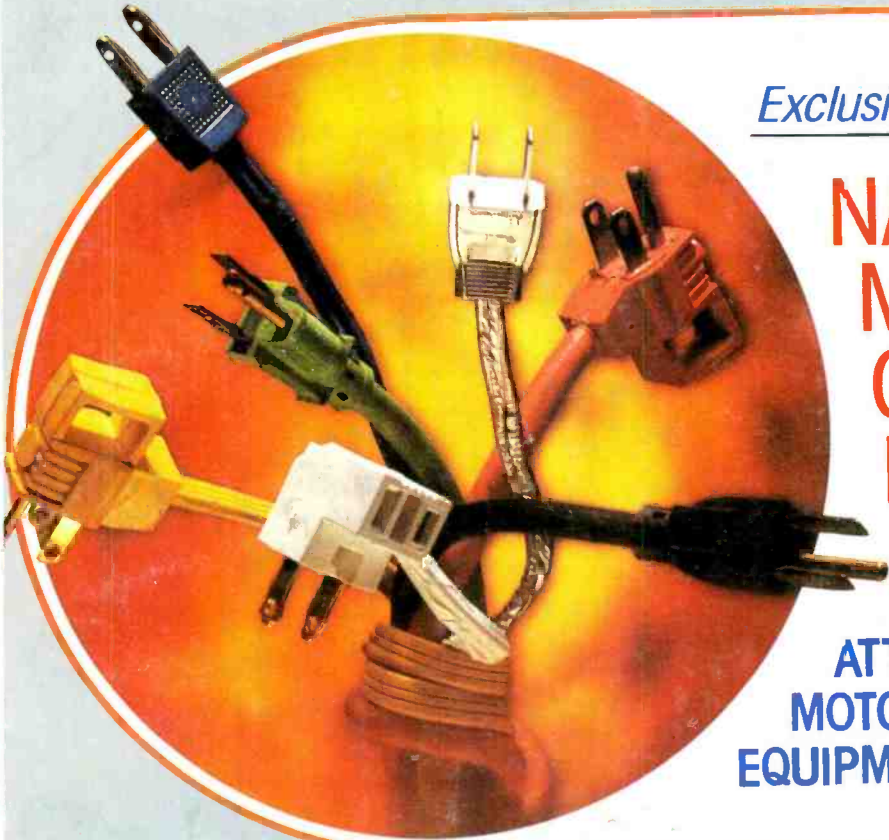
Popular Electronics®

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE OCTOBER 1979/$1.25

25th ANNIVERSARY ISSUE

Special Focus on the Electronics Revolution



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How to Add I/O Ports to Microcomputers

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CIRCLE NO. 17 ON FREE INFORMATION CARD

NEW PRODUCT

Endorsement Battle

A famous golf star endorses the Lanier. Our unit is endorsed by our president. You'll save $100 as a result.

We not only took the unit apart, we examined our competition as well.

Judge for yourself. That new Olympus micro recorder shown above sells for $150. Its closest competition is a $250 recorder called the Lanier endorsed by a famous golf star.

FANCY ENDORSEMENT

The famous golf star is a pilot who personally flies his own Citation jet. The Olympus recorder is endorsed by JS&A's president who pilots a more cost-efficient single engine Beachcraft Bonanza. The golf star does not endorse the Lanier unit for free. After all, a good portion of his income is derived from endorsing products.

Our president, on the other hand, does not get paid for endorsing products–just for selling them. And his Bonanza is not as expensive to fly as the golf star's Citation. In fact, our president also drives a Volkswagon Rabbit.

SOLD DIFFERENTLY

The Lanier is sold through a national network of direct salesmen similar to the IBM sales force. Naturally, these salesmen must be paid expenses and commission.

JS&A efficiently sells the Olympus through this advertisement–a very direct and inexpensive way to market a product.

With less overhead, no direct national sales staff, and no expensive endorsements, Olympus can sell its recorder for less money to JS&A. And with our company's efficiency, we can sell you practically the same recorder as the Lanier for much less–a savings of $100.

Is the Olympus better than the Lanier for less money? We weren't sure, so we took them both apart and what we found amazed us. Other than a slight size difference, the units were practically identical. For example:

CORELESS MOTOR

Both units have the new coreless motor. Conventional motors require a long and heavy solid core that is wirewound. In a coreless motor, the windings are on the outside or stationary part of the motor making it flatter, yet it has greater initial torque and more consistent speed than any other conventional motor.

THE FERRITE HEAD

Both units use ferrite for their recording heads–the same material used in precision studio recorders. This extremely hard, diamond-like material will last a lifetime and prevents oxide build-up.

A NEW KIND OF MIKE

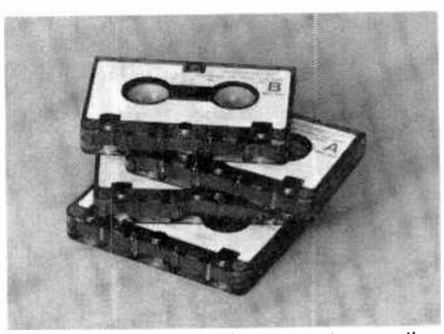
Both units also use an electret condenser microphone with automatic level control. In an electret system, the impedence of the microphone remains constant, thus passing on the natural sound quality of all frequencies without distortion. The result is a clear recording with an extremely low signal-to-noise ratio, so you'll hear less objectionable background hissing or humming.

MANY SIMILAR FEATURES

Both units use the microcassette tapes that play 30 minutes per side. The Olympus measures only 1"x 2½"x 4⅞" and weighs only 9 ounces. The Lanier is the same weight as the Olympus and measures only ⅞" x 2½" x 4"–practically the same size.

HERE'S OUR PLAN

But prove it to yourself. Order an Olympus recorder from JS&A. After you receive it, call in your Lanier sales representative. Have him bring you a sample of his unit. (You might even check to see what kind of car the salesman drives.) Then make a side-by-side comparison. Compare both units feature for feature



Micro cassettes are the newest recording medium. Each cassette will record for 30 minutes per side.

and see how much better the Olympus sounds. Then carry them both in your pocket and on trips. Use them at meetings or while you drive in your car. Really give them both a workout.

Then decide. If you don't feel that the Olympus is as good a unit or better than the Lanier for $100 less, simply return the Olympus within 30 days for a prompt refund and then purchase the Lanier unit, keeping one of our tapes as a gift. If you decide to keep the Olympus, consider yourself a smart shopper. Anyone who would take the time to read this advertisement and take the action to order and test the Olympus unit, deserves to save $100.

SERVICE AT ITS BEST

Both the Lanier and the Olympus units are solidly backed by efficient service organizations. Olympus has an outstanding service-by-mail facility so no matter where you live, just slip your unit in its handy mailer and send it in. Olympus is the same company that manufactures high quality precision cameras and optics, and JS&A is America's largest single source of space-age products–further assurances that your modest investment is well protected.

To order your Olympus unit for our comparison trial, send your check for **$150** plus $3.50 for postage and handling to: JS&A Group, Inc., One JS&A Plaza, Northbrook, Illinois 60062. (Illinois residents add 5% sales tax.) Credit card buyers may call our toll-free number below. We will promptly ship your unit, one free tape, complete instructions, and one-year warranty. If you wish to order additional cassettes, you may order them for $3 each or $15 for a package of five (our minimum quantity).

CONSUMERS CAN BENEFIT

Endorsements are very helpful when you sell products. They attract attention and give consumers confidence that their purchase is also used by someone famous. But indirectly, consumers pay for endorsements. They also pay for a large sales force and less efficient marketing methods.

When you purchase an Olympus from JS&A, you pay for just what you get. A great product. Why not order an Olympus recorder at no obligation, today?

JS&A PRODUCTS THAT THINK®

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Call TOLL-FREE 800 323-6400
In Illinois Call .... (312) 564-7000

When you're not available, Phone-mate's Remote 930 is!

Our *Telephone Products Division* of **Communications Electronics™** is pleased to introduce the new and improved *Phone-mate* Remote 930 telephone answering system. Unlike other telephone answerers, the Remote 930 has many useful and unique features *not* available on any other machine at any price. Features such as a LED digital message counter and Audio-Scan™ are standard on the Remote 930.

You can connect your Remote 930 to *any* phone system including the new "com-key" and private business systems. More importantly, the Remote 930 has built-in fail-safe features controlled by an internal computer to correct common user mistakes.

The incredible, new Phone-mate Remote 930 gives you complete control of all calls while you're away!

MANY IMPORTANT FEATURES

Only the Remote 930 gives you so many important features such as call monitor, ring adjust and remote control. You can retrieve your messages from anywhere in the world by calling in from any telephone, anywhere, anytime. Sound your coded pocket tone key and hear your messages played over the phone in complete privacy. The Remote 930 is your 24 hour message center for business contacts, family and friends.

SAVE TIME AND MONEY!

Save valuable time and money when retrieving messages by remote control. *One phone call* plays all messages *as many times* as you like without requiring you to hang up and call again. The **remote backspace feature** allows you to replay individual messages instantly without waiting for the entire tape to rewind and replay.

C-VOX™ AN EXCLUSIVE FEATURE

Controlled Voice Activation will allow your caller to leave a lengthy or involved message, but will *also* let you set a maximum time limit. With the Voice Controlled Announcement feature, you can tailor your *personal* outgoing message to *any* length, up to 30 seconds. A **single control knob** for operational simplicity can be set for: **Record Calls, Playback Calls, Record Two-Way Conversations,** Tape Record/Dictation, Record Announcement and Announce Only. A **LED Digital Message Counter** instantly indicates (up to 99) how many messages you have received. The counter also functions as a "timer" to let you know the precise length of your outgoing message.

The Remote 930 uses readily available, reliable cassettes that pop in and out instantly. Messages can then be stored for future reference.

FAIL-SAFE DESIGN

Advanced computer technology, unavailable until now, has been designed into the Remote 930. The specially engineered microprocessor has been programmed to recognize user mistakes and *automatically* correct them. For example, when the incoming message tape is full, some systems will not answer the phone. This means you would not be able to access your system to retrieve calls. However with the Remote 930, when an incoming message tape is completely filled, the machine will allow you to playback your messages and also respond to *all* remote commands. This is only one of several built-in self-correcting back-up measures to insure ultimate reliability and ease of operation.

TEST IT FREE FOR 31 DAYS!

Test a *Phone-mate* Remote 930 FREE for 31 days. Because the Remote 930 is such a new and improved answering system, we want you to put it to the test at your office or home for 31 days before you decide to keep it. Check out the unique features that put the Remote 930 in a class by itself. See how the handsome woodgrain styling and compact size compliment any home or office. Notice how effectively the Remote 930 will take your every call and give you your messages *exactly* as you received them. If for any reason you are not completely satisfied, we insist that you return it in new condition with all enclosed parts in 31 days, for a prompt refund.

phone·mate

COMPLETE NATIONAL SERVICE

With your *Phone-mate* Remote 930, we will send a complete set of simple operating instructions and a one-year limited warranty on parts and 90 days on labor. If service is ever required on any *Phone-mate* product purchased from **Communications Electronics**, simply send your system to one of our approved national service centers. When you purchase your telephone answering system from **CE**, you're buying **from one of the world's leaders in high technology electronics.**

MADE BY PHONE-MATE QUALITY CHECKED BY CE

Since all Remote 930 telephone answering systems sold by **Communications Electronics** are products of *Phone-mate*, the company that *pioneered* consumer answering devices, you can be assured of purchasing the finest and most reliable telephone answering machine in the world. In addition, our Quality Control Department further audits the quality of every *Phone-mate* model sold by us to ensure the high reliability found in all *Phone-mate* answering devices. **CE** has given the Remote 930 our quality control rating #1, which is our highest quality grade for technologically sophisticated equipment.

BUY WITH CONFIDENCE

The Remote 930 is an extraordinary telephone message center. It provides virtually any answering and message processing features that the most demanding businessperson could require. To order **the world's only computer controlled and fail-safe engineered remote controlled answering system,** send or phone your order directly to our *Telephone Products Division*. Mail orders to: **Communications Electronics**, Box 1002, Ann Arbor, Michigan 48106 U.S.A. Send $299.95 plus $5.00 for U.P.S. U.S. shipping for each Remote 930 system. If you have more than one person using your system, we suggest that you purchase an extra remote pocket tone key for every person authorized to receive messages at $29.95 each. Prices and specifications are subject to change without notice. No COD's please. Cashier's checks and credit card order will be processed immediately. All sales are subject to availability, but because this is the most fantastic answering device that **CE** has ever offered, we have reserved enough units for immediate shipment. If you have a Master Charge or Visa card, you may call anytime and place a credit card order. **Dial toll free 800-521-4414.** International orders are invited at slightly higher cost. If you are outside the **U.S.** or in Michigan, dial anytime 313-994-4444. Michigan residents please add 4% tax. All order lines at **CE** are staffed 24 hours, seven days a week.

Due to the high demand for this most exciting and useful telephone answering system, please place your order today *without* obligation, to assure prompt delivery.

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CIRCLE NO. 1 ON FREE INFORMATION CARD

Other Phone-mate® Remote 930 Features:

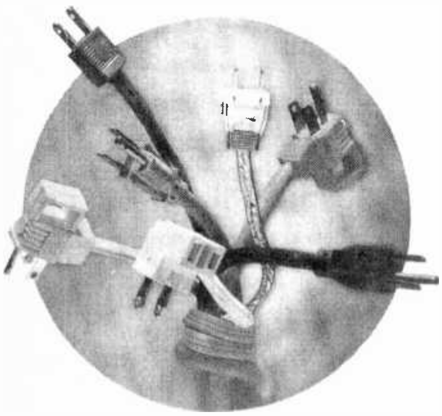
- **Exclusive C-VOX**—Controlled Voice Activation means your caller has time to leave a long or involved message. As long as C-VOX™ recognizes the sound of a voice it will continue to record, making it ideal for detailed job orders or messages.
- **Remote Control Feature**—Hear your messages played back over the phone from any phone, anywhere by sounding your coded pocket tone key. *Backspace* to repeat message or backspace directly to the message desired. *Erase/Store* messages...you can reset back to the beginning, record new messages over old ones, or continue recording *after* old ones to save them.
- **Fail-Safe Design**—Advanced computer technology in the Remote 930 represents a major breakthrough in telephone answerers. The Remote 930's specially designed and engineered microprocessor is programmed to recognize user mistakes and automatically correct them. The built-in self-correcting back-up features insure ultimate reliability and ease of operation.
- **Dual Cassettes**—means versatility and convenience. By keeping your incoming messages and outgoing announcements on separate tapes, you can file important messages for future reference while also establishing an "Announcement Library" for recurring needs.
- **Useful for Dictating Ideas**—Use the Remote 930 as a tape recorder or for dictation, then file the cassette or have it ready for transcription.
- **Change Tape Without a Service Call**—Unlike reel-to-reel answerers, the Phone-mate's dual cassette system allows you to quickly change tapes without the inconvenience and expense of having a technician do it for you.
- **Voice Controlled Announcement**—Allows you to tailor your outgoing message. The voice controlled announcement feature, with automatic level control, lets you record outgoing announcements up to 30 seconds in length. This eliminates the inconvenience of having to rehearse and time messages to fit a fixed time limit.
- **Call Monitor**—screens your calls and eliminates unwanted interruptions by letting you hear who's calling without touching your phone or letting the caller know you're there. If you wish to talk, just pick up the phone. If not, let Phone-mate take the message and return the call at your convenience.
- **Record Two-Way Conversations**—Keep a record of important conversations. Phone-mate records both sides of important telephone conversations. This enables you to keep a record of negotiations, orders or appointments.
- **Audio-Scan™**—Designed to help you locate your messages fast. The specially engineered cassette system enables you to hear messages in rewind or fast-forward. This lets you locate specific messages rapidly for instant replay. Fast-forward moves the tape rapidly past unwanted messages.
- **Ring Adjust**—Phone-mate answers when you want it to. Adjust your Phone-mate to answer on any ring one through five, and leave it on at all times. When you're in, you have ample time to answer the phone yourself. If you're away, Phone-mate will take the call for you. Never worry about remembering to always turn your machine "on" when you leave. This protects you from the "telephone burglar." Your phone is never left to ring and ring unanswered...a sure signal that no one is home, and an open invitation to burglary.
- **Announce Only**—Broadcast important information. The announce only feature lets you give each caller an announcement message *without* recording an incoming message. Ideal to announce business hours, vacation schedules, movie times, etc. The message counter always operates, so you know how many people have called and heard your message. Great for tabulating calls in telephone surveys, etc.
- **Communications Electronics™**—quality control approval rating #1. Our highest quality grade for FCC certified technologically sophisticated telephone equipment.
- **LED Power On Light**—tells if your unit is on and functioning without examining power knobs.
- **LED Digital Message Counter**—Indicates how many messages you have received. The counter also functions as a "timer" to let you know the precise length of your outgoing announcement.
- **Manual Erase**—allows you to erase previous messages when rewinding.
- **FCC Registered**—Conforms to all requirements for plug-in connection to a standard phone company modular jack.
- **Power**—Regular 110V AC; 60 Hz. house current.
- **Warranty**—1 year parts, 90 days labor.
- **Dimensions**—8¾" Wide, 11¾" Deep, 3⅛" High
- **Shipping Weight**—3.18 Kilograms, 7 pounds

OCTOBER 1979 25TH ANNIVERSARY

Popular Electronics®

VOLUME 16, NUMBER 4

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE



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PE celebrates its twenty-fifth anniversary with a breakthrough article designed to save energy on motor-driven electrical appliances.

Cover photo by Don Carroll

25th Anniversary Issue

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ZIFF-DAVIS PUBLISHING COMPANY
Editorial and Executive Offices
One Park Avenue, New York, New York 10016
212-725-3500
Joseph E. Mesics (725-3568)
John J. Corton (725-3578)
Bonnie B. Kaiser, Eastern Adv. Mgr., (725-3580)

Midwestern Office
Ted Welch
Suite 1400, 180 N. Michigan Ave.,
Chicago, IL 60601 (312-346-2600)

Western Office
9025 Wilshire Boulevard, Beverly Hills, CA 90211
213-273-8050;

Western Representative: Norm Schindler
7050 Owensmouth Ave., #209
Canoga Park, CA 91303 (213-999-1414)

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

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Editorial

A SIXTY-YEAR-OLD ELECTRONICS PUBLISHING HERITAGE

POPULAR ELECTRONICS is now 25 years old, publishing its 300th issue last month. In truth, its lineage really extends back *sixty years* since it was spawned out of the pages of *Radio & TV News*, which started publishing life as *Radio Amateur News* in 1919. (Genealogically, *Radio Amateur News* was the begetter of *Radio News* which, in turn, begat *Radio & TV News*, which begat both *Electronics World* and POPULAR ELECTRONICS, the former merging into PE in 1972.)

The past quarter of a century was, of course, the period in which electronics truly blossomed. The very first issue of POPULAR ELECTRONICS, October 1954, observed that it is devoted to the science of electronics at the how-it-works, why-it-works, how-to-do-it and how-to-use-it level. The lead article was written by "Solid State" columnist Lou Garner: "Build Your Own Bike Radio," a four-tube battery-powered radio that attached to a bicycle's handle bars with "U" bolts. And John Frye's "Carl and Jerry" column titillated readers.

In keeping with PE's quest to present exciting, up-to-date electronics information for active enthusiasts, the following year covered such topics as: "A Scintillation Counter" to detect and measure atomic radiation; "Market Survey of Geiger Counters" accompanied by a build-your-own device; President Eisenhower's announcement of plans to launch a small, unmanned satellite for communication purposes; the beginning of an audio and hi-fi section; solar battery experiments; and the first "Transistor Topics" column.

The May 1956 cover story was "The Truth about Radar Speed Traps." In 1958, there were articles on "The Language of Digital Computers," "Play Games with Nixie® Tubes," "3D Color TV with Glasses," "Go Mobile with Audio Fi Speakers," and "Electronic Robots."

In 1959, PE had articles on Citizens Band Radios, a new Color TV Projection System (called Eidophor), "Stereo Records—Fad or Fulfillment?" "Special Report on Color TV," "Understanding Transistor Circuits," "Hams Go Video," and a special Hi-Fi Stereo issue. That was also the year when PE changed from pulp paper to smooth, "slick" paper.

Readers in the early-Sixties cut their eyeteeth on Dave Weems' "Sweet Sixteen Speakers" (16 small speakers working in unison to produce resoundingly deep bass), "An Introduction to Logic Circuits," "Build a One-Tube Radiation Fallout Monitor," "A Transistorized Car Ignition System," "Air Suspension Speaker Systems," "Home Video Tape Recording—When?" "TV Pictures on Phono Discs" (Westinghouse's "Phonovid"), "A White-Noise Generator to Aid Sleep," and "Build a Field-Effect Transistor Voltmeter" (a 2N2498 cost $12.75 then).

In 1966, there were articles about the integrated circuit and its bright future, and "The Logic Demon" (a logic-function demonstrator project that used integrated circuits). This was followed in 1967 with "The Brute 70," a project to build a 70 watts rms audio power amplifier.

The year 1968 was truly a "breakthrough" one with Don Lancaster's $12/decade counting unit project. And the decade ended with PE's publication of Dan Meyer's "Tiger Amplifier" audio projects (which were low-cost 40-to-100-W power amps), "A Dwell Extender for Ignition Systems," a "Logic Probe and Pulser," an "Experimenter's Laser," and a "Hand-Held Op-Amp Tach."

