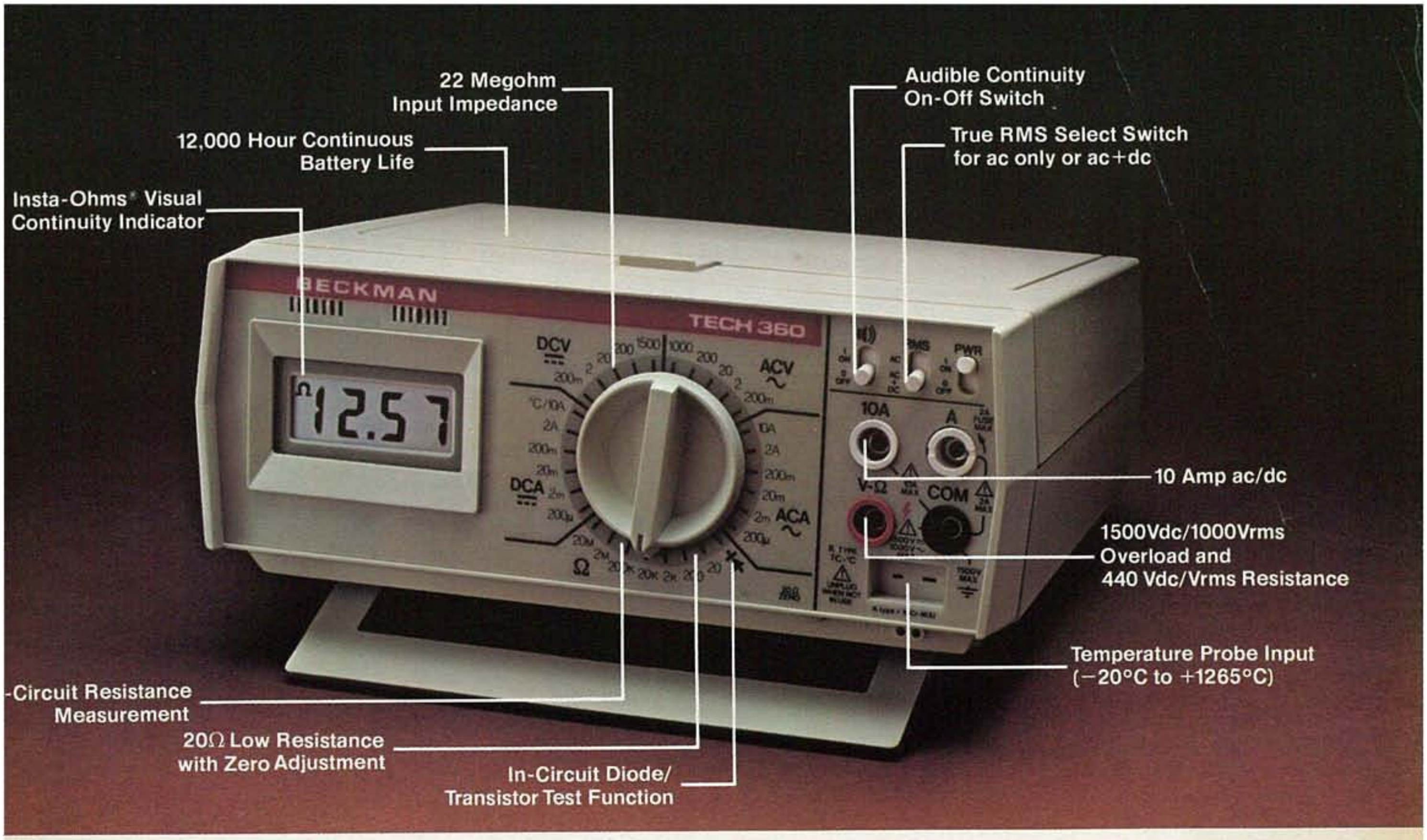

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