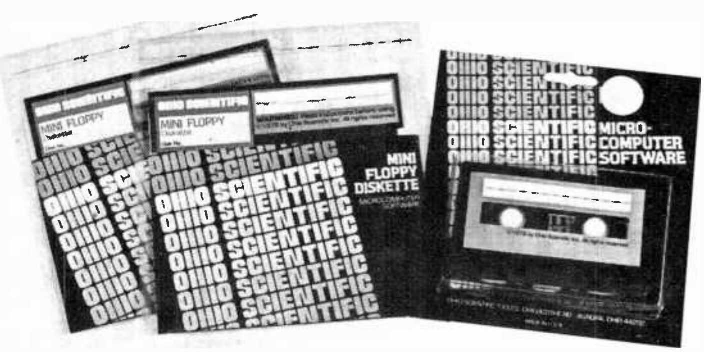
(Continued on page 6)

Here it is at last... THE FIRST FLOPPY DISK BASED COMPUTER FOR UNDER $1000

The C1P MF $995

- Complete mini-floppy computer system
- 10K ROM and 12K RAM
- Instant program and data retrieval

The Challenger 1P Mini-disk system features Ohio Scientific's ultra-fast BASIC-in-ROM, full graphics display capability and a large library of instant loading personal applications software on mini-floppies including programs for entertainment, education, personal finance, small business and now *home control!*



The C1P MF configuration is very powerful. However, to meet your growth needs it can be directly expanded to 32K static RAM and a second floppy by simply plugging these options in. It also suports a printer, modem, real time clock and AC remote interface as well as the OS-65D V3.0 development oriented operating system.

Or Start with the C1P CASSETTE BASED Computer for just $349.

The cassette based Challenger 1P offers the same great features of the mini-disk system including a large software library except it has 4K RAM and conservative program retrieval time. Once familiar with personal computers, you'll be anxious to expand your system to the more powerful C1P MF.

You can move up to mini-disk performance at any time by adding more memory and the disk drive. Contact your local Ohio Scientific dealer or the factory today.

*Both systems require a video monitor, modified TV or RF converter and home television for operation. Ohio Scientific offers the AC-3 combination 12" black and white TV/monitor for use with either system at $115.00 retail.

All prices, suggested retail.

OHIO SCIENTIFIC

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CIRCLE NO. 40 ON FREE INFORMATION CARD

EDITORIAL continued

In 1970, PE's "Laser Beam Communicator" wound up at the Smithsonian Institution's National Museum of History. The new decade brought a "new look" to PE, too. Its logo and type face were changed, and the editorial thrust was directed even more toward the serious electronics enthusiast. This marked a new maturity on the part of readers, whom research studies indicated were more technically knowledgeable than were earlier readers and enjoyed a higher income.

A host of construction projects on products not previously available to readers at low cost followed: George Meyerle's graphic stereo tone-control system, a mini DVM, a digital clock, an electronic desk calculator, a TV preamp for blacked-out sports transmissions, the "Drummer Boy" rhythm maker for musical instruments, an "Alpha Brain-Wave Monitor," a "Super Audio Sweep Generator" that essentially launched function generators as basic test instruments outside professional labs, and other "breakthrough" articles.

Emerging from the pages of POPULAR ELECTRONICS in 1973 and 1974 were such innovative projects as an "Electronic Digital Wristwatch" for under $80 when commercial equivalents were selling for upwards of $200, and an impressive ESP test machine, among others.

PE's size was changed to its present large format in August 1974 to accommodate more complex schematics and foil patterns. Articles in the rest of the year included a digital electronics course and "How New FTC Hi-Fi Rules Affect You."

The world's first microcomputer kit to rival commercial models—the Altair 8800—was introduced on the cover of PE's January 1975 issue, with how-to-build plans detailed inside. This computer stunned the electronics world since its total price, including a beautiful enclosure, cost virtually the same as what its microprocessor—the powerful Intel 8800—was selling for at the time. It's commonly acknowledged that this milestone was the beginning of the home/very-small-business computer market. A myriad of "firsts" followed: the first low-cost all-solid-state TV camera, how to build a direct-drive single-play turntable, a programmable music box, and others. Also, Forrest Mims' popular "Experimenter's Corner" was initiated.

This creative publishing effort was carried through over the next few years with the introduction of construction plans for computer color graphics ("TV Dazzler"), a modem for data communications by telephone (The "Pennywhistle"), an all-in-one computer and terminal ("SOL"), the COSMAC "Elf," "Speechlab" computer voice communications, a low-cost logic analyzer, a Bucket Brigade audio delay system, Morse Code automatic alphanumeric-readout receiver, a computer chess game, etc., as well as feature coverage of new electronics products such as electronic games, video cassette tape recorders, home projection TV systems, car stereo, and video disk systems.

In keeping with the country's energy crisis, 1979 issues contained articles on building a 55-mph "Cruisealert," a "Low Fuel Warning Buzzer," and this issue's motor energy-saving device (developed by NASA), as well as advanced technology articles such as the recent "Upcoming New World of TV Reception," which clarified how the vertical interval can carry information for a variety of purposes.

Next month, you'll read about a solid-state humidity controller project that reduces heating fuel use, a Guide to Buying Printers for Computers, an RTTY Reader project, and more.

So as you can see, POPULAR ELECTRONICS has been an active participant in the startling electronics revolution that took place over the past quarter of a century, both as an information medium and as a "mover and shaker" of events by spearheading the introduction of new types of electronic equipment. We look forward to sharing future developments in electronics with you for the next 25 years, particularly since many of you have been (and will be) part of the continually growing electronics scene through writing articles, creating construction projects and sending us feedback letters.

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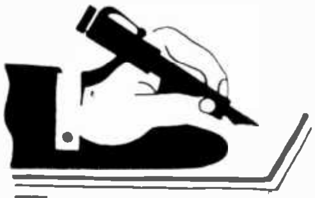
CIRCLE NO. 54 ON FREE INFORMATION CARD



Letters

PE BACK ISSUES NEEDED

I recently had a fire in my house and garage and all of my early issues of POPULAR ELECTRONICS, from Volume 1 No. 1 through 1972, were destroyed. I would greatly appreciate it if you could forward information as to where I can obtain replacements.—*Thomas D. Laase, 9 Hadley Rill, Pueblo, CO 81001.*

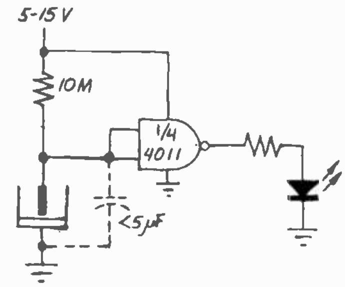
Perhaps one of our readers has a set he's willing to part with. If so, please contact Mr. Laase directly at the address given.

VOLTAGE SPIKE PROTECTION

Having built the "Automatic Garage Door Closer" (March 1979), I would like to call your attention to one problem. There is no diode across the relay's coil to protect the transistor from voltage spikes. After burning out a couple of transistors, I installed a 1N4004 rectifier diode across *K1*'s coil. Now the circuit operates just fine. Thanks for a useful project.—*Glen Charnock, WB6JKM, Oxnard, CA.*

ALTERNATE METHOD

I enjoyed "Space-Age Electronic Projects for Boats" (July and August 1979) and would like to share a simpler way to detect high liquid levels. The circuit is shown here. Any CMOS inverter or inverting gate can be used. If a hex inverter were used, you could have six detectors per IC. So, using this scheme



for the fresh-water tank gauge would eliminate three ICs, nine capacitors, and three transistors. An electrolytic capacitor of 5 µF or less will eliminate LED flashing when the liquid in the tank sloshes.

CMOS level detectors will even work in demineralized water, where the LM1830 will not. They will also work on unrectified ac power, which should eliminate any tendency for the electrodes to electroplate. If the tank is nonconductive, a ground probe must be used in the liquid.—*Clyde Hyde, Tenino, WA.*

TEST RECORD EXPLANATION

In the July "Stereo Scene," Ralph Hodges refers to the Soudcraftsmen Test Record, with a brief explanation of its content and application. That description was incomplete and actually incorrect. The test tones on the record are clearly specified to be all at the same level—there is no roll off or compensation at top and bottom. The Test Record can be used correctly with a sound-level meter. Only the 1-kHz Reference Tones, designed specifically for "listening EQ," are Fletcher-Munson compensated and they appear only on the opposite channel, designed so that the EQ process also compensates for the user's hearing idiosyncracies.

As a further aid in the equalization process, the Test Record also contains all-band pink noise to be used with any further instrumentation the consumer wishes to utilize for his own purposes. The test instructions clearly explain these methods. —*Ralph F. Yeomans, President, Soundcraftsmen, Santa Ana, CA.*

Out of Tune

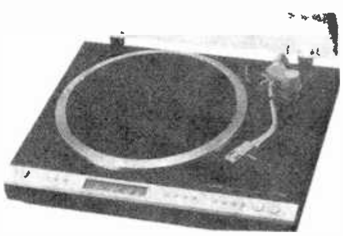
In "Build an In-Circuit Transistor Tester for $10," p. 54, July 1979, there is an omission in the schematic diagram (Fig. 1). The RESET input of *IC2*, a 4027 CMOS flip-flop, must be connected to V_{SS} if the circuit is to operate properly. This can be accomplished by connecting pin 12 to pins 3 through 9.

New Products

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

Hitachi Microprocessor Turntable

The top model of Hitachi's new turntable line is the HT-860. It uses a Uni-Torque di-



rect-drive motor with quartz-locked speed regulation and features fully automatic operation under control of a microprocessor. A photoelectric sensor indexes the tonearm for records of various sizes, and fine-speed control for correction of musical pitch is provided. Operation is by means of front-panel electronic touch controls. Digital readout of speed and disc size is also included. Wow and flutter is rated at 0.025% wrms and S/N at 78 dB DIN B. $800.

CIRCLE NO. 89 ON FREE INFORMATION CARD

Communication Microphone

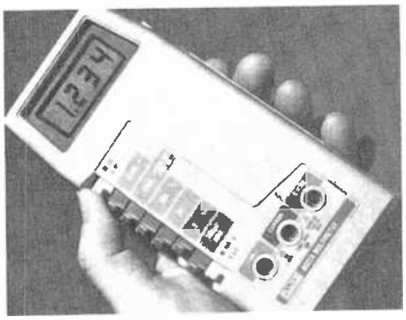
The Model 526T Series II Super Punch* microphone from Shure can be used with transmitters and transceivers with 500 ohms or greater input impedance. It has a six-conductor coiled cord and a triple-pole, double-throw switch arranged for compatibility with most transceivers. The microphone's dynamic element is backed up by a preamplifier with volume control. The transmit/receive switch can be locked in the closed position. This same switch permits connection of speech processors, antenna relays, on-the-air lights, and other

accessories. The microphone is housed in a tough plastic case that provides full shielding to minimize hum pickup and r-f interference. $58.32.

CIRCLE NO. 91 ON FREE INFORMATION CARD

3½-Digit LCD DMM

Fluke's 8022A handheld 3½-digit DMM features an LCD display, automatic negative-polarity indication, and 24 measurement ranges for dc and ac volts, dc and ac current, and resistance with rated dc accuracy of ±0.25%. Also, its case is a high-impact type. It is rated to withstand overloads up to 500 V on resistance ranges, 1000 V on voltage ranges, 2 A on current ranges, and voltage transients up to 6 kV.

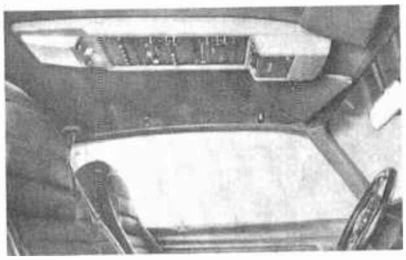


Finger guards on the test probes offer the user protection against accidental contact with high voltages. A 9-V battery powers the instrument for up to 150 hours; an LCD indicator activates when 20 hours of battery life remains. $129.

CIRCLE NO. 92 ON FREE INFORMATION CARD

Futuristic Car Audio

"Cockpit," introduced by Panasonic, is a ceiling-mounted control unit for a car audio system. Included in the package are an auto-reverse cassette player with normal/ CrO_2 tape selection and Dolby, an FM stereo tuner, and a preamp. The FM section, said to be highly sensitive, includes an automatic multipath noise suppressor



and has three presets for instant station switching. Bass and treble controls with center detents, a volume control with 21 detents, and a 10-LED power-output indicator are found in the preamp. The system includes a plug-in power amp (30 watts per channel into 4 ohms at 0.5% THD, 20-20,000 Hz) that can be installed in a hidden location.

CIRCLE NO. 93 ON FREE INFORMATION CARD

Versatile Home Computer

Ohio Scientific has unveiled the C8P DF, dubbed "Home Computer of the Future."

The computer, which uses two 8-inch floppy disks, offers a full keyboard, BASIC programming language, a video display (with high-resolution graphics) that handles up to 2K characters and 16 colors, audio output, a D/A converter for voice and music, joystick interfaces, and a large software library. In addition, an ac control interface allows power lines to be used as a route for control signals. Using an optional telephone interface, the system can dial telephone number and communicate via voice, touch-tone signals, or conventional modem signals at a 300-baud rate. $2,597.

CIRCLE NO. 94 ON FREE INFORMATION CARD

Low-Cost Cordless Telephone

Mura Corp.'s recently introduced "Muraphone" is a cordless telephone system

*FEATURES	EXIDY SORCERER	TEXAS INSTRUMENTS 99/4	ATARI 800	APPLE II	COMPUCOLOR MOD III	COMMODORE PET	TANDY TRS-80
Price of Minimum Configuration	$995	$1150	$999.99	$1150	$1495	$795	$599
Computer Type	Z80	9900	6502	6502	8080	6502	Z80
Maximum RAM in Unit	48K	16K	49.1K	48K	32K	8K	16K
ROM Supplied	12K	26K	16K	8K	17K	14K	4K
Display	B/W	Color	Color	Color	Color	B/W	B/W
CHAR/Line	64	32	40	40	64	40	64/32
Line/Screen	30	24	24	24	16/32	25	16
Graphic Resolution	512/240	192/256	380/192	280/192	128/128	320/200	128/48
Keyboard	79 Key Typewriter	40 Key Calculator	57 Key Typewriter	52 Key Typewriter	77 Key Typewriter	73 Key Calculator	53 Key Typewriter
Lower Case Standard	Yes	No	No	No	No	No	No
Numeric Keypad Standard	Yes	No	No	No	Yes	Yes	No
Programmable Characters Standard	128	No	No	No	No	No	No
I/O Electronics Included	Dual Cassette RS232 Communications 8 Bit Parallel	Joystick Sound	Joystick Serial Single Cassette	Single Cassette Joystick	Single Disk RS232 Communication	Single Cassette IEEE 488	Single Cassette
Expansion Bus	S-100	No	No	Yes	Yes	IEEE 488 Daisy Chain	Yes
Disk Available	630K Byte	No	92K Byte	116K Byte	51.2K Byte	125K Byte	45K Byte
System Software Available	ROM Basic ROM Assembler ROM Word Processor CPM EXT. Basic CPM Fortran CPM Cobol CPM APL CPM Pascal	ROM Basic	ROM Basic ROM Assembler	ROM Basic Disk Basic Pascal	Disk Basic	ROM Basic Disk Basic	ROM Basic Disk Basic Cassette Assembler

*Prices and specifications available June 1979.

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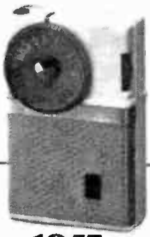
CIRCLE NO. 22 ON FREE INFORMATION CARD

There is only one real pioneer It's Sony.



1957: The world's first pocket transistor radio.

In 1954, a fledgling Japanese tape recorder manufacturer visited America to investigate a new device called the transistor.

At first, things were less than encouraging.

"Transistors are only good for hearing aids," they were told. "And besides, they can't be mass produced."

Undeterred, the Japanese representatives returned to Tokyo.

Thirty-six months later, the world saw its first pocket transistor radio.

Followed by the world's first all-transistor FM radio.

1954: The first Japanese transistor.

And, partially as a sign of their continuing dedication to audio, the Tokyo Telecommunications Engineering Corporation adapted the Latin word for sound—"sonus"—and changed its name to Sony.

In the years that have followed, Sony has never faltered in its dedication to technological innovation. And we'd be loathe to estimate how often our advances have ended up on the circuit boards and front panels of our competitors' equipment as "technological breakthroughs."

But enough of the past.

The hi-fi components featured here stand as eloquent proof that Sony—the company that virtually founded the era of transistorized high fidelity—is still at its very forefront.

A few Sony Audio firsts:

- **1949:** Obtained patent on the basic magnetic tape-recording system.
- **1952:** Developed stereo broadcasting in Japan.
- **1954:** Introduced condenser microphone.
- **1955:** First consumer stereo tape recorder in Japan.
- **1959:** Invented "Tunnel Diode"; basis of all high-speed, low-distortion semiconductors.
- **1965:** First all-silicon solid state amplifier.
- **1966:** The first servo-controlled turntable. Forerunner of quartz-locked turntables.
- **1968:** First electronic end of record sensor.
- **1969:** First digital-synthesized FM tuner.
- **1969:** Invented the ferrite tape head.
- **1973:** Invented the V-FET: Opened era of high-speed transistors.
- **1973:** First to manufacture ferrichrome tape.
- **1973:** Dr. Esaki wins Nobel Prize in Physics for "Tunnel Diode."
- **1975:** First turntable with carbon-fiber tone arm.
- **1977:** The world's first consumer digital audio processor.
- **1977:** First consumer amplifier with pulse power supply.
- **1978:** Patented liquid crystal recording meters.

The V5 receiver: To this day, only Sony offers Sony quality.

Unlike hi-fi receivers designed to impress you with a facade of magic buttons and switches, Sony receivers are designed to impress you with rich sound.

Case in point: the V5.

In technical terms, the V5 delivers 85 watts per channel at 8 ohms from 20 to 20,000 hertz with no more than 0.07% total harmonic distortion.

In human terms, this means the receiver can reproduce every note of music any instrument can play with no audible distortion. And it can power two sets of speakers without straining.

But that's only the beginning.

Instead of using the mundane power transformers found in competitors' products, the V5 utilizes more expensive toroidal core transformers that provide richer bass.

1950: Japan's first tape recorder, the "Type G."

1979: The V5 receiver: Designed for people who appreciate value as much as they appreciate sound.

in high fidelity.

1979: The new TA-F40 integrated amplifier and ST-J60 digital synthesized FM tuner. Separate components that sound as sophisticated as they look.

Instead of cutting corners by using a flimsy pressboard bottom, we've cut interference by encasing the *entire* receiver in metal.

And for better FM reception, instead of using the standard three- or four-gang variable-tuning capacitor, we've opted for a higher quality five-gang model.

All of which explains why if you pay a few dollars less for one of our competitors' receivers, it's probably because you're getting less receiver.

The new Sony cassette decks: The state of the art, from the people who invented it.

Since we introduced tape recording to Japan in 1950, Sony has sold millions of tape decks.

A quick look at our new TC-K65 cassette deck will explain why.

1979: The new TC-K65. Sony remains one of the only hi-fi companies to produce our own tape transports, motors, meters, heads—even the tape itself.

Like all two-motor cassette decks, the TC-K65 is designed for low wow and flutter. Unlike others, however, we feature "brushless and slotless" motors that reduce this problem to the point of being inaudible.

Instead of using just any tape head material, the TC-K65 features Sony "Sendust and Ferrite" heads that combine wide response with extreme durability.

Instead of using an ordinary metering system, we've developed a 16-segment LED meter whose life expectancy far exceeds the fancy blue fluorescent models other companies are currently touting.

And there's also a "Random Music Sensor" for preprogramming tapes, settings for metal tape, remote control and timer capabilities, and the kind of high-quality D.C. tape head amplifier you'll find in almost no one else's tape decks.

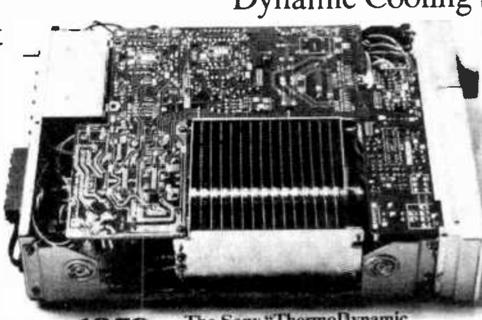
But you really haven't heard anything yet.

Unfortunately, we don't have enough space here to tell you the complete Sony hi-fi story.

Like the way a recent dealer survey rated our turntables #1 in value and performance.

Or the way our new separate tuners and amplifiers (not to mention micro components) utilize highly advanced light-weight pulse power supplies whose levels of distortion are virtually unmeasurable.

Or how they use a NASA developed "Thermo-Dynamic Cooling System" that eliminates heat, excess wire and the distortion and interference that normally accompany them.



1979: The Sony "ThermoDynamic Cooling System." Until now, only available in satellites.

If you'd like to hear more about the complete line of Sony hi-fi components (or if you need the name of your nearest dealer) write to Sony, P.O.Box CN 04050, Trenton, New Jersey 08650.

In the meantime, if somebody makes noise about innovations in high fidelity, think of the biggest pioneer in audio. And remember Sony.

SONY AUDIO

We've never put our name on anything that wasn't the best.

CIRCLE NO. 53 ON FREE INFORMATION CARD

consisting of an ac-powered base station and a pocket-size, battery-powered remote unit. Incoming calls—the only ones the system handles—cause a beep in the remote unit. To answer, the user simply extends the antenna and presses the TALK button on the side of the unit. Alternatively, the Muraphone can be used as an intercom between the base telephone and the remote unit. Dimensions are 7¾" × 6⅜" × 2⅛" (197 × 162 × 54 mm) for the base unit and 7½" × 2⅞" × 1½" (191 × 73 × 38 mm) for the remote. Maximum range is said to be 700 ft (213 m). $90.

CIRCLE NO. 95 ON FREE INFORMATION CARD

Film-to-Videotape Converter

Quasar's new Film-to-Tape Converter, Model KT502, is said to permit quick, simple transfer of any film format to videotape. The system accepts 8-mm, Super-8, 16-mm, and 35-mm formats, and the transfer can be monitored through a TV set while in progress. Setting up the converter is said to be simple and require little time. $130.

CIRCLE NO. 96 ON FREE INFORMATION CARD

MOSFET Power Amp Kit

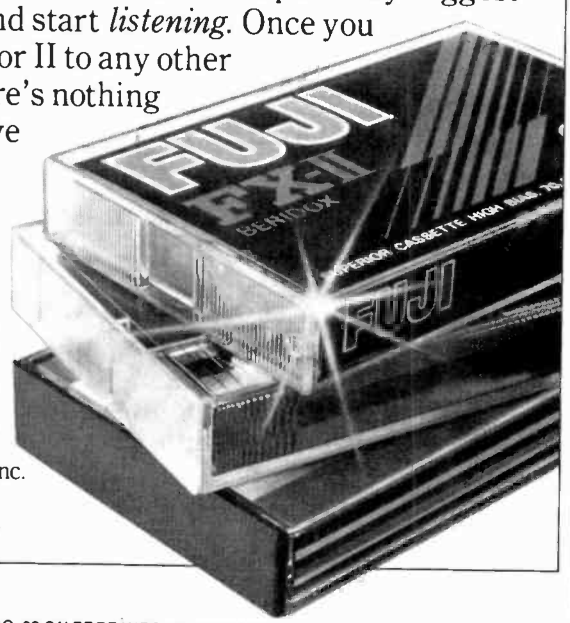
Model DH-200, the first power amplifier kit announced by the David Hafler Company, uses the new Hitachi MOSFET output devices in a circuit that is said to be completely original. The manufacturer claims the minimal crossover distortion characteristic of Class A without disadvantages of that mode of operation. Rated output is 100 watts per channel into 8 ohms, 20-20,000 Hz with no more than 0.02% THD. Reactive loads are said to be handled without the creation of interface distortion. Pretested modules, comprising all of the active circuitry, simplify the task of assembly. $300.

CIRCLE NO. 97 ON FREE INFORMATION CARD

Half-Speed Cassette Deck

The new Model 680 two-speed cassette deck with metal-tape capability from Nakamichi operates at 1⅞ and 15/16 ips. Highly advanced magnetic heads are said to result in minimal loss of fidelity at the lower speed. Other features included in this three-head deck are Random-Access Music Memory, which by counting the pauses between selections can automatically find any piece of music on a tape, fluorescent level indicators for recording and playback, and a diffused-resonance transport system claimed to reduce flutter effects. Specifications for low-speed operation with metal-particle tape include frequency response of 20-15,000 Hz, ±3dB and wow and flutter of less than 0.08% wrms. Corresponding specs at 1⅞ ips are 20-20,000 Hz and less than 0.04% wrms. Signal-to-noise ratio is specified as better than 60 dB at low speed, better than 66 dB at high, both A-weighted, using metal tape and Dolby. $1350.

CIRCLE NO. 98 ON FREE INFORMATION CARD



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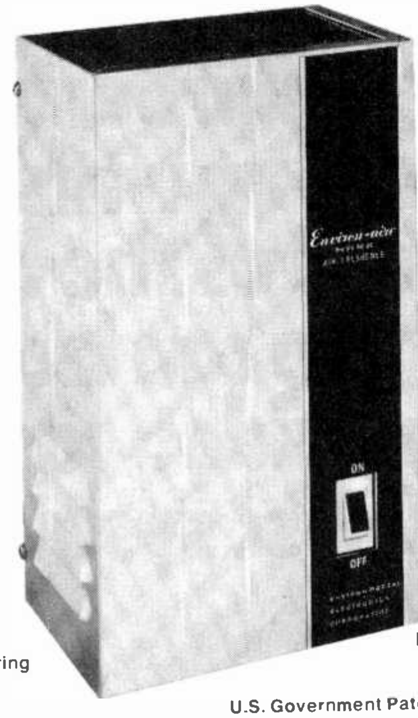
Guaranteed to Control Odors.



listed by UL

Now, through this exclusive scientific breakthrough, *indoor* air can be purified in exactly the same way outdoor air is purified by lightning during a thunderstorm.

U.S. Government Patent No. 3,925,673

Think of that sweet "country fresh air" smell following a thunderstorm. That's actually the *absence* of odor. The electrical activity in the air created by lightning adds a small negatively-charged electron to each oxygen molecule in the air. Science has long recognized the miracle of this phenomenon known as *ionization*. Amazingly, these ionized molecules combine with any odor-bearing molecules in the air—destroying them.

The Environ-air unit's patented process electrostatically creates these same negatively-charged oxygen molecules that permeate any enclosed space and attract odor molecules like a magnet until they're totally "neutralized."

BEFORE ENVIRON-AIRE

There were two ways to control odors: *Dilute*—constantly recycle fresh air to dilute odor molecules or *deodorize*—constantly mask odor with a heavy perfumy scent. Now, with Environ-air, there's a third, more effective and highly scientific way. And that's to *destroy* all organic odor molecules electronically.

WHAT THE ENVIRON-AIRE IS NOT

It's not a one-shot cover-up. It doesn't mask odors—it destroys them electronically. And it kills tough odors *continuously*—not temporarily like sprays, wicks, stick-ons, etc. There are never any chemicals to buy, bulbs to burn out or filters to replace. The unit uses only as much electricity as a 25-watt light bulb.

WHAT IT IS

The Environ-aire is a *continuous* air-cleansing process so unique it's patented. It uses the latest in space-age electronic technology to create the first energy and cost-efficient air purification system for the home. Even in a smoke-filled room, you will be breathing only clean, fresh air all day long.

FORCED AIR—THE MOST IMPORTANT NEW FEATURE INNOVATION

One of the secrets of this new system is that it keeps the ionized air in *constant motion*. The Environ-aire is the *only* electronic air freshener that *continuously* "pumps out" ionized oxygen molecules into the air, permeating every square inch of space—ready to attack and deactivate any odor-causing molecules instantaneously. Keeping the ionized air circulating is such an important factor that so-called "space age" air fresheners without it are truly outdated. Without it, odor-killing molecules simply fall to the ground near the unit, rendering them useless against odors.

A DUST-FREE ENVIRONMENT: AN UNEXPECTED BONUS

The Environ-aire also de-activates dust particles suspended in the air. The ionized oxygen pumped into your room will attach itself to any impurities in the air, causing them to fall to the ground. Ahhhh...what's left is pure, clean air.

PROVEN EFFECTIVE IN HOSPITALS, FISH MARKETS, PET SHOPS & MORE

Prior to this special introduction to consumers, hundreds of Environ-aire units were used by businesses with their own peculiar odor problems. After using it for over 8 months they found it to be the only answer to annoying, persistent odors. Why? Because it outperforms other systems in what it does and how it does it.

TO USE IT IS TO LOVE IT

You will feel the difference immediately. The Environ-aire will cleanse any 20' x 20' room of odor-causing molecules within just 5 minutes! Imagine how exhilarated you'll feel with a fresh supply of ionized oxygen surrounding you day and night!

CLEAR THE AIR ONCE AND FOR ALL

In the kitchen...bathroom...basement...nursery...pet areas...smoke-filled offices. Use it anywhere stale, musty, offensive or pungent odors are a problem. The attractive wood-grain unit is compact—10" x 6" x 4" deep—and lightweight—only 8 pounds. It can be wall mounted as an inconspicuous permanent fixture where annoying odors tend to accumulate. Or, it can be moved from place to place as needed, taking up little space on a shelf or floor. And installing it is simple—just plug it in. It uses regular household current.

LET YOUR NOSE PROVE ITS EFFECTIVENESS IN YOUR HOME OR OFFICE

The Environ-aire may sound too good to be true. That's why we offer a 30-day trial period and ask you to really give it a workout. For starters, simply turn the unit on, then cut up a big, juicy onion. No tears. No smell.

SOLIDLY BACKED

If anything goes wrong with your unit during the first year Environmental Electronics Corporation will repair it—without charge. Although the Environ-aire is built to last and be virtually maintenance free, it's still nice to know the manufacturer is service conscious.

SPECIAL INTRODUCTORY PRICE

The Environ-aire is manufactured for Cambridge International by EEC. We are offering this exciting new product directly to our customers exclusively through the mail for only $119.95 during our national introduction. Order one at no obligation today.

CAMBRIDGE INTERNATIONAL, Inc.

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4. Excellent enough to earn government approvals or UL listings (when applicable)
5. Developed from the most advanced technology available

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☐ Please rush me ______ Environ-aire unit(s) at just $119.95 each plus $6.95 shipping & handling. (Ill. residents add 5% tax.) I understand that if I am not absolutely satisfied with my purchase, I may return it within 30 days for a prompt and courteous refund.

☐ Check or MO enclosed. ☐ Charge to: ☐ Visa ☐ Master Charge
☐ American Express

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Signature ______________

NRI training in TV and Audio Servicing keeps up with the state of the art. Now you can learn to service video cassette and disc systems.

You build color TV, hi-fi, professional instruments.

Now, in addition to learning color TV and audio systems servicing, you get state-of-the-art lessons in maintaining and repairing video cassette recorders, and the amazing new video disc players, both mechanical and laser-beam types.

Learn at Home in Your Spare Time

And you learn right at home, at your own convenience, without quitting your job or going to night school. NRI "bite-size" lessons make learning easier...NRI "hands-on" training gives you practical bench experience as you progress. You not only get theory, you actually build and test electronic circuits, a complete audio system, even a color TV.

Build Color TV with Computer Programming

As part of your training in NRI's Master Course in TV/Audio/Video Systems Servicing, you actually assemble and keep NRI's exclusive designed-for-learning 25" (diagonal) color TV. It's the only one that comes complete with built-in computer tuning that lets you program an entire evening's entertainment. As you build it, you introduce and correct electronic faults, study circuit operation, get practical bench experience that gives you extra confidence.

You also construct a solid-state stereo tuner and amplifier complete with speakers. You even assemble professional-grade test instruments so you know what makes them tick, too. Then you use them in your course, keep them for actual TV and audio servicing work.

NRI Includes the Instruments You Need

You start by building a transistorized volt-ohm meter which you use for basic training in electronic theory. Then you assemble a digital CMOS frequency counter for use with lessons in analog and digital circuitry, FM principles. You also get an integrated circuit TV pattern generator, and an advanced design solid-state 5" triggered-sweep oscilloscope. Use them for learning, then use them for earning.

NRI Training Works... Choice of the Pros

More than 60 years and a million students later, NRI is still first choice in home study schools. A national survey of successful TV repairmen shows that more than half have had home study training, and among them, it's NRI 3 to 1 over any other school. (Summary of survey on request.)

That's because you can't beat the training and you can't beat the value! For hundreds of dollars less than competing schools, NRI gives you *both* color TV and audio...

Other NRI training includes Computer Technology, Complete Communications Electronics.

and now includes training in video cassette and disc systems. Send for our free catalog and see for yourself why NRI works for you.

Free Catalog... No Salesman Will Call

Send today for our free 100-page catalog which shows all the kits and equipment, complete lesson plans, and convenient time payment plans for courses to fit your needs and budget. Or explore the opportunities in other NRI home study courses like Microcomputers & Microprocessors, CB and Mobile Radio, Aircraft and Marine Radio or Complete Communications. Send the postage-paid card today and get a head start on the state of the art. If card has been removed, write to:

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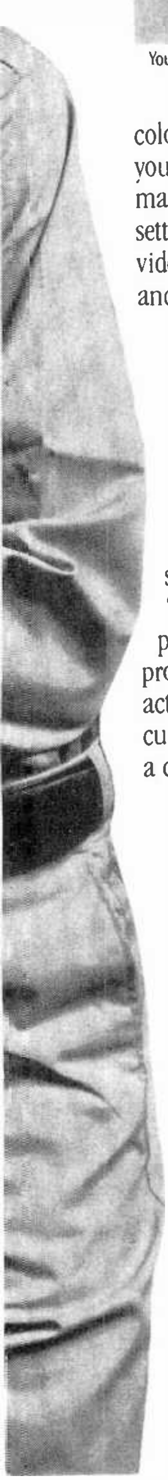

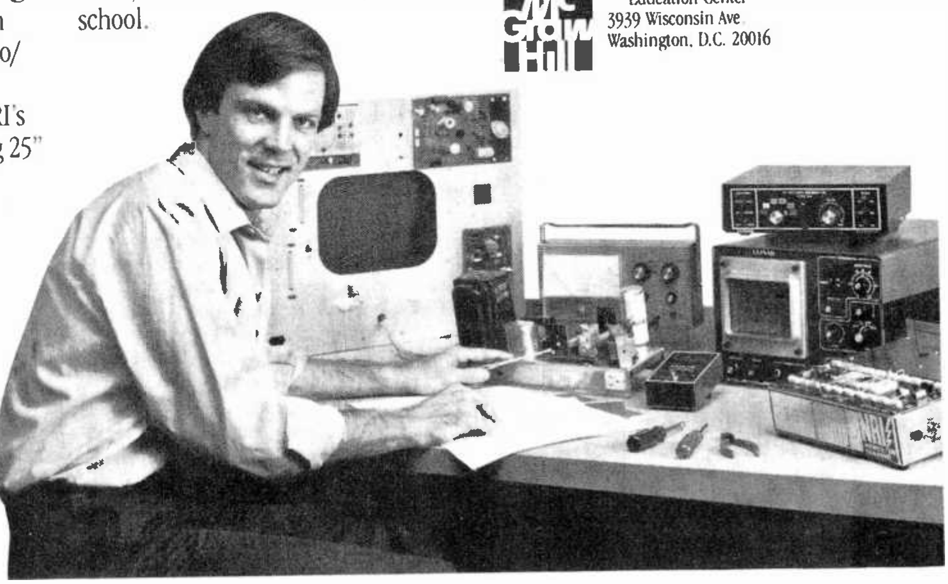

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Stereo Scene

By Harold A. Rodgers
Senior Editor

ADVENTURES WITH AMBIENCE

SINCE THE demise of four-channel, time delay has become the darling of those who seek to recreate concert-hall ambience in the listening space. But listening to time delay in operation at times is sufficient to give one pause. Too often the music sounds as if some atavistic force were propelling us back to the caves——and echoey ones at that. Simply, many users of time delay, encouraged by misleading controls and heavy-handed hype, are applying too much of a good thing. Accordingly, let's examine the nature of reverberation as it applies to musical performance and perception and explore how we can simulate it in a listening room so it actually enhances the music.

It is well known that a reverberent sound field carries information about the space in which a sound is produced. The size of a room is reflected in the quality of its echos, as is the absorptivity of its interior surfaces. Reverb also tends to broaden the apparent dimensions of sound radiators and make their locations less precise. Beyond that, it adds a "tail" to every sound subject to it. Thus, in a reverberant space, a new sound usually occurs simultaneously with the tail of the preceeding sound.

For musical purposes, this last property can be rather critical, for it determines, at least to some extent, how rapidly a composition can be performed and remain intelligible. Consider a hall having a reverberation time of two seconds (a fairly common value) and assume that the decay of reverberation in the hall is linear with time. That means that the reverb is down 60 dB in two seconds, 30 dB in one second, etc. Now if the music suddenly drops in level by 35 dB, say, from forte to piano, the note following the shift must last longer than a second if its level is ever to exceed the reverberation from the note before. Thus, if the conductor chooses too fast a tempo, the first note to be played softly in a case like this might not be heard clearly—or even at all! Note, however, that in a hall with a reverb time of one second (a little on the "dry" side) a faster tempo could work perfectly well.

Conductors, of course, know about this and choose tempos partly on the basis of hall acoustics. But choosing a sufficiently slow tempo is not the end of the story. Apparently, the "collision" of a note and the tail of the preceding note is a factor that adds interest and excitement to music. Consequently, if the reverb is allowed to die out before a significant clash occurs, the music will likely appear to lack vitality. This means that a tempo can as easily be too slow for the prevailing acoustics as too fast. (A case can be made that the very fast tempos used by Toscanini in his recordings of the Beethoven Symphonies with the NBC Symphony were not the result of a stunning new insight into Beethoven, but rather an accommodation to the notoriously dry acoustics of the studio in which the recordings were made.)

Now let's consider the influence of hall size. Ultimately, the linear dimensions of a hall determine how far a sound can travel before being reflected and, therefore, the longest time that can elapse between a sound and a delayed near-replica of itself. Generally speaking, it is best to limit this time to 40 ms or so, approximately the fusion time of the ear; otherwise the reflections may be heard as separate and distinct entities rather than blending into continuous reverberation.

One might suppose that the longest dimension of a concert hall, usually the distance from front to back, would determine the longest delay. This is rarely the case, though. Usually, reflections from the rear wall cause so many problems that acousticians go to considerable pains to suppress them. Or, failing that, they design the hall so that the direct sound is very weak at locations where the rear reflection is strong. As a consequence, occupants of some seats hear almost no direct sound at all.

At first glance, it may seem that adding diffuseness to the locations of sound sources (which reverberation indeed does) will conflict with adequate stereo imaging, but this is not necessarily so. Actually, the radar-like precision that some listeners seem to enjoy in a stereo image is an artifact of close-miked recording. (Try closing your eyes at a live concert and see how close you can come to locating an instrument by its sound.)

What properly recovered or synthesized reverb will do is make the locations just vague enough that instability due to minor errors or gain and/or frequency response between the signal channels will be far less noticeable. The stereo image, therefore, should be improved, not worsened.

We have now established some criteria, albeit vague ones, by which to decide what we want an ambience-simulation system to do (and not do).

It should: (1) Produce a smooth reverberation without perceptible single echoes. (2) Soften the sense of location just a bit.

It should not: (1) Obscure any musical detail. (2) Introduce any distortion or coloration of its own.

How Time Delay Works. Most time-delay "boxes" try to create an electronic analog of a performance environment. This is done by using delay lines to simulate sound traveling through the air and by recirculating the signal through the lines to simulate multiple reflections. Such niceties as multiple taps on the delay lines and/or crossfeed between the two stereo channels are often applied to enhance quality of the electronic analog, but cost generally precludes exactitude in the duplication. We must settle for fewer delays and recirculative paths than would be ideal.

Despite these compromises, devices of this kind have proved themselves capable of fine performance when applied with moderate delay and recirculation to program material that is fairly "dry", that is, without much reverb of its own. This creates the illusion of a musical performance in the "environment" synthesized by the box.

When the program material is not dry, the situation is different and, on theoretical grounds, potentially troublesome. Ignoring listening-room effects, as we have to this point, the ambience box in effect replays the already reverberant recorded signal in a synthetic room before routing it to our speakers. This creates a reverberation pattern that could not occur in the real world. However, the effect can be highly listenable if the record reverb and that added by the box are sufficiently random.

What can sometimes happen though, is that once the level in the rear speakers is high enough to move the reverb's directionality away from the front speakers, conflict between recorded and synthetic ambience becomes apparent. In some cases, this level of reverberation will obscure musical details. Another problem with this approach is that each piece of music is likely to require its own control setting, which will have to be found by trial and error.

Enter the Madsen Effect. Some years ago, Ernst Madsen of Bang & Olufsen, experimenting with the Haas effect—the phenomenon by which the ear becomes "deaf" to the repetition of a sound that occurred a few milliseconds earlier—discovered that it could be used to recover ambience from recordings. How Madsen arrived at his findings is beyond the scope of this column, but his setup consisted of a normal stereo pair of speakers at the front and a second pair *off to the sides.* When signals to the second pair were delayed so as to reach the listener 5-15 milliseconds after the sound from the front pair, the listener felt that he was surrounded by the ambience of the hall in which the recording was made. By trying this arrangement with a recording made in an anechoic room, Madsen showed that the sense of ambience was not an artifact of the time delay. This recording sounded just as "dead" with the time delay as without; the only change was a modest increase in loudness due to the power contributed by the back speakers. It is more than a little surprising and ironic that this technique, that exploits a peculiarity of human hearing rather than attempting to model reality, is the one that gives the more convincing results.

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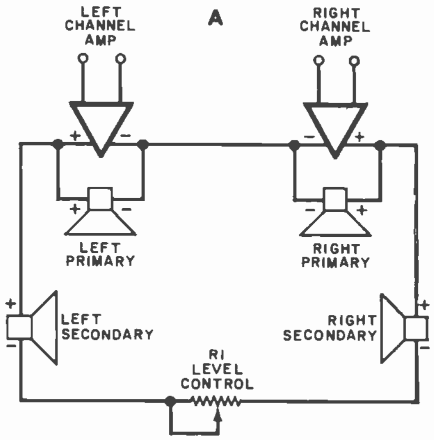
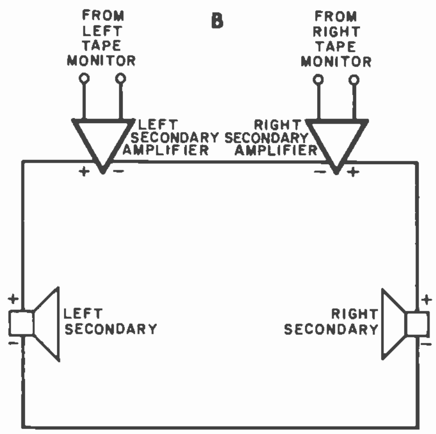
STEREO SCENE
continued

Setting It Up. The first step is to make sure that your secondary speakers are off to the sides and no more than slightly toward the rear. Then, if your ambience generator has a straight-delay mode, engage that and route the delayed signals to the secondary speakers. Otherwise, set recirculation to zero. Next, estimate or measure the distance from either of your front speakers to the listening position (it should be the same for both). Do the same for one of the side speakers and subtract the distance from the front speakers, retaining the minus sign if the difference is negative. Subtract that number from 15 and set the delay for the difference in milliseconds (we have been using the approximation that sound travels one foot per millisecond), and you've completed the basic setup.

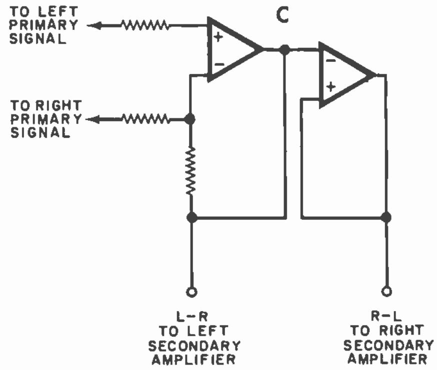




All you have to do now is balance ambience with the direct sound and adjust treble balance for the side speakers so that switching them in adds minimum coloration. Although these adjustments vary from one recording to the next, the delay setting does not.

From time to time you will run into recordings so inherently dry that you cannot recover ambience from them. Here is where you will use the other controls on the box. You may find that adding more delay and recirculation will help. Another possibility is that you have a recording in which you feel the tempo is too slow. It may be possible to make it seem faster—or at least make its slowness seem more acceptable—by adding delay and recirculation. In this way, time delay adds greatly to the power in the hands of the closet conductor or record producer.

Low-Cost Experiments. If you look back to the way in which we calculated the length of artificial delay, you will see that there is a possibility (if the geometry of your room permits) of placing the side speakers far enough away from the listening position that the Madsen effect takes place with no artificial delay. The secondary speakers in many cases can be driven by the same amp as the primaries. However, slightly better results are obtained if the secondary speakers have their own amp, so that lowering levels will not interfere with damping. Even in quite a small room fairly long delays can be achieved by aiming the secondary speakers so that their sound bounces from a wall before reaching the listening position. (For this application, beaminess is a virtue in a loudspeaker.)



The Hafler Effect. In A, the secondary speakers are connected in series across the "hot" terminals of the main amp. Potentiometer R1, with a rating of 50 to 100 ohms and 10 to 20 watts, controls secondary level. Secondary speakers must be at least as efficient as primaries, and R1 may interfere with woofer damping. In B, the secondary pair is driven by a secondary amplifier whose gain is varied to set levels. Damping is better, but series connection of speakers may still interfere. In C, subtraction is done at low level and signal is routed to secondary amp with speakers connected conventionally. Rear channels of a matrix decoder may substitute for set-up in C.

And there are the more traditional ways to extract ambience, such as using the "ambience" position of a matrix decoder or using the Hafler effect to extract a difference signal. These are shown in the accompanying diagrams and nothing more will be said about them except the following: if front-channel crosstalk is a problem with any of these hookups, increasing the distance to the secondary speakers and rolling off some of their high frequencies will sometimes give relief. These methods, like the Haas effect, depend on ambience included in the recording. If there's not enough, the adjustable delay and recirculation of a time-delay box will be needed. ◇

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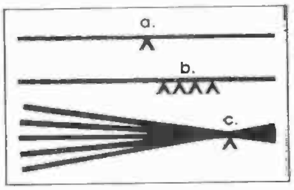

a. Center of Mass. Starting point for conventional tonearm designs.

b. Typical trial-and-error pivot points, usually placed close to a so that counterweight is not too heavy, tonearm not too long.

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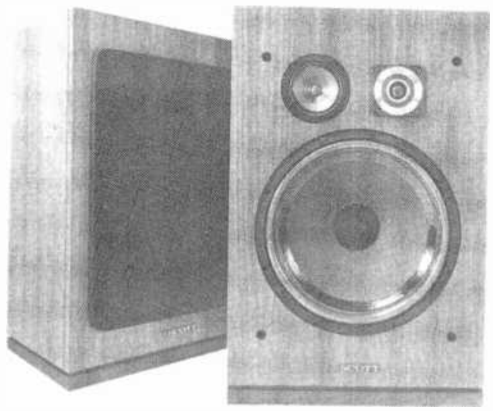

H.H. Scott Model PRO 100B bidirectional three-way speaker system

HIRSCH-HOUCK LABS REPORT

The Model PRO 100B, which heads Scott's line of speaker systems, is an improved version of the Model PRO 100. This floor-standing three-way system is designed to supply a mixture of direct and reflected sound to the listening area, in adjustable proportions. It also shares with other Scott speaker systems a "controlled-impedance" characteristic that maintains impedance at or above the rated value throughout the entire audio frequency range. Although it is relatively efficient, the PRO 100B has a nominal 150-watt power rating. Its tweeters are protected against overload by a novel passive circuit.

The system's walnut-veneer cabinet measures 29¼"H × 19"W × 14½"D (743 × 483 × 368 mm). Overall weight is 67 lb (30.5 kg). Black grille cloths, held in place by snap fasteners, cover the front and top of the cabinet. Level-control switches are located below the top grille, and input terminals are recessed into the back of the cabinet. Suggested retail price is $549.95.

General Description. The heavy-duty 15" (381-mm) woofer has a 2" (51-mm) diameter voice coil and operates in a 3.3-cu ft sealed enclosure. The cone's edge is damped to provide a high-frequency response rolloff to supplement the effect of the crossover network. At 750 Hz, there is a crossover to a pair of 4½" (114-mm) diameter midrange cone drivers housed in individual tuned isolation chambers within the main enclosure. One of these drivers faces forward, while the other radiates upward. At 3500 Hz, there is a second crossover to a pair of 1" (25.4-mm) soft-dome tweeters arranged like the midrange drivers, with one facing forward, the other up.

On the top of the cabinet, there are three three-position toggle switches. Two control the levels from the midrange and high-frequency drivers, providing 0- ("flat"), and −3-, and −6-dB output-level selection. The third switch alters the ratio of upward-to-forward radiation and affects both the midrange and high-frequency speakers. At maximum, the top speakers radiate 50% of the total power in their respective frequency ranges. The other switch settings reduce upward radiation to 35% and 25% of the total while keeping the latter constant. Unlike some other speaker systems that combine direct and reflected sound (including Scott's PRO 100), the PRO 100B has a minimum dependence on the characteristics of the wall behind it. It can even be used in some normally unacceptable locations, such as on both sides of a sofa, without suffering serious reduction in listening quality.

its low bass distortion readings correspond to very loud listening levels

The tweeters are protected by a small filament lamp in the crossover circuit. The lamp serves as a current-sensitive resistor that, under normal operating conditions, has a resistance of less than 1 ohm. When power to the tweeters approaches unsafe levels, the filament heats up and resistance increases, limiting current and protecting the tweeters against burnout.

Laboratory Measurements. Frequency-response measurements in the reverberant field of our test room were made initially with all level switches "flat" (0 dB) and with equal radiation from the forward- and upward-facing drivers. When we used the other ratios of front-to-top radiation, the high-frequency response was exactly the same, confirming that our measurement closely approximated a total power output response. Horizontal dispersion was excellent; exactly the same response was measured on-axis and 30° off-axis.

The midrange level switch affected the output between 750 and 3500 Hz but had a range of only about 3 dB instead of the indicated 6 dB at its maximum point (2500 to 3000 Hz). The high-frequency switch had a total range of about 7 dB and took effect above 3000 Hz.

A close-miked woofer response revealed a moderate rise of about 2.5 dB in the vicinity of 60Hz and rolled off at a 12-dB/octave rate below about 50 Hz. When this curve was spliced to the middle- and high-frequency curve, the result was an extraordinarily "flat" response free of most of the irregularities normally found in "live-room" measurements, even when considerable smoothing is used. The overall response of ±2.5 dB from 35 to 20,000 Hz is impressive in its own right and surpasses Scott's rated response of ±4 dB from 36 to 20,000 Hz.

System impedance is nominally rated at 4 ohms and, as claimed, it never fell below that. The minimum occurs between 8000 and 10,000 Hz. Over most of the audio band, the impedance measured 5 to 8 ohms. Maximum impedance, about 14 ohms, occurred at 45 Hz.

Bass distortion of the system was measured at nominal inputs of 1 and 10 watts. At 1 watt, distortion was barely measurable from 100 Hz down to 70 Hz, with readings on the order of 0.1% to 0.2%, rising to 0.5% at 50 Hz and 2% at 35 Hz. At a 10-watt level, the distortion had a similar distribution, with readings of 0.4% to 1% down to 60 Hz and 5% at 35 Hz.

Sensitivity of the PRO 100B is rated 94 dB at 1 meter on-axis when driven by 1 watt of pink noise. In our tests, 2.83 volts of noise in the octave centered at 1000 Hz produced a 93-dB SPL at 1 meter. This does not include the full contribution of the top drivers, since the microphone was located in front of the cabinet and below its top edge. The high sensitivity of this system makes its low bass distortion readings especially noteworthy, since they correspond to very loud listening levels.

Tone-burst response was good, with no signs of serious discontinuities or ringing.

(continued on page 28)

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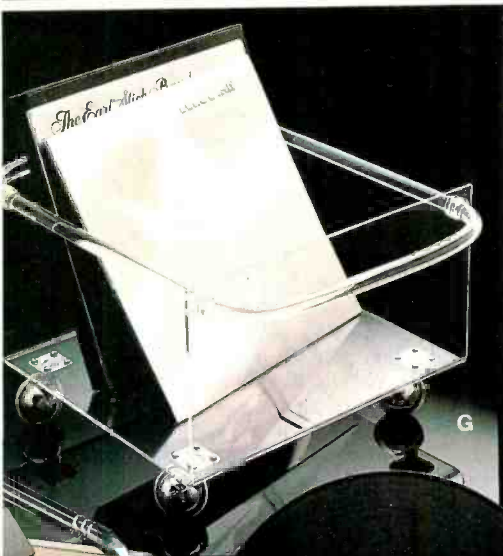

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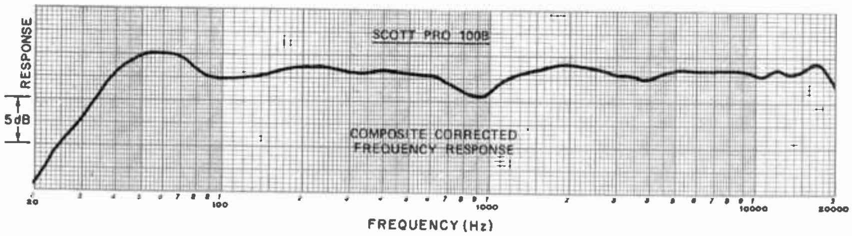

Composite corrected frequency response for speaker system

User Comment. With all controls flat and using maximum upward radiation, the sound was a trifle "bright" by comparison to some other excellent speaker systems. When we reduced both middle- and high-frequency outputs by 3 dB, the sound balance was very close to that of the comparison speaker systems. This shows that the sound of the PRO 100B speaker system can be adjusted with relative ease to suit almost any type of listening taste or acoustic environment.

Bass response, which always depends to some extent on room conditions and speaker placement, is deep enough for critical music listening, but did not have the floor-shaking character that we have encountered with some systems. However, the flexibility of adjustment afforded to the midrange and treble drivers should allow the balance to be tweaked to almost any reasonable bass characteristic one might possibly want.

This, in our opinion, is a speaker with a very fine sound quality. Its outstanding horizontal dispersion allows great freedom of choice with respect to listening position, and its high sensitivity and well-behaved impedance should give the driving amplifier a relatively easy time. Without a doubt, the performance of the Scott PRO-100B justifies its price.

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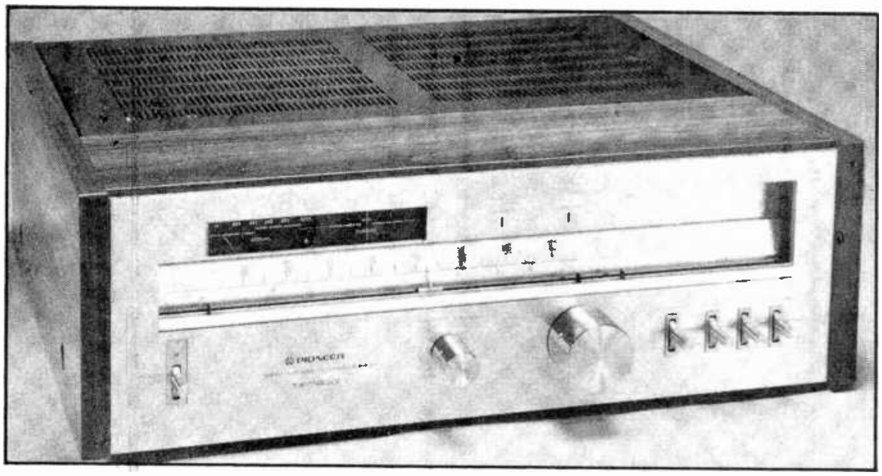


Pioneer Model TX-7800 AM/FM stereo tuner with servo-lock afc

HIRSCH-HOUCK LABS REPORT

Pioneer's Model TX-7800 AM/FM stereo tuner makes full use of the latest integrated circuit developments. It features an FM "servo-lock" amplified afc system, controlled by a touch sensor through the tuning knob, a PLL multiplex decoder, and an audio amplifier IC with built-in muting. Even the AM tuner section has selectable wide and narrow i-f bandwidths to optimize noise and audio bandwidth for different receiving conditions.

The styling of the TX-7800 is distinctive and includes a satin-finish panel and walnut-grain wood cabinet. It measures 17¾"W × 15⅜"D × 6⅛"H (453 × 390 × 155 mm) and weighs 18 lb 5 oz (8.3 kg). Suggested retail price is $350.

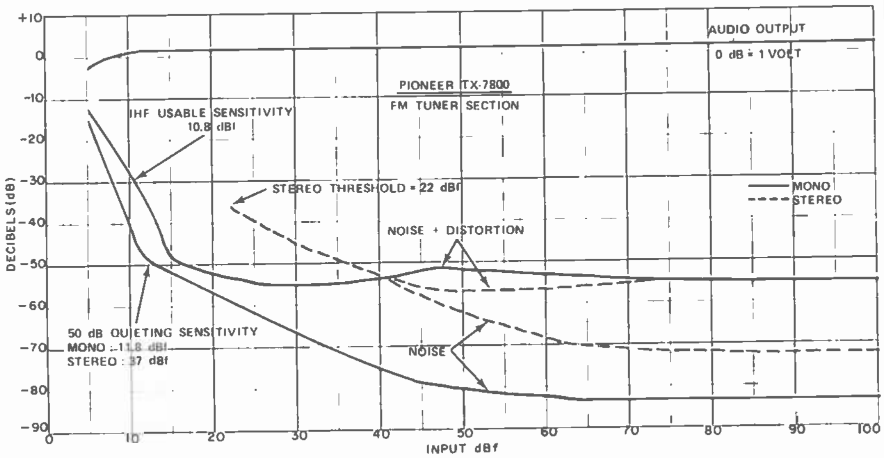
General Description. The AM and FM dial scales extend across most of the width of the front panel. Meters that indicate relative signal strength for FM and AM and center-channel tuning for FM are provided, as are red STEREO and green LOCKED indicators. The latter operates with the automatic "servo-lock" tuning system, which is actually a highly amplified afc circuit. Touching the large tuning knob defeats the afc voltage applied to a voltage-variable capacitor in the local oscillator. Once a station is tuned, even approximately, releasing the knob restores full afc action, locking the tuner solidly on the received signal and turning on the LOCKED indicator.

An OUTPUT LEVEL control varies signal level at the VARIABLE OUTPUT jacks on the rear apron. A second pair of jacks carries audio at a FIXED level. Lever switches control POWER, FUNCTION (FM or AM), AM IF BAND (WIDE or NARROW) and MPX NOISE FILTER that reduces noise on weak stereo signals by partially blending the channels at high frequencies. The FM MUTING/MODE switch simultaneously controls the tuner's mono/stereo operation and its muting system. In AUTO, the presence or absence of a 19-kHz pilot carrier determines the tuner's operating mode and muting is operative. Switching the tuner to mono reception disables the muting.

In addition to the two sets of audio jacks on the rear, there is a pair of MULTIPATH jacks for connection to the horizontal and vertical inputs of an oscilloscope to display multipath distortion. The horizontal output jack is also labeled DET OUT and carries a signal that can be used to drive any future four-channel FM decoding device. The antenna connections accept a 300-ohm or 75-ohm FM antenna, and a long-wire AM antenna, supplemented by a pivoted AM ferrite rod. A slide switch permits changing the FM deemphasis time constant from 75 to 25 microseconds for use with an external Dolby decoder. Another switch provides two degrees of sensitivity for the touch sensor that operates the tuning-lock system. There is also a single unswitched ac outlet on the rear apron.

S/N for mono was the highest we have measured on an FM tuner

Laboratory Measurements. The FM usable sensitivity was 10.8 dBf in mono. In stereo, it was set by the stereo/muting threshold of 22 dBf. The 50-dB quieting



Noise and sensitivity curves for FM section of tuner.

sensitivity in mono was 11.8 dBf with 1.6% THD, while in stereo it was 35 dBf with 0.32% THD. The S/N at a 65-dBf input was 84 dB in mono (the highest we have ever measured on an FM tuner) and 72 dB

in most environments the TX-7800 should give nearly perfect FM performance

in stereo. Distortion at that level, with 100% modulation at 1000 Hz, was 0.18% in mono and 0.145% in stereo. Slightly lower distortion could be obtained by holding the tuning knob (to disable the LOCK circuit) and tuning for minimum distortion. Although there is no practical way to defeat the LOCK system, the distortion it caused was negligible.

The stereo-FM frequency response varied less than 0.5 dB overall from 30 to nearly 10,000 Hz, but the output increased slightly to +1.3 dB at 15,000 Hz. Channel separation was better than 34 dB from 30 to 15,000 Hz and about 48 dB through the midrange. The FM capture ratio was 1.38 dB at a 45-dBf input and 1.5 dB at 65 dBf. The respective AM rejection measurements for these signal levels were 60 and 66 dB. Image rejection was 66 dB. Alternate-channel selectivity measured 78 dB, and adjacent-channel selectivity 6.5 dB. The 19-kHz pilot carrier in the output was down 76 dB, and hum was −75 dB.

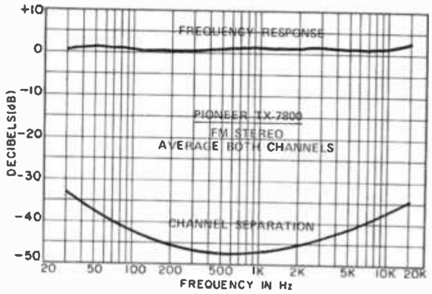
The only measurements we made on the AM tuner section were of its frequency response. With the WIDE bandwidth, the response was down 6 dB at 65 and 5600

Performance Specifications

Specification	Rating	Measured
Usable Sensitivity: Mono	9.3 dBf (1.6 μV)	10.8 dBf (1.9 μV)
50-dB quieting sensitivity:		
Mono	15.5 dBf (3.3 μV)	11.8 dBf (2.1 μV)
Stereo	37.1 dBf (39.2μV)	35 dBf (31 μV)
S/N ratio at 65 dBf		
Mono	83 dB	84 dB
Stereo	79 dB	72 dB
Distortion at 65 dBf (1 kHz)		
Mono	0.05%	0.18%
Stereo	0.08%	0.145%
Capture ratio	1.0 dB	1.38 dB
Alternate-channel selectivity	75 dB	78 dB
Adjacent-channel selectivity	Not specified	6.5 dB
Stereo separation: 1 kHz	50 dB	47 dB
20-10,000 Hz	35 dB	34 dB (30-15,000 Hz)
Frequency response, 20-15,000 Hz	+0.2/−0.5 dB	+1.3/−0.1 dB (30-15,000 Hz re. 400 Hz)
Spurious-response ratio	95 dB	Not checked
Image-response ratio	85 dB	66 dB
I-f-response ratio	100 dB	Not checked
AM-suppression ratio	65 dB	65 dB (at 65 dBf)
Subcarrier-product ratio	70 dB	76 dB
Muting threshold	19.2 dBf (5 μV)	22 dBf (7 μV)
Audio output (Level/Z)		
Fixed:	650 mV/4.2 ohms	Not checked
Var:	0-1.3 V/3.6k ohms	0-1.15

Hz—much better than average. With NARROW bandwidth, the −6-dB frequencies were 130 and 3300 Hz—about average.

User Comment. This tuner had excellent handling characteristics, including a muting circuit completely free of clicks, thumps, and noise bursts. Tuning was easy and noncritical, due to the servo-lock tuning system that effectively overrides adjustment errors. The coupling of the stereo and muting functions on a single switch presents no problems in practice. Any signal too weak to overcome the 22-dBf muting threshold will certainly be too weak for satisfactory stereo.



Average frequency response and crosstalk for both channels.

The AM section was quite good, and people living in low-noise areas may find AM to be a more listenable medium with this tuner than with most others.

In any but the most severe receiving environments, the TX-7800 should be able to provide virtually perfect FM performance. Its least impressive measured parameters fall into the "good" category, with "very good" or "excellent" applicable to most. Emphasis has been placed on utility rather than on "gimmicks" that contribute nothing to the final sound quality. These characteristics, in our view, make the tuner an unusually fine value.

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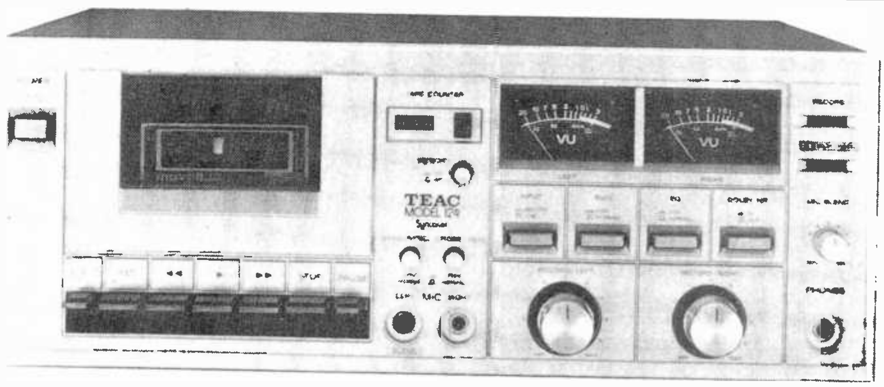

Teac Model 124 stereo cassette deck with Simul-Sync

HIRSCH-HOUCK LABS REPORT

Teac's new Model 124 "Syncaset" is the first home cassette recorder capable of making "Simul-Sync" recordings. Available in open-reel recorders from Teac and other companies for some time, Simul-Sync has not been offered in the cassette format until now. This function makes it possible to record a program on one tape track and, while playing it back through headphones, record an accompaniment on the second track in exact synchronism with the first. The two tracks are then heard simultaneously in the normal stereo format during playback.

The 124 is a front-loading, two-head machine with the usual facilities for setting bias and equalization for different tape formulations and a Dolby noise-reduction system. Driven by a single servo-controlled dc motor, the tape transport is mechanically controlled by "piano-key" levers. The recording inputs can be switched to either line or microphone sources, but not both simultaneously. There is a separate MIC BLEND feature that can be used to mix the output of a single microphone equally between the two channels while a line source is being recorded.

Overall size is 16 5/16"W x 11⅝"H x 6⅛"D (414 x 295 x 156 mm) and weight is 16.5 lb (7.5 kg). Suggested price is $449.

General Description. All transport-control levers can be operated in any sequence without first pressing STOP, except when going into the record mode. The entire cassette can be seen through the window on the door.

a high-quality cassette deck oriented toward a particularly unique function

Pressing in the SIMUL-SYNC button removes erase current from the left track of the erase head and connects the left channel of the combined record/playback head to the playback amplifier input. Illumination of the left meter is extinguished at the same time. (The deck has two large illuminated VU meters that are calibrated from −20 to +3 dB with the Dolby reference points at +3 dB.) When the deck is then put into the RECORD mode, recording occurs on only the right channel.

The line outputs of the deck can be monitored through the headphone jack or, preferably, through the headphone output of a separate amplifier, since the deck's own headphone output is at a fixed level. With SIMUL-SYNC engaged, the left-hand channel is heard in the left earcup, while the incoming signal being recorded on the tape's right channel is heard in the right earcup. Since the record and playback head gaps for the two tracks are precisely aligned, the two signals will be fully synced during playback. For some Simul-Sync recordings, a more pleasing playback effect occurs when the channels are partially blended. To allow this, a CROSS-FEED button operates on the recorder's playback outputs.

The MIC jacks are designed for use with microphones rated at 600 ohms or higher impedance. One MIC jack is also labelled BLEND. When recording from a line source, a microphone can be plugged into this jack and a small MIC BLEND control is used to inject an equal amount of its signal into both channels. This feature can also be used in playback, for superimposing voice announcements on a program. On the deck's rear apron are only the line input and output jacks and a DIN socket. The deck also features a built-in MEMORY feature that stops the tape when the counter reaches 000 in the rewind mode.

Laboratory Measurements. Our test recorder had been factory adjusted for TDK SA (chrome) and Maxell UD-XL I (normal) tapes, which we used for our tests. A 0-dB recording indication on the meters required a line input of 60 mV and a microphone input of 0.21 mV. The microphone amplifier overloaded at 27 mV.

Playback output from a 0-dB recording was 360 mV with UD-XL I tape and 310 mV with SA tape. The reference 3% third-harmonic distortion level in the playback

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500HH	$149.95	50Hz-550MHz	TCXO 1 PPM 17°-40°C	25MV	20MV	75MV	8	.4 Inch	*115 VAC or 8.2-14.5 VDC or NICAD PAK.	1" x 3½" x 5¾"

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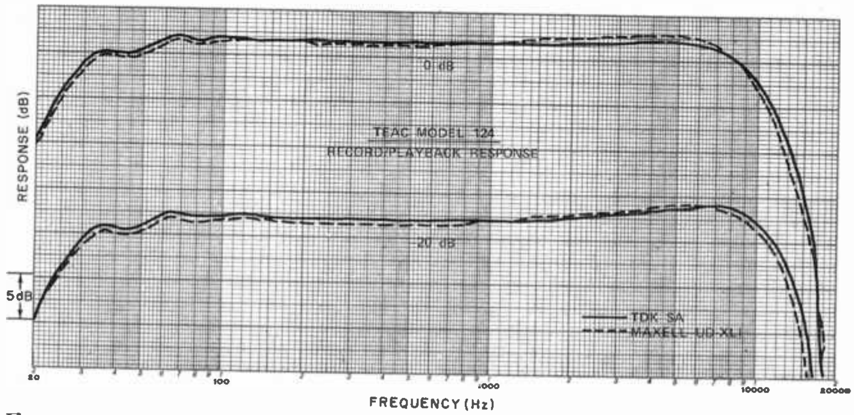

Frequency responses at 0 and −20 dB for two different tape types.

signal was obtained with a recording input of +6 dB with UD-XL I and +3 dB with SA tape. The unweighted S/N ratio referred to those levels was 45 and 41 dB, respectively, for the two tapes. With A-weighting these figures improved to 56.2 and 55 dB. With Dolby engaged and CCIR/ARM weighting, the S/N was about 62 dB with either tape. Through the microphone inputs at maximum gain, the noise increased by 12.5 dB. At a slightly reduced gain, the noise increase was only 3.7 dB.

The meters were calibrated correctly, relative to the standard Dolby level of 200 nW/m, and ballistic response was almost exactly that of a standard VU meter. The tape speed was very slightly fast—about 0.45% at the beginning and 0.3% at the end of a cassette. Flutter, measured with a TDK AC-342 test cassette, was ±0.09% weighted peak (CCIR) and 0.055% weighted rms (JIS). Combined record/playback readings were slightly higher at 0.13% and 0.08%, respectively. In the fast speeds, a C-60 cassette was moved from end to end in 82 seconds in fast forward and 79 seconds in rewind.

Record/playback frequency response was virtually identical with the two tapes at both −20-dB and 0-dB recording levels. At −20 dB, the high-frequency response rolled off a little earlier than in many cassette decks, but there was much less evidence of tape saturation at 0 dB than we are accustomed to seeing. Low-frequency head contour ripples were barely visible. Overall frequency response at −20 dB was ± 2 dB from 31 to 11,500 Hz, relative to the 1000-Hz level. At 0 dB, the response was +0.5/−1.5 dB from 34 to 8000 Hz. We measured the 120-microsecond normal playback equalization with a TDK AC-337 tape and the 70-microsecond chrome equalization with a TEAC 116 SP tape. With normal tape, equalization was within +1/−1.5 dB from 40 to 12,500 Hz, relative to the 315-Hz level, and with chrome tape, it was within +2/−0.7 dB from 40 to 10,000 Hz.

The Dolby tracking was consistent with the measured frequency response. When we measured the response at −20 and −40 dB, both with and without Dolby noise reduction, we noted how the Dolby system inherently exaggerates any departure from flatness in the recorder. Nevertheless, the differences were less than 1.5 dB and usually about 1 dB at all frequencies up to 11,000 Hz.

User Comment. The Model 124 will probably have its greatest appeal to people who have a need for its Simul-Sync capability. This feature is not limited to use in music recordings. Speech therapy, language instruction, and other educational activities often require that a student imitate or respond to a verbal instruction.

The numerical results of our laboratory measurements may seem lackluster compared to the frequency response and dynamic range data from other high-quality cassette decks. However, compensating for any lack of sheer bandwidth is the rather unusual high-frequency overload margin of the Model 124, which is substantially greater than we have found on any other two-head deck. Since one of the chief limitations of the cassette medium is its tendency to saturate the tape at high frequencies, thus dulling or compressing the sound, we put the Model 124 to the additional test of recording interstation FM-tuner hiss and comparing the playback to the original. The differences between the two, at a level of −10 dB, were very minor and much like those we have found in most good cassette machines. When we raised the level to 0 dB (something that one would not ordinarily consider doing with noise on a cassette recorder), playback was still barely distinguishable from the original. The perceived difference was no greater at 0 dB than at −20 dB. Normally, a 0-dB noise recording sounds intolerably dull on playback. S/N performance, also not quite the equal of some other cassette decks, nevertheless met Teac's specification and was adequate for the intended use.

In general, the Teac Model 124 proved itself to be a high-quality cassette deck. It is, clearly, oriented toward performing a particular, unique function. To the credit of the machine, this is accomplished while leaving normal home record/playback performance substantially intact.

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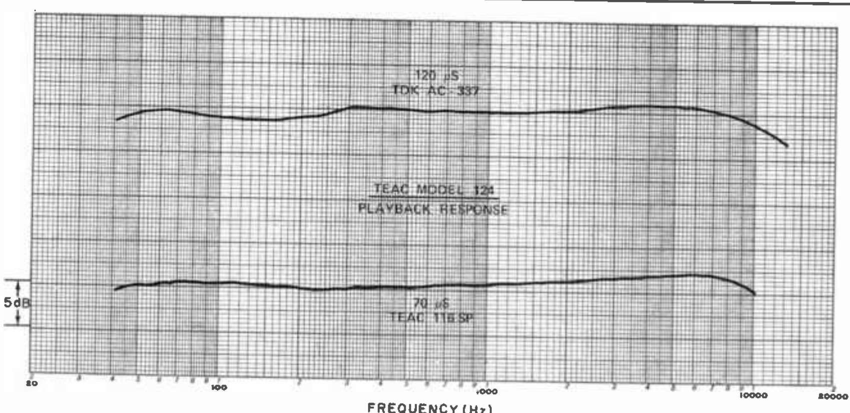

Normal playback equalization at 70 and 120 microseconds.

Performance Specifications

Specification	Rating	Measured
Frequency response	30-16,000 Hz (CrO_2) 30-13,000 Hz (normal)	31-11,500 Hz ± 2 dB 34-11,000 Hz ± 2 dB
Wow/flutter (NAB)	0.07%	0.055% wrms (JIS) 0.09% w-pk (CCIR)
Signal/noise	55 dB	45 dB normal 41 dB(CrO_2) unwtd 56 dB normal A-wtd 55 dB (CrO_2) 62 dB Dolby/CCIR/ARM
Rewind/fast forward time (C-60 cassette)	90 seconds	82 seconds FF 79 seconds RW
Inputs	60 mV/50k ohms LINE 0.25 mV MIC	60 mV 0.21 mV
Output	LINE 0.3 V/50k ohms PHONES 8 ohms	0.31 to 0.36 V. Volume adequate for 200 ohm phones (fixed level)

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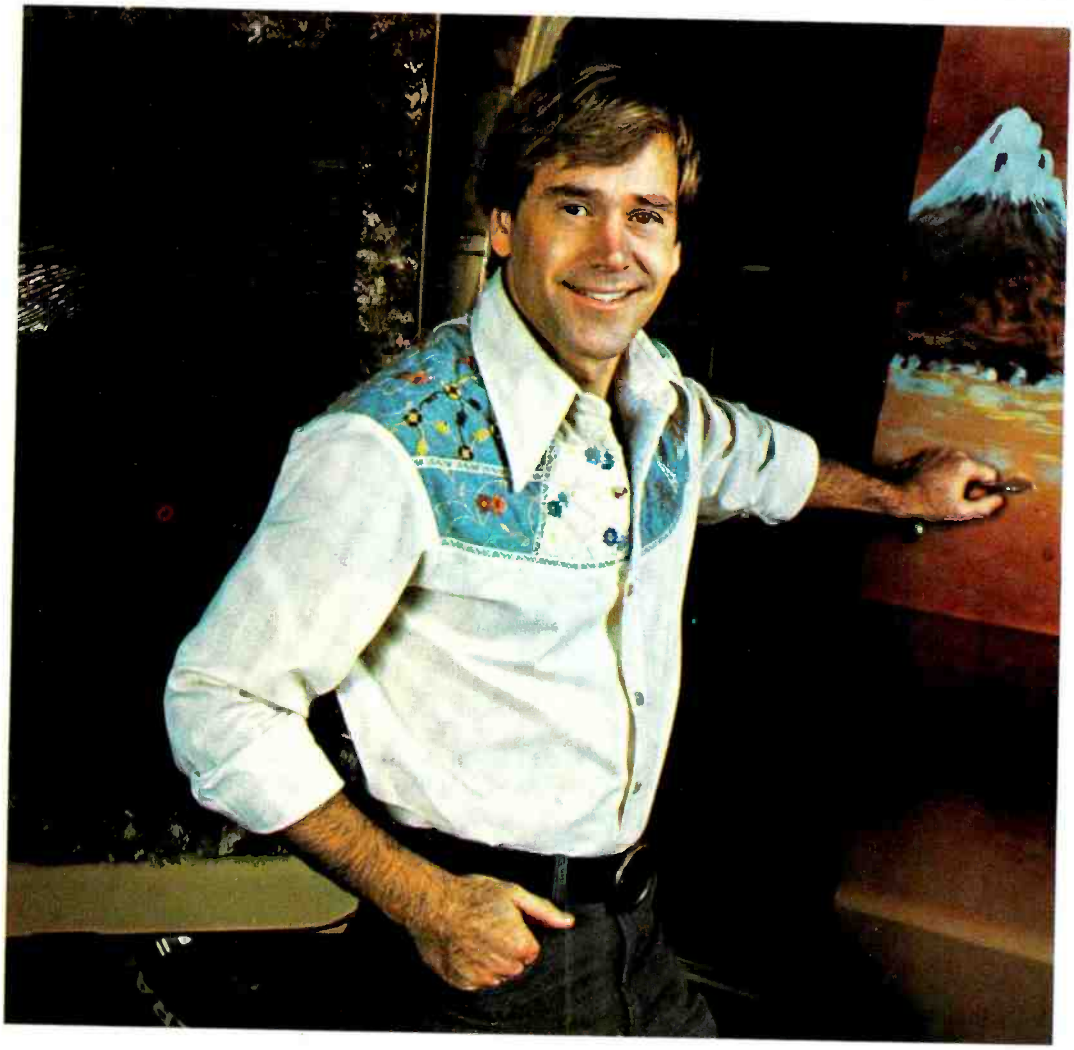

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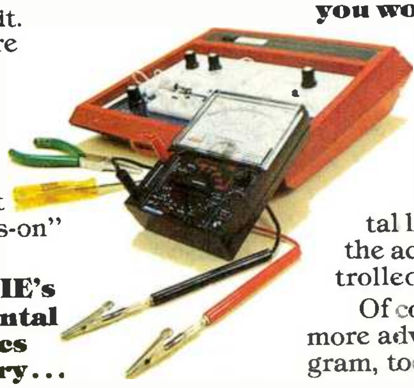

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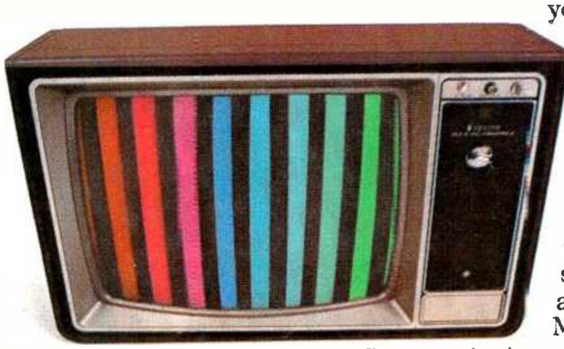

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25TH ANNIVERSARY ISSUE

An inexpensive solid-state controller that reduces inefficiencies in electric motors such as those used in refrigerators and dishwashers has been developed at the NASA Marshall Space Flight Center (by Frank J. Nola). Since total electric energy consumed by motors in the U.S. is equivalent to six-million barrels of oil per day and 25% or more of this electricity is pure waste in the form of heat and other factors, the discovery's import is obvious.

In keeping with our tradition of publishing significant new developments as construction projects, POPULAR ELECTRONICS is especially pleased to present plans for building this under-$30 device in its 25th anniversary issue.

(Continued overleaf)

BY MYLES H. MARKS

EXCLUSIVE PROJECT!

NASA Motor-Control Circuit Cuts Electric Cost...

Motor-Control Circuit Cuts Electric Cost...

continued

The NASA-developed controller is meant to work with ac induction motors, probably the type most widely used today. They characteristically run at a nearly constant speed that's fixed by power-line frequency and independent of load and supply voltage. When heavily loaded, the motor draws line current that is nearly in phase with the applied voltage, keeping its power factor (cosine of the angle between current and voltage) high and developing a large torque. Under light load conditions, the motor develops less torque by allowing more lag between the voltage and current. This reduces the power factor while leaving the current essentially the same in magnitude.

Though the low power factor means that conversion of electricity to mechanical power is small, the large current causes considerable I^2R losses (heat) in the supply lines and motor windings. This is what reduces efficiency. To minimize this waste, Nola's device monitors the motor's power factor and, when it detects light load conditions, it reduces the supply voltage. This increases "slip" in the motor, which causes a speed reduction of 2% or less so that the motor acts as if it were heavily loaded.

The current, now more nearly in phase with the voltage, therefore does as much useful work as before, but it and the voltage are smaller, resulting in a net saving of electric power.

Power Savings. The device was tested at Marshall Center on over 40 types of motors. Power savings ranged to 60%, depending on the loading. Up to 40-50% power reductions are claimed for motors running lightly or intermittently loaded.

The savings derived by using the controller with motors driving relatively constant loads (refrigeration systems and pumps, for example) are smaller, since the device can then do little more than reduce the 8-10% safety factor allowed for low-voltage conditions. On the other hand, since such motors typically have long duty cycles, significant economies may be realized over a period of time.

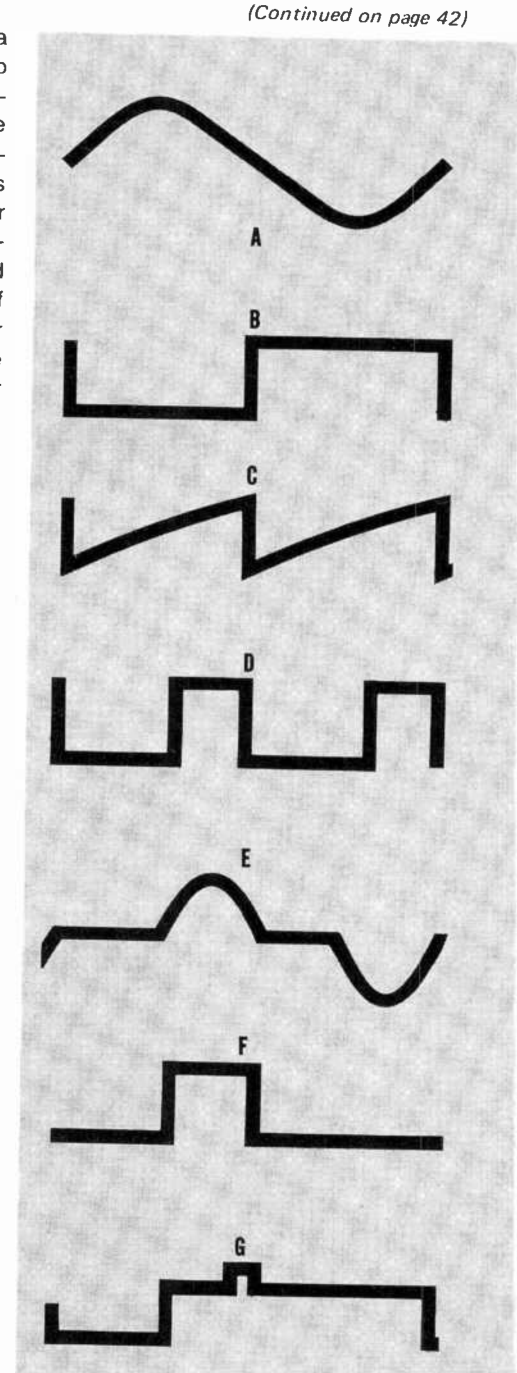
Figure 1 was constructed from data averaged from tests made on a ⅓-hp split-phase motor, and ¼- and ¾-hp capacitor-start motors. The top curve shows the typical power required for various loads when no control system is used. The lower curve shows the power consumed when the power-factor controller is used. The controller reduced the no-load power drain by a factor of 5 or 6 and increased the power factor from 0.2 to 0.8. In all three motors, the speed reduction resulting from lower voltage was less than 2%.

Circuit Operation. The circuit shown in Fig. 2, which is a simplified version of the original invention, operates in exactly the same manner. Also shown in Fig. 2, facing the diagram are waveforms for the corresponding letter-in-a-circle points on the schematic.

Typically, current may lag the voltage by 80° in an unloaded motor and only 30° when loaded. The controller continuously monitors phase angle between voltage and current, producing a voltage proportional to that phase angle. This voltage is summed with a preset reference voltage that corresponds to a desired phase angle. The difference between the two produces an error signal that biases a ramp voltage synchronized to the 60-Hz line voltage.

The intersection of the ramp and the error voltages is detected by a squaring amplifier whose output provides proper timing for controlling a triac in series with the motor. The triac is triggered at a point during the cycle, and the circuit switches to "off" as the line current goes through zero. Triggering the triac earlier in each half cycle raises the average voltage to the motor and vice versa.

(Continued on page 42)



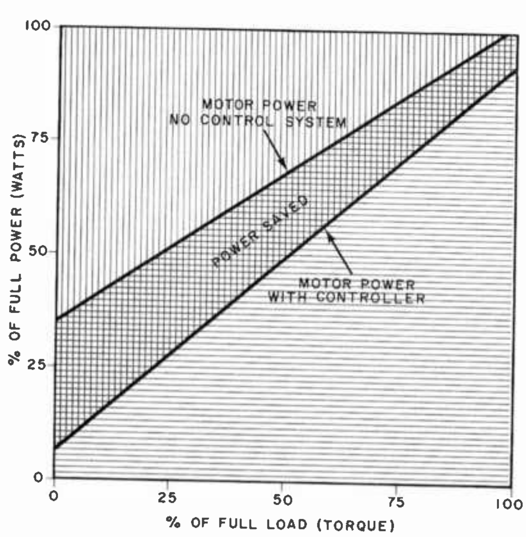


Fig. 1. These curves are the results of tests made by NASA on a ⅓-hp split-phase and ¼- and ¾-hp capacitor-start motors. Note that the power-factor controller reduced the no-load power demand by a factor of 6. Motor slowdown was less than 2%.

PARTS LIST

C1—1-μF non-polarized capacitor, Mouser Electronics 19NK001 or equivalent
C2—4.7-μF, 20-V electrolytic
C3—6.8-μF, 20-V electrolytic
C4—0.25-μF, 400-V capacitor
C5,C6—470-μF, 35-V electrolytic
C7—2.2-μF, 20-V electrolytic
C8,C9—0.033-μF capacitor
C10—0.33-μF capacitor
D1,D2,D9—1N4148 or 1N914
D3 through D6—1N4001 or similar
D7,D8—1N757, 9.1-V, 400-mW zener
IC1—Quad 741 op amp, LM324N
Q1,Q2,Q3—2N2222 or similar
Q4,Q5—2N2907 or similar
Following are ¼-watt, 5% resistors unless otherwise specified:
R1—0.02 ohm, 5 W (see text)
R2—620,000 ohms (see text)
R3,R18—39,000 ohms (see text for R3)
R4—1800 ohms (see text)
R5—3300 ohms (see text)
R6—1.5 megohms (see text)
R7—100 ohms, 2 W (see text)
R8—51 ohms, 1 W
R9, R13—1000 ohms
R10,R20—3000 ohms
R11,R12,R23,R24,R25—27,000 ohms
R14,R29—9100 ohms
R15—15,000 ohms
R16—68,000 ohms
R17—150,000 ohms
R19—1 megohm
R21—200 ohms
R22—91,000 ohms
R26—36,000 ohms
R27,R28—5600 ohms
R30—20,000-ohm linear taper pot. (see text)
S1—Spst switch
T1—20-V CT, 0.3-A secondary (115/220-volt version is Signal DP-241-4-20 or similar)
Triac—200-V, 15-A (400-V unit for 220-V operation is available. See note below.)
Misc.—Suitable enclosure, heavy-duty ac line cord (male and female connectors), mounting hardware, etc.
Note—The following are available from M. H. Marks Enterprises, 315 Thornberry Ct., Pittsburgh, Pa 15237: Kit of all components for 115-V system including triac and pc board, cabinet, line cord and ac socket or 220-V version including 115/220-V transformer and 400-V triac, without cabinet, line cord and chassis socket for $29.95 plus $3.00 postage and handling; or 115-V version excluding cabinet, line cord and ac socket at $24.95 plus $2.50 postage and handling. Also available separately: Etched and drilled pc board at $7.95 postpaid. All sales to U. S. A. only. Pennsylvania residents, please add 6% sales tax. Allow 6–8 weeks delivery.

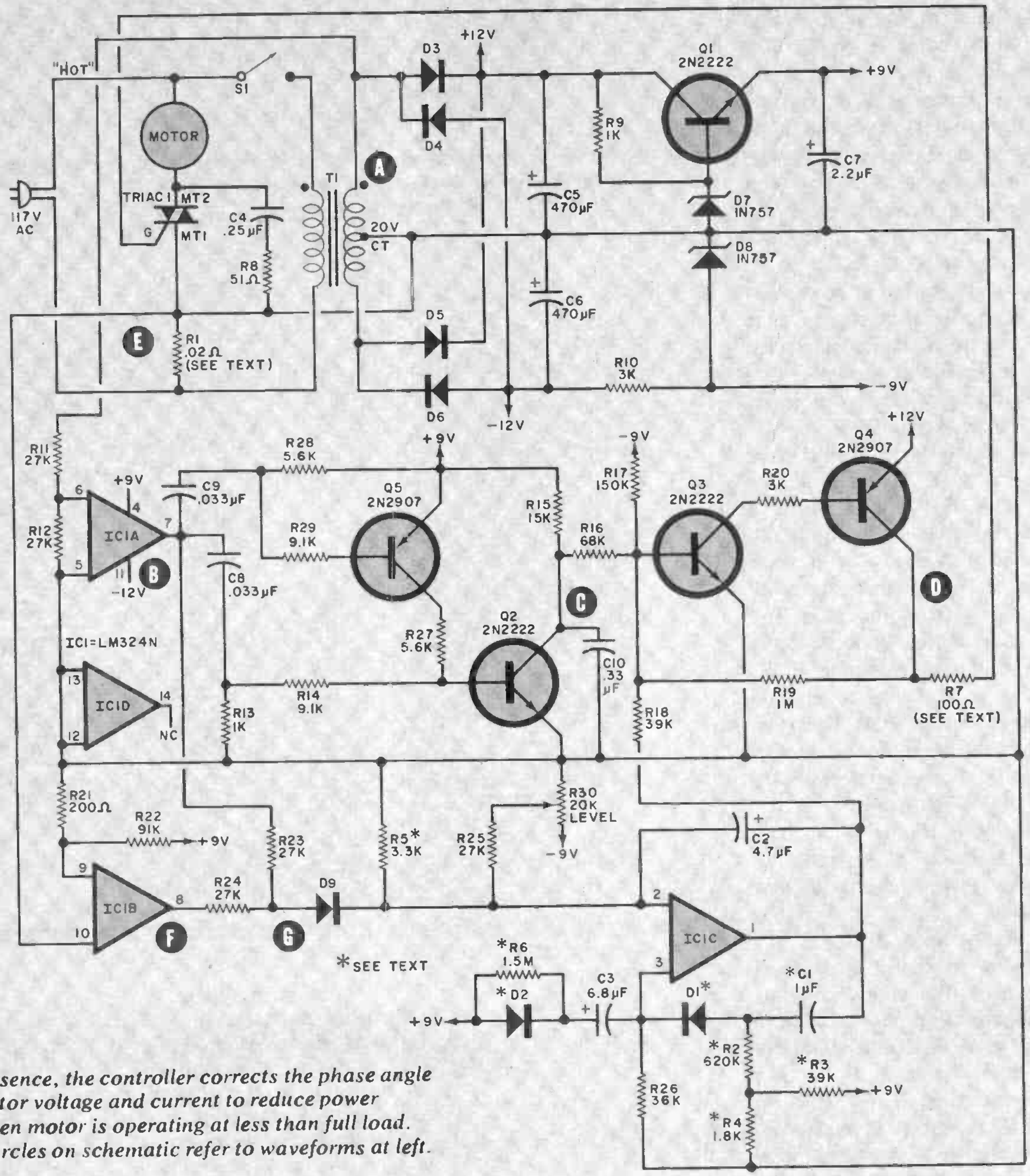


Fig. 2. In essence, the controller corrects the phase angle between motor voltage and current to reduce power required when motor is operating at less than full load. Letters in circles on schematic refer to waveforms at left.

Motor-Control Circuit Cuts Electric Cost...

continued

The triac's control signal is created by sensing the voltage (A) developed at the top end of transformer *T1*—which also serves as the power source for the conventional dc supply. (Note how the secondary of *T1* is phased with the primary ac power.) The voltage is applied via *R11* to the input of op-amp *IC1A*. Since this op amp is operating at full gain, the output is a square wave at power-line frequency. This IC has two outputs (B). One, via *C8* and *C9*, drives the ramp generator, which consists of *Q5*, *Q2*, and associated components. Capacitor *C10* charges through *R15* to form the ramp. The positive-going step from *IC1A* turns on *Q2*, thus rapidly discharging *C10* to complete the ramp function. The negative-going step from *IC1A* turns on *Q5*, which, in turn, causes *Q2* to saturate, thus discharging *C10*.

Since *IC1A* is triggered at power-line rate, the ramp generated across *C10* is synced to the power line, with each ramp occupying a half power-line cycle. The other output of *IC1A* is coupled through *R23* to diode gate *D9*.

A voltage proportional to the current through the motor (E) develops across sensing resistor *R1*. This voltage is passed to *IC1B*, whose squared-off output (F) is passed through *R24* to diode *D9*, where it combines with the output of *IC1A* to make waveform (G). The summed voltage at the cathode of *D9* is differentiated and fed to integrator *IC1A*, along with a dc control level determined by LEVEL potentiometer *R30*. This control is used to set the motor's optimum phase angle. Time constant network *C3* and *R26* provide a delay to let the motor develop maximum torque when first turned on. Capacitor *C2* provides the high-frequency roll-off necessary for system stability.

Since suddenly applied loads may cause the motor to stall if the system reacts too slowly, the circuit contains some components to prevent this from happening. These parts, which alter the integrator's time constant, are shown with an asterisk in Fig. 2 (*R2*, *R3*, *R4*, *R5*, *R6*, *D1*, *D2*, and *C1*). If you do not need this capability, eliminate these components and tie the positive end of

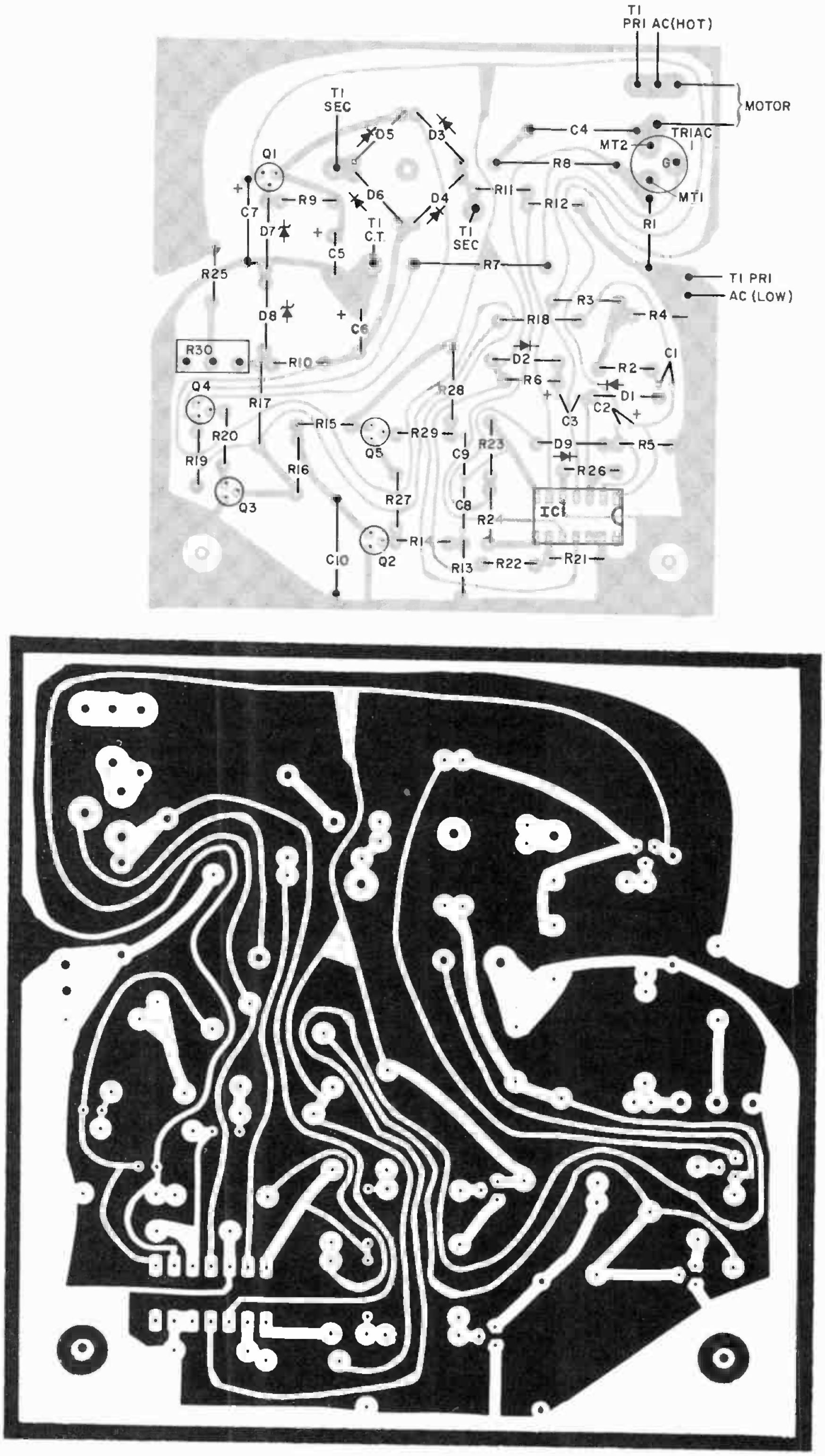


Fig. 3. Actual-size etching and drilling guide for a printed-circuit board for the controller is shown above. Component layout is at top. Note that there are sevral different options regarding components and construction, as outlined in text and Parts List.

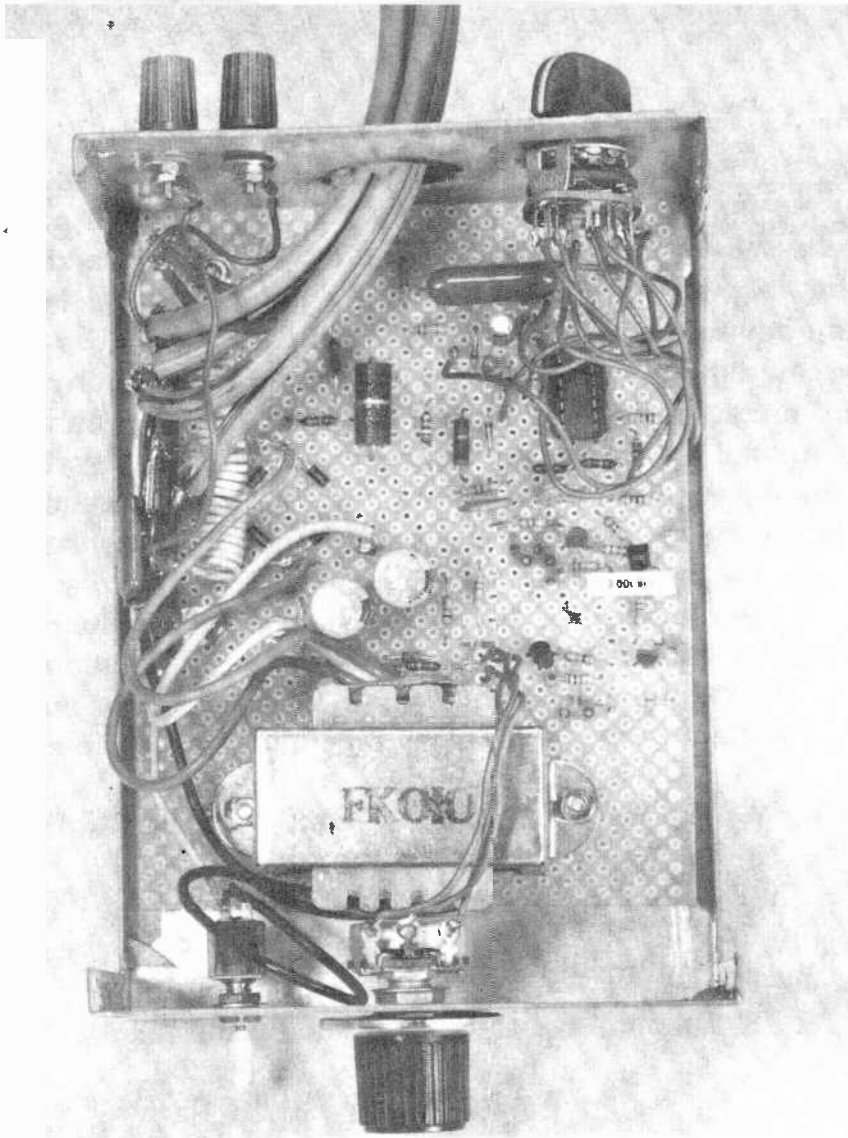
C3 to the +9-volt line by replacing R6 with a jumper. The IC1C output signal is coupled through R18 to the Q3 input, in parallel with the ramp from C10.

Triac controller Q3-Q4 is normally biased off by R17. When the composite signal (ramp plus pulse) arrives at the base of Q3, this transistor will turn on when the peak of the composite signal overcomes the bias. Since the ramp level is fixed, the pulse from IC1C, controlled by R30, determines when the Q3-Q4 combination turns on. When turn-on occurs, the waveform shown at (D) triggers the triac, thus applying voltage to the motor.

Construction. The circuit can be most easily assembled on a pc board using the foil pattern and component layout shown in Fig. 3. A bridge rectifier can be used in place of the four rectifier diodes (D3-D6). If a 24-volt transformer is employed, increase the value of R7 to 150 ohms. Resistor R1 can be fabricated from a 9" length of #22, or a 6" length of #24 solid copper wire that's wound on an insulated support dowel.

At this time, you make the decision about the aforementioned possibility of sudden or clutched-in loads that would require using the asterisked components. Furthermore, if this device is to be used with motors requiring in excess of 300 watts, to prevent damage to the triac or pc board, remove the triac, R1 and the ac input from the board, mounting a terminal strip in their place. Mount the triac with R1 to the chassis or optional heat sink (suitably isolated) and wire them into the circuit board, using the terminal strip. Make sure that the "low" side of the ac line is used as the circuit common, and use polarized plugs for all ac-power connections. *Do not use the metal chassis as the common ground!* Failure to observe these precautions may cause a serious shock hazard.

Mount the pc board and transformer in a chassis, securing the board on insulated spacers so that no part of the ac line makes contact with the chassis. If desired, LEVEL potentiometer R30 can be removed from the pc board and a conventional rotary potentiometer of the same value can be mounted on the chassis. The motor can be plugged into an optional socket mounted on the chassis (wired to the motor-connector pads on the pc board), or use a suitable length of heavy-duty ac line cord having a socket at one end. Do not forget to use ac line cord having sufficient current-carrying capacity to handle the load.



Photograph of the author's prototype which was built on perf board, though a printed circuit board is recommended. The binding posts and switch on the rear were used for testing during design.

Since many of the systems to which the controller can be usefully applied have motors fed from 220-volt ac mains, you may wish to adapt the circuit to work at that voltage. This can be done by exchanging T1 for a similar transformer with twice as many primary turns and substituting a higher voltage triac (400 PIV minimum). Both "hot" legs of the 220-volt line should be isolated from the chassis, while the center tap should be connected to the ground circuit. An appropriate line plug and receptacle can be used, or the controller can be hard-wired to the load.

Use. Plug the power-factor controller into an ac outlet and connect the motor to be controlled. Turn both on. With the motor operating, slowly adjust LEVEL control R30 until a slight drop in speed or mechanical power is noticed. Vibration, too, will probably diminish. Slightly back off on R30 until you feel the point where the speed barely drops off. This should be the optimum setting of the controller. It will probably be necessary to readjust R30 for each different motor you wish to control.

As noted earlier, the savings effected by using the power factor controller (and the length of time required for the device to pay for itself) depend on the way in which a particular motor is loaded and for what proportion of the time it is in use. Clearly, intermittently used appliances such as power tools are poor candidates. In most households, refrigerators, air conditioners, ventilating fans, swimming-pool pumps, and other machines that run for extended periods will let the power factor controller pay for itself more quickly than smaller and/or intermittently used appliances. Savings will depend on your electric rates, too. In New York City, where one kilowatt-hour costs 11.5 cents in the summer and 9.52 cents in the winter, the controller, used on a 16-cu-ft frostfree freezer, might well pay for itself in about two years. ◇

25TH ANNIVERSARY ISSUE

It was only a few short years ago that engineers became increasingly interested in what might well become the most significant advance in semiconductor technology since the invention of the transistor—the single-chip microcomputer. It has stimulated interest in electronics to levels seldom before experienced.

Yet relatively few people truly understand the impact of the "computer-on-a-chip." Microelectronic technology moves so rapidly that it becomes impossible for even those intimately involved with a new development to grasp its full significance. Something new to divert the attention always seems to evolve. But without some understanding of the depth and scope of these technological changes, potential users too often perceive them as added confusion rather than practical innovations.

Webster defines the word *evolution* as the "art of unfolding or unrolling . . . a process of development, formation or growth." *Revolution* is defined as a "complete and drastic change of any kind." Understanding the "evolution" of these "revolutions" will help place future development possibilities into a more readily discernible perspective.

The MICROCOMPUTER

An Evolving Revolution in Consumer Electronics

BY JAMES T. VAN TASSEL

Texas Instruments Inc

It's November 1, 1954, fully 25 years ago. A remarkable new invention has just been announced that will lead innumerable people—young and old alike—to seemingly plug their ears with a small, handheld device. This "earplug" isn't designed to solve auditory problems, but it will start a revolution in personal communications and help make "solid-state" a household word.

The First Revolution. The innocuous hand-held device alluded to was the first transistor radio. Blaring out such hits as "Rock Around the Clock" or Elvis in his "Blue Suede Shoes," this transistor radio represented the first volume application of the germanium transistor invented six years earlier by Bell Labs. Transistor prices had dropped from $16.00 to $2.50.

Another major breakthrough in transistor technology had been announced six months earlier. At a meeting of the National Conference of Airborne Electronics in May, Gordon Teal of Texas Instruments was next to last on the agenda. The title of his presentation was "Some New and Recent Developments in Germanium and Silicon." Not sensing the impact of the subject, one speaker after another predicted that the technology for producing silicon crystals of sufficient purity for semiconductor manufacture was years away. Teal said, stunning his audience: "Contrary to popular belief about the prospects for the silicon transistor, I happen to have a few here in my pocket." The last speaker of the day lost his audience as they clamored en masse to the rear of the hall for literature on the new devices.

These two seemingly different events heralded the first revolution in solid-state electronics. Not only had the transistor

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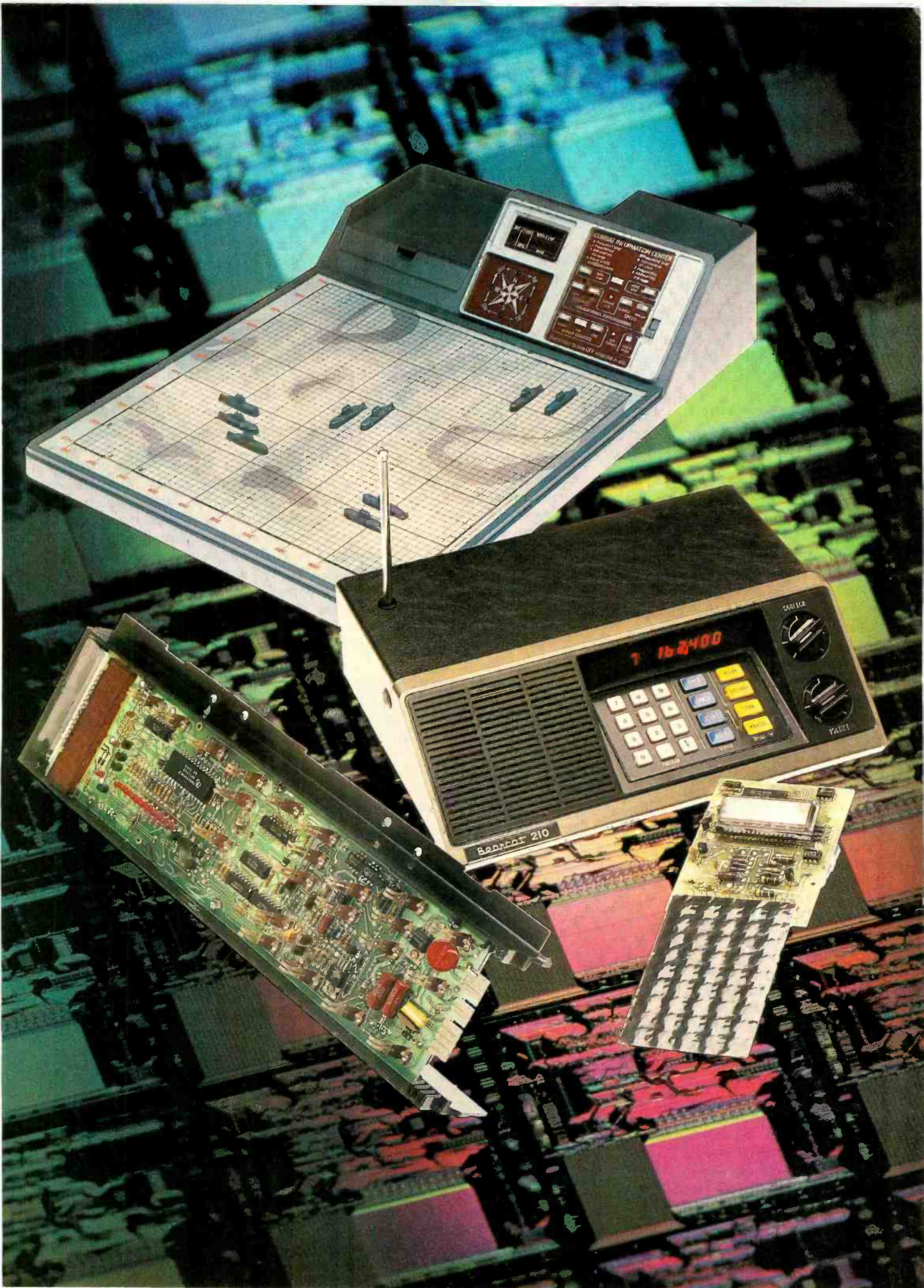
Development of the single-chip microcomputer, such as the TMS1000, has led to the establishment of entire new product areas such as electronic toys and games, a variety of programmable appliances, and sophisticated automatic scanners.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Evolving Revolution

continued

been mass-produced, the temperature problems inherent in germanium had been solved through the use of silicon. This opened the way for the fledgling aerospace industry to explore alternatives to the large, overly expensive and unreliable vacuum-tube systems that had encumbered aircraft since before World War II.

The Second Revolution. In November of 1958 Jack S. Kilby, who had only joined TI about six months earlier, demonstrated a unique semiconductor that for the first time incorporated more than one transistor, resistor and capacitor on a single chip of silicon. The integrated circuit eliminated the need for masses of separate discrete devices and the multitude of electromechanical interconnections they required. It has thus paved the way for a host of consumer products that were less costly and more reliable.

The first production integrated circuits delivered to the Air Force in 1962 were simple devices with two to four Active Elements Groups (AEGs) per package, priced at $100 each in small quantities. An AEG is a measure of circuit complexity defined as one digital logic gate, a single bit of memory or a single stage of amplification.

Commercialization of this revolutionary technology led to an increasing number of AEGs being packed into a rapidly shrinking area. For comparison, a vacuum-tube AEG of the mid-1950's occupied about four square inches. The transistor AEG of the early 1960's occupied only three-fourths of a square inch. Progressing from Small-Scale Integration (SSI) through Medium-Scale Integration (MSI) with over 100 AEGs per chip to Large-Scale Integration (LSI) with over 1000 AEGs per chip, the typical active element group was reduced to two and one-half millionths of an inch. Cost dropped also from $7.00 per AEG in 1960 to less than $0.001 currently.

One of the major developments that contributed to the development of LSI technology was the change from a concentration of bipolar devices to a unipolar configuration called the Metal-Oxide-Semiconductor, or MOS. With bipolar devices, high component densities were very difficult and chip sizes were limited because of problems with heat dissipation and low product yields. MOS technology, where only one type of current carrier is used as opposed to two, offered the higher packing densities, lower power consumption and fewer machine steps. However, it did so at the expense of throughput speed.

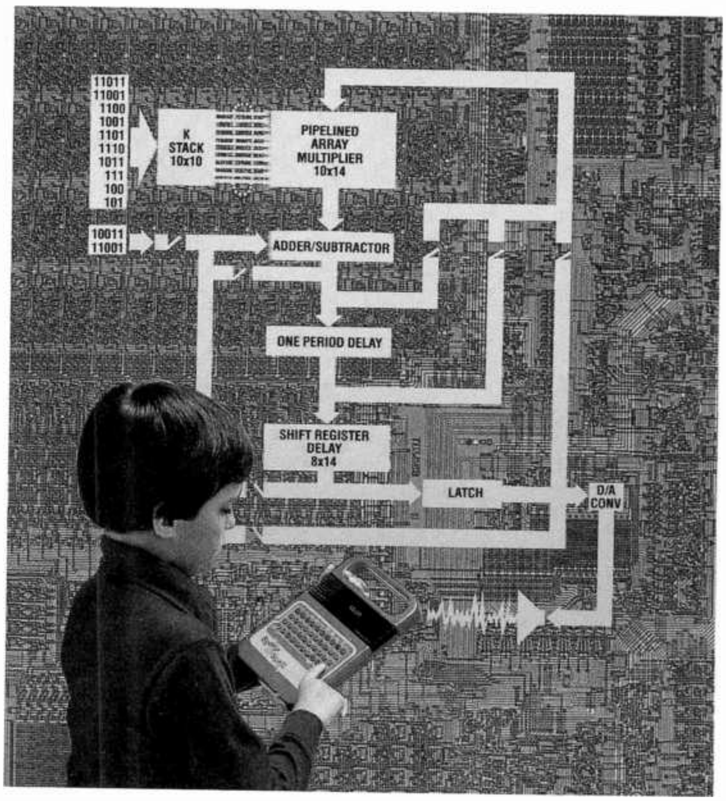
Among the outgrowths of this advanced MOS/LSI technology was the hand-held calculator invented in 1967 by Jack Kilby, Jerry Merryman and the author. Measuring only 4¼ × 6⅛ × 1¾ inches, this first miniature calculator had as its working heart an integrated-circuit array that contained all of the necessary electronics for performing addition, subtraction, multiplication and division.

PMOS (Positive-channel MOS) technology and demand for low-cost calculators led a number of companies to undertake development of a calculator chip. Intel Corporation was among those that chose to design a versatile, programmable single-chip microprocessor, one element of a multi-chip microcomputer system. Introduced in 1972, the Intel 4004 processed data blocks of 4 bits each. Less than a year later, National Semiconductor, Rockwell International, and Fairchild Semiconductor also entered the marketplace with microprocessors capable of processing 8 bits and containing anywhere from 5000 to 10,000 transistors.

For the purposes of definition, the microprocessor is the basic CPU—Central Processing Unit—of a computer. When memory, clock and input/output circuits are added, the system becomes a microcomputer. With software, a power supply, interface devices, control and a display capability, the configuration becomes a microcomputer system that operates like a true computer.

The Third Revolution. The next revolutionary step in microelectronic technology was taken in early 1971 when Michael Cochran and Gary Boone of Texas Instruments developed the single-chip microcomputer. There were over 20,000 transistors and other components comprising all of the elements of a computer on a chip of silicon a few thousandths of an inch thick and less than one-fifth of an inch square. Component count was reduced from about 10 to only 1 with system costs reduced from about $150 or $200 for a comparable microprocessor or custom LSI system to less than $5.00 currently.

This tiny computer-on-a-chip offered



Superimposed over the photomicrograph of the TMC0280 Speech Synthesis chip is block diagram of linear predictive coding-based system used in TI's Speak and Spell.

4-bit computational power to help execute automatically a wide array of complex operations. On board the chip there are: (1) the arithmetic and logic unit (ALU) that performs basic decision-making and data processing, (2) memory for storing both computer software instructions and input data that the computer manipulates or processes, (3) control and clock circuitry for retrieval of instructions from memory and directing the rest of the system to execute these instructions in proper sequence and timing, and (4) input/output subsystems that allow the computer to productively communicate with the outside world.

During the processing of the silicon slice, the software program generated from the end system's functional specifications is imbedded in memory by a single-level mask technique that programs three parts of the microcomputer—the ROM, the instruction decoder and output encoder. These programmed parts control data input to the central processing unit, the processing of the data, and the encoding of the output to meet the needs of the system. Electronic elements in the microcomputer are reduced to micron dimensions so that an enormous amount of task-performing power is packed into an area of 1/20 of a square inch. What is truly significant is not so much that such a high degree of miniaturization is achieved, but that substantial economies of manufacture have been realized both for the electronics and the end-systems, along with substantial increases in reliability. For example, a current family of four series of 4-bit devices that have evolved from the original microcomputer offers a reliability of more than 0.05% per 1000 hours. This equates to less than one failure per 210 years. And the cost is $1.75 or less in high-volume production quantities.

With a cost and reliability impact of more than 15 to 1 over microprocessor and hard-wired LSI systems, the microcomputer is revolutionizing digital electronic control. The most obvious impact has been in consumer electronics, where entirely new product lines are technically and economically feasible.

The transistor radio of the 70's now offers automated frequency scanning coupled with digital readout.

The calculator now performs a full array of scientific and engineering functions at a retail price more than 90% less than it was just a few years ago.

Microwave ovens have been made programmable through the use of the microcomputer, as have washing machines, blenders, food processors, automotive systems, TV tuners, security systems, and even children's toys.

In a very real sense, the microcomputer has brought what has long been perceived as science fiction into the realm of science fact. The microcomputer, the microprocessor and custom LSI logic are all the result of extremely rapid technological progress that continues to be made within the semiconductor industry. And there is every reason to believe that this is just the beginning; that the complexity will increase in direct proportion to the reduction in cost.

Where Do We Go From Here? If the past decade can be any indication, the future possibilities are virtually unlimited. They're difficult to predict in specific terms, however, because technology is snowballing in a way that few people could have foreseen only a few short years ago.

The toy industry is a good example. The microelectronics revolution has hit the toy business harder than anything since batteries replaced wind-up mechanisms a generation ago. In the beginning, manufacturers were somewhat timid about getting into the area of electronic playthings. Toys are a big, serious business, and overnight failures and fortunes are common. However, when a few toy companies cautiously came out with their first electronic games in 1977, the market subsequently exploded.

Not even the most optimistic of industry observers could have foreseen the blockbuster success of the electronic toy and game products of 1978, which were sold out virtually overnight. In just three years, the market has jumped from $21 million in 1977 to $152 million in 1978 with a projected $225 million in 1979, according to the Toy Manufacturers of America. Some predict the market will hit $500 million in 1980 and that eventually most games will become electronic.

As with the toy business, the speed with which innovation spreads makes it virtually impossible to predict accurately the impact of the microcomputer on other consumer products and services. However, certain trends are beginning to emerge which give a generalized indication of coming developments.

Much of what has happened over the past few years represents a relatively simple adaptation of calculator technology, the addition of touch-panel or keyboard-based electronic control to existing products. Recently, however, entirely new concepts have been developed; new consumer and commercial products are available that would not be practical or even possible, in some cases, without the microcomputer.

The digital thermometer is one such product. A very simple semiconductor, the thermistor, is used to measure the change in resistance caused by the change in temperature. However, the change in resistance for either negative or positive temperature coefficient thermistors follows a complex curve that can be almost logarithmic in shape. It is possible to select a narrow range for healthcare applications, as an example, and then add various shunt resistors to linearize the curve. The linear signals can then be converted to a digital readout, but this limits the application of the thermometer and tends to price it out of the commercial market.

A far more cost-effective answer is being carried out by Electro-medics, Inc. of Denver, Colorado. There, designers put the algorithm that defines the temperature-resistance curve into the microcomputer and then use it to solve analog-to-digital computations. The result is a broad-range thermometer that can serve a multitude of applications with an accuracy of 0.1 degree. So because of the microcomputer, it is possible to take a patient's temperature in one-tenth the time, with greater accuracy, without the cost of breakage, and without the human error that was always inherent in a technician's attempting to read a glass thermometer.

A new toy organ recently introduced by Kenner Products of Cincinnati, Ohio, exemplifies another type of product made possible by the microcomputer. Using a TMS1000 4-bit single-chip microcomputer, the Play 'N Playback organ allows preschoolers to hear any of eight songs programmed into memory played out, to play songs of their own composition, and to record and then play back those songs or others from the accompanying songbook in proper sequence and rhythm.

For those that have long been associated with mechanical and electromechanical buzzers, bells and whistles, the concept of a tiny piece of silicon talking back or making music seems incomprehensible. In the past, where sound effects have been essential, discrete semiconductors have provided a limited variety of sounds. The products, however, suffered from the variations between individual discrete components and the high costs involved in development, assembly and packaging.

(continued on page 48)

Evolving Revolution

continued

Custom integrated circuits to generate sound effects were not an attractive alternative because of the lack of external programming capability. If the sound was not correct or even quite accurate, the circuit had to be redesigned. The original was simply a wasted effort. Another major problem with custom sound circuits was that they were limited to only one application, thus necessitating large-volume orders to amortize development costs.

The microcomputer was the technological breakthrough that opened the door to the low-end sound generator market. It can be used independently or to control a variety of sound generator circuits. By itself, the microcomputer can only produce square waves by holding an output ON for a short period and then holding if OFF for an equal period. This creates a square-wave cycle which, for most low-end applications, is of acceptable sound quality. For purer tones, as in musical instruments, the square waves can be shaped outside of the microcomputer quite simply by adding a resistor and capacitor to the output.

Musical tones are not the only type of sound that can be generated through the microcomputer. The new Marx Electronic 300 Bowling Game™ is a microcomputer-controlled table-top game that creates the sights and sounds of a real bowling alley. The 4-bit microcomputer brain of the game drives incandescent lamps to represent bowling pins and LED displays to indicate the score. In addition, it receives inputs from fourteen switches strategically placed in the alley surface and controls outputs to a sound circuit to imitate the sound of pins falling. This is achieved by generating a low-frequency tone and then decaying the sound through external components. The falling-pins effect is made by stringing several of these sounds together to represent a number of pins being hit.

For applications requiring more complex sounds or those of higher frequencies, the microcomputer can be used to provide the control signals for a complex sound-generator chip to produce sirens, whistling missiles, explosions, chirping birds, and a host of other sound effects. More advanced chips can produce truly complex sounds composed of up to three tones, random noise, or various mixtures of the two with independent attack and decay envelopes.

Using the speed and processing power of a 16-bit microcomputer, such as the TMS9940, it may well be possible to even teach the soon-to-be-available SN76489 complex sound generator to talk. The vocabulary of such a circuit would, of course, be quite limited, but perfectly adequate for a variety of annunciator circuits. It may prove feasible to expand some of the aircraft collision-avoidance systems to include an auditory response. Thus, rather than alarms or flashing lights which the pilot of an aircraft must interpret, a voice may well shout out, "Pull up. The aircraft is 100 feet below glidepath." Farther out in the future, voice recognition ability built into this flight-control system may well react to human vocal commands.

Microcomputer applications in the home have generally been limited to the kitchen, but this can be expected to change in the near future with more being accomplished in the areas of convenience and communications products.

Automatic telephone dialing, repertory dialing and automated phone-answering systems will become reasonably priced for the average homeowner through application of the microcomputer. It's likely that this will become popular in much the same way as the pushbutton phone has been replacing the circular dial. Uses of the phone can be expected to expand, allowing the homeowner to do his banking, pay bills, and send and receive printed information over the phone lines.

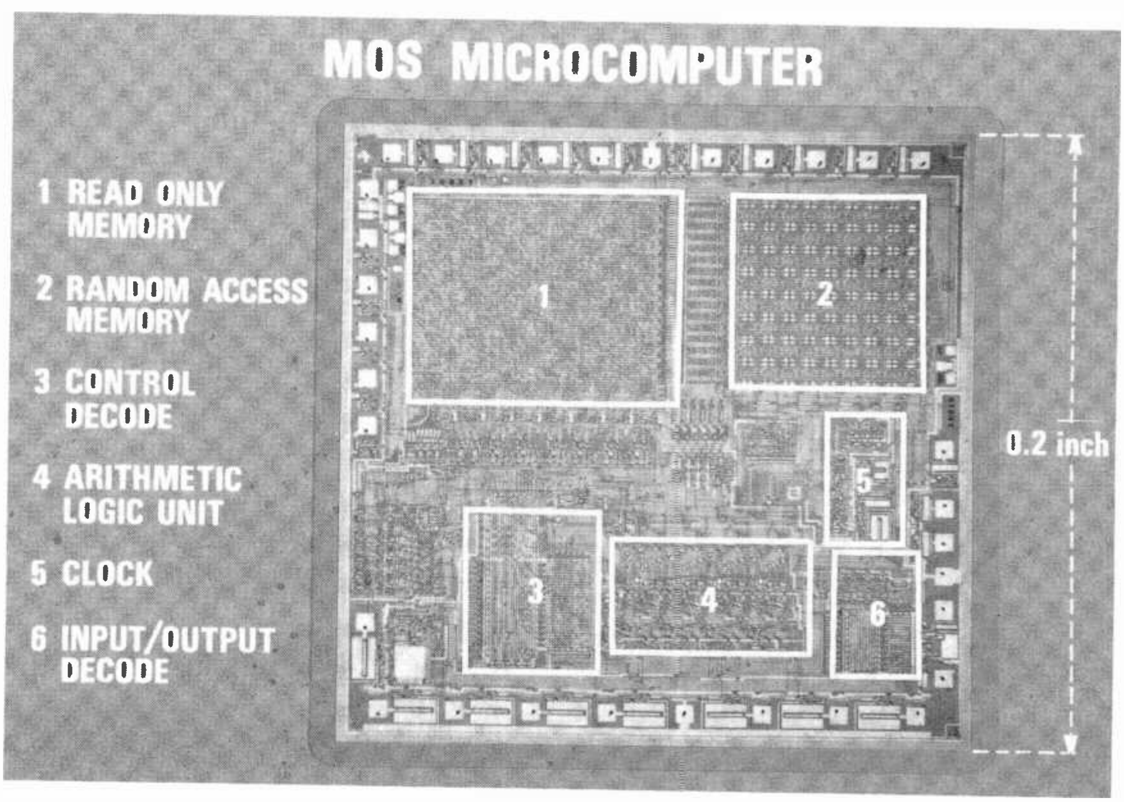


Photo of a microcomputer chip with important functional areas identified.

The key to this expanded use will be mass-acceptance of the personal or home computer.

In the 1960's, electronics hobbyists busied themselves with the design and construction of that "perfect" sound system. The spreading popularity of the hobby led to the commercialization and mass-production of those sophisticated systems to where they became readily available for a palatable cost.

In the 1970's, the hobbyist has also turned his attention to the computer. Developing games and other programs for the professional calculator once was a favorite diversion for computer specialists and mathematicians. As microcomputer modules became more readily available, the experimentor turned the calculator-based hobby into a microcomputer-based hobby. As happened with high-fidelity and stereo systems, electronics manufacturers have taken note of this spreading interest, developing first a series of personal computers specifically for the enthusiast and now products for even broader markets. Home computers are now available that require no computer-expertise or knowledge of programming. Software comes in pre-programmed ROM packages that simply plug into the computer much like the video game cassettes plug into the video games introduced in the mid-70's.

It's anticipated that the day will come in the future when a home computer will be another appliance designed to simplify and expand communications capabilities within the home. Through standard modem interfacing, it will connect to the telephone to provide the advantages of automated audio and visual communications. Electronic mail, electronic newspapers and automated communications will become commonplace. With an interface to the home electrical system, energy management and automated electrical control of any kind will be made possible.

The microcomputer will also make complex fire and security control systems practical realities for the consumer. Security systems will detect the presence of an intruder, and indicate the point of entry. This information will be displayed to both the homeowner and police via video monitors. Fire alarms will sense the location of a fire, calculate intensity and speed of growth, signal the occupants, indicate the safest route out of the house, and also alert the local fire department—again providing details of the fire via a video monitor.

Wouldn't it be convenient to have a microcomputer-controlled lawnmower that, once it was run through the mowing sequence, would automatically follow that sequence time-and-time again? With the simple addition of radio-control, it might even be programmed to back itself out of the tool shed and start the mowing job.

The family car will not escape microcomputer control. In some of the luxury models, it is there now! A microcomputer will control brakes to equalize application of pressure to minimize skidding. The same microcomputer will control engine operation to minimize exhaust emissions and maximize economy. With recent advances in speech synthesis, the day will come when the family car will *tell* the driver when the fuel is low, oil pressure is approaching a danger point or it's time to buckle up.

The microcomputer has just begun to tap the immense potential that exists in the field of education. Learning aids such as TI's Little Professor™ and Speak & Spell™, with other products, have found wide acceptance as simple, low-cost handheld devices that help make learning fun. Calculators and computers are being adapted to classroom work to help teach not only the fundamentals of arithmetic but also the use of math as a pure, universal language.

Teacher and student response to calculator-oriented mathematic learning aids has been so enthusiastic that studies are now being conducted in ways to utilize the technology in other subjects. The time is not far off when students will be using calculator or computer-extended materials to learn reading, writing, spelling, geography, history and foreign languages. The science is still in its infancy, but is already perceived as a positive educational influence on many levels. Computer simulators, for example, of the kind most readily associated with driver education and flight training, will eventually be available in smaller, maybe even portable, units to provide specialized instruction in a number of diversified fields—from shop training to first aid, from bridge lessons to computer maintenance.

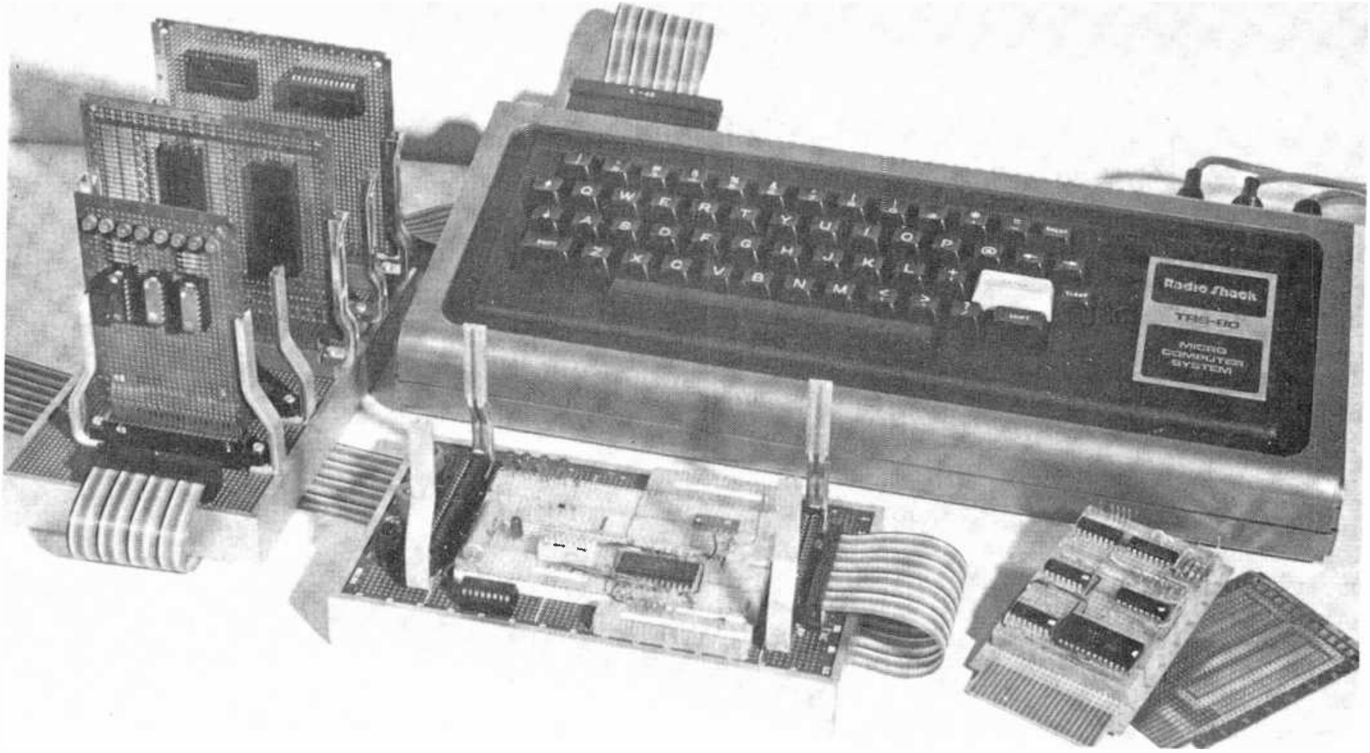
Among all of the new features, one to evolve will be the most important—ease of programming. Simplified programmability will lead to ease of use in applications undreamed of today. An exciting new area of development is synthetic speech and voice recognition. The technology to enable appliances to "talk" is not only here, but economically practical, as is evident in TI's "talking" learning aid, Speak & Spell. And some electronic experts predict that speech recognition will be cost-effective within another three to five years. By the mid-1980's, appliances may be intelligent enough to carry on simple conversations with consumers. One of man's fondest dreams—the interactive machine that listens, responds and talks back to him—is the next big challenge.

In the not-too-distant future, a homemaker may well put a frozen roast in a microwave oven before leaving for a day's shopping. After lunch she (or he) calls home and accesses the oven through the home computer, telling it to turn on at 4:00 p.m. The oven responds, "What temperature, please?" A few hours later, the homemaker arrives home and tells the door to open. The electronic lock recognizes the voice as authentic and opens the door. As the person enters the house, lights turn on as the room is entered and off as it is left—automatically! The oven will eventually announce over the home intercom, "The roast is ready."

Is this science fiction? Not at all! The technology to produce such a system is already at hand. Mass production for the consumer will have to wait a while, however. And behind it all is the evolution of the microcomputer revolution.

In the mid-Sixties, Margaret Meade described society as being in the midst of an information explosion, a situation where technology has provided the capability of gathering, organizing, storing and disseminating far more information much faster than ever believed possible; but man has yet to learn to synthesize this information. This is the problem facing the consumer electronics industry today. There is a wealth of information, products and capabilities available now through microelectronics. The "problem" is for creative manufacturers to synthesize this information into more efficient and useful appliances.

The nature of the consumer electronics industry is changing, as is the nature of the job functions within it. Individual product designers now work together as systems designers. Engineers who once rarely left their drawing boards are now active in consumer research. And manufacturers cannot afford to ignore human factors in product and control design or the potential of newly developed microelectronics. If they do, along with designers of the wringer washing machine, the horsedrawn buggy, and the ice box, they'll wonder what ever happened to the good old days. ◇



How to Add I/O Ports to Microcomputers

The basics of computer port operation and instructions for using them to expand computer flexibility

BY ADOLPH A. MANGIERI

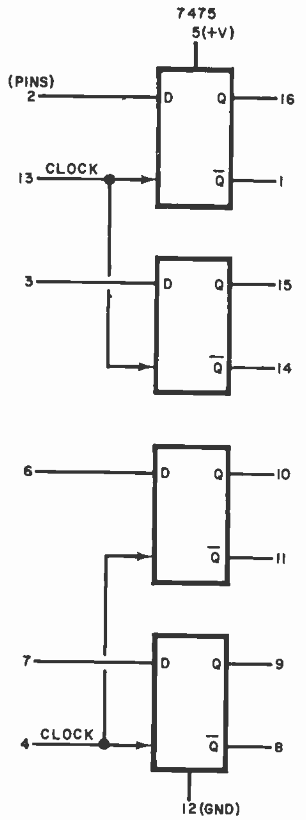
FOR A microcomputer to "do something" truly useful, it must have input and output ports. The I/O ports make it possible for the computer to "interface" with practical devices—relays for appliance control, switches (or a keyboard) for feeding in desired commands, keyboard and video or hard-copy terminals for communicating with the computer, etc. Though 8080- and Z80-based micros can control up to 256 I/O ports, few are equipped with more than two. In this article, therefore, we will describe how to add I/O facilities to expand a Z80 or 8080 computer's flexibility.

To add the I/O ports described here to any Z80 or 8080 micro, you must have a basic familiarity with port operation and addressing and bus structure. (This information is detailed in manuals that accompany the computers.) A few ICs will get your computer up and running. Port examples presented here are for a Radio Shack TRS-80 Level I computer that uses the T-BUG monitor and a Level II computer with machine code and BASIC. You can use a solderless breadboard to perform experiments and to prototype circuits.

Port Basics. There are a number of different types of I/O ports in use. An elementary port may simply display information on a bank of LEDs, operate relays, or input data from a bank of switches. A complex port, on the other hand, can accommodate such sophisticated devices as an ASCII keyboard, full-graphics CRT monitor, and hard-copy terminal. Although all ports share the common computer bus, each is assigned a specific address and is provided with logic circuitry that enables the port only when it is addressed.

Machine-code instructions define CPU input and output operations. Two-byte instruction D3 XX initiates an output operation to a port. (D3 is the output instruction and the Xs indicate numbers for specific port addresses, such as D3 00, D3 01, D3 02, etc.) When a Z80 CPU fetches and executes this instruction, it generates an $\overline{IOREQ}$ (I/O request) pulse and a $\overline{WR}$ (write) pulse, both active low, as indicated by the lines above them. These are logically added in an external AND gate and delivered as the $\overline{OUT}$ pulse on pin 21 of the TRS-80's bus. The data byte in the CPU accumulator register is placed on data bus lines D0 through D7. Simultaneously, address byte XX is placed on address lines A0 through A7.

Port-select logic constantly examines the $\overline{OUT}$ and address lines, waiting for the simultaneous appearance of the $\overline{OUT}$ pulse and port address. When this occurs, the port is enabled and data on the data bus lines enters the port. Ad-



TRUTH TABLE

CLK	D	Q EQUALS
0	X	LATCH
1	0	0
1	1	1

X= DON'T CARE STATE

Fig. 1. Internal logic of 7475 (including pin-out) and truth table for each latch.

dress bytes can be from 00 to FF (hexidecimal) to allow up to 256 output ports to be used with suitable decoding.

Machine-code instructions DB XX (input instruction with port address) initiates an input operation from the selected input port. Here, $\overline{IOREQ}$ and $\overline{RD}$ (read) pulses are added in an external AND gate and delivered as the $\overline{IN}$ pulse on pin 19 of the TRS-80's bus.

Port logic detects the simultaneous appearance of the $\overline{IN}$ pulse and port address and enables the port. At this time, the port connects its output lines to the data bus and the CPU copies any data present on the bus into the accumulator register. After data acceptance, the port frees the data bus for other purposes. The accumulator register is the source and destination of data with the D3 and DB instructions. The Z80 instruction set includes a number of special I/O instructions that effect data transfers to and from other registers and memory, with some instructions allowing movement of data in blocks.

Output and input ports can have the same address, such as output D301 and input DB 01. Port-select logic differentiates between the two by $\overline{OUT}$ and $\overline{IN}$ pulses. "Standard" or "isolated" I/O addressing allows up to 256 input and 256 output ports to be addressed by the computer. This is ample for just about any imaginable home computer system.

An alternative form of port addressing employs memory-mapped I/O. Each port, in effect, is addressed as memory. This method allows thousands of ports to be addressed and affords some programming advantages.

Simple Output Port. Inexpensive 7475 TTL ICs can be used to make 2-, 4-, and 8-bit latching-type output ports. As shown in the truth table in Fig. 1, data latch output Q follows input data D as long as the clock (CLK) line is high. When the CLK line goes low, data D is latched to output Q. The internal logic of the 7475, including pinout, is shown in Fig. 1. Note that each clock line drives two latches.

Two 7475's can be connected as an 8-bit latching port (Fig. 2). LEDs connected to the $\overline{Q}$ outputs turn on when their respective data D input is high.

The port shown in Fig. 2 is addressed by instruction D3 00, which places binary 00000000 on lines A0 through A7. The least-significant bit is on A0. When $\overline{OUT}$ and $\overline{A0}$ are true, the port is enabled by *IC3A* and the data byte held in the CPU accumulator register is displayed in binary on the LEDs. Address line bits A1 through A7 are "don't cares," provided they are not assigned to other ports. Hence, instruction D3 FE also selects this port because bit A0 is low.

Ports that do not require all eight data bits are easily arranged. To set up two 4-bit ports, break the clock line at X and add the second NOR gate (Fig. 2). Port *IC1* is enabled by instruction D3 01, which places binary 00000001 on the address lines. The 1 bit on line $\overline{A0}$ causes selection of port *IC1*. You can also separate the four clock lines and arrange four 2-bit ports, using address lines A2 and A3 for port selection.

Progressive addressing allows up to eight input and output ports to be used. One or more ports can be enabled by one instruction, simplifying programming and hardware requirements. Although it requires additional ICs in each port, full decoding of the address bits allows up to 256 input and output ports. For example, the TRS-80 cassette port is fully decoded and selected by instruction D3 FF. For this and other reasons, the ports described here are assigned active-low address bits for selection. For an elementary example of both fully decoded port and memory-mapped port, refer to the TRS-80 Technical Reference Handbook.

Complex I/O Port. Intel's versatile 8212 I/O chip can be used as either a latching or a nonlatching output port, input port, gated bus driver, or straight-

(Continued on page 56)

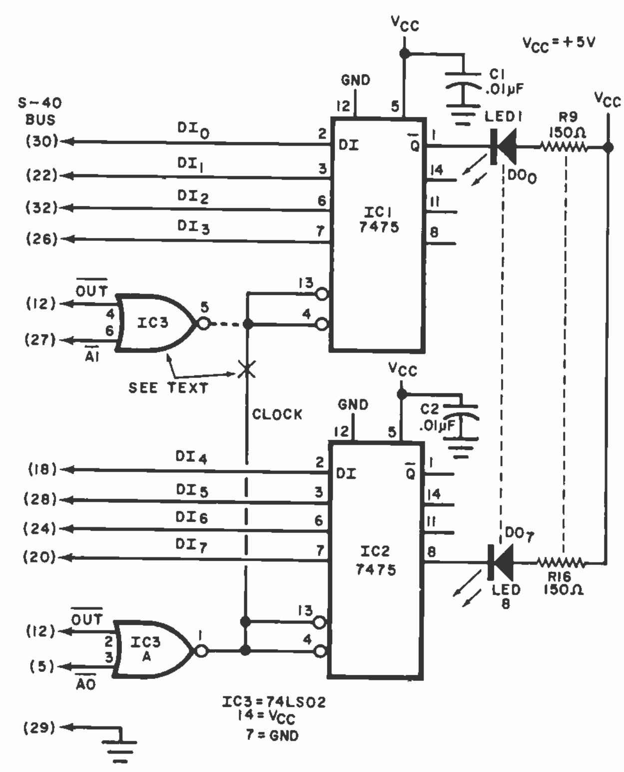


Fig. 2. Two 7475s and a 74LS02 can be used to form an 8-bit port or, with slight modifications, two 4-bit or four 2-bit ports.

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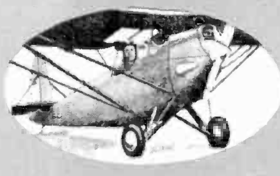
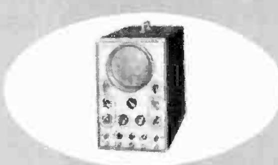
We've enjoyed serving folks interested in electronics for a long time, too!

1926



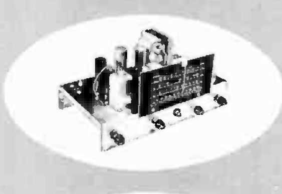
FIRST AIRCRAFT KITS An airplane was the Heath Company's first kit. Carrying the name, "the Heath Parasol," it sold for $199 (less engine) in kit form.

1947



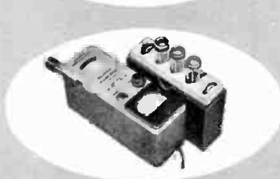
FIRST ELECTRONIC INSTRUMENT KITS The electronics era blossomed after World War II, and Heath was offering a kit-form oscilloscope for the low price of $39.95 F.O.B. Benton Harbor.

1949



FIRST CONSUMER ELECTRONICS KITS Encouraged by the scope's success, Heath expanded its line and by '49 offered an FM tuner kit, a hi-fi amp, and a 3-tube "all-wave radio."

1952



FIRST AMATEUR RADIO KITS Amateur Radio gear entered the Heath line when a grid dip meter was offered in 1952, soon followed by the AT-1 CW transmitter kit.

1957

FIRST PERSONAL COMPUTER KITS In March of 1957, a new Heathkit flyer announced the introduction of two analog computer kits. The computer age had arrived for the kit builder.

1979

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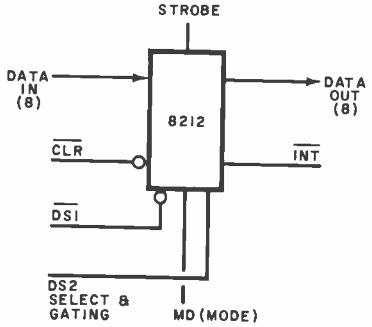


STATE	STB	MD	($\overline{DS1}$ · DS2)	D OUT EQUALS
1	0	0	0	3-STATE
2	1	0	0	3-STATE
3	0	1	0	LATCH
4	1	1	0	LATCH
5	0	0	1	LATCH
6	1	0	1	DATA IN
7	0	1	1	DATA IN
8	1	1	1	DATA IN

Fig. 3. The 8212, an 8-bit I/O port, and its truth table. This IC has tri-state provisions. That is, in one mode it can be electrically isolated from the system bus.

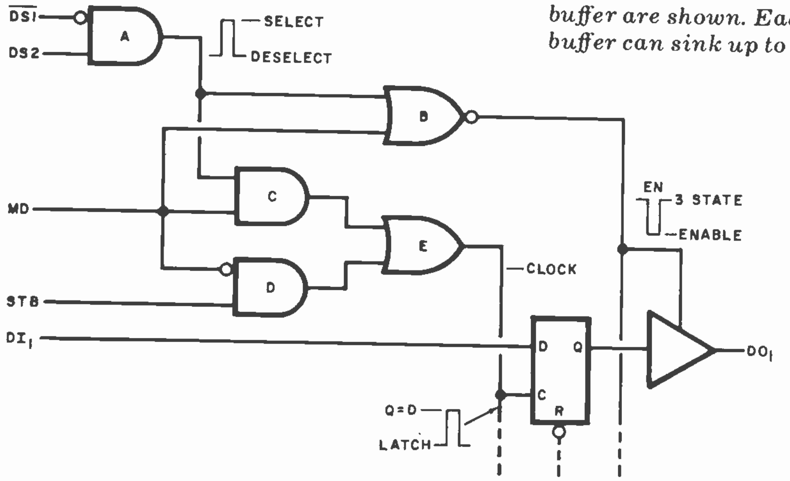


Fig. 4. A portion of the internal control logic of the 8212. Only one of its eight latches and output buffer are shown. Each output buffer can sink up to 15 mA.

(Continued from page 52)

through buffer, to name just a few of its applications. This high-speed Schottky TTL device includes eight data latches and output buffers that can be tri-stated (switched to high impedance). Each buffer can sink up to 15 mA.

The function diagram of the 8212 is shown in Fig. 3, which also illustrates chip signals and the IC's truth table. A portion of the internal control logic and one of the latches and its output buffer are illustrated in Fig. 4. For simplicity, CPU-interrupt control logic, which controls interrupt output INT, is omitted.

Familiarity with the control logic simplifies application. Mode control line MD is tied low (logic 0 or ground) for the input-port mode and high (logic 1 or V_{CC}) for the output-port mode. Lines $\overline{DS1}$ and DS2 are the device-select, or gating-control, lines. When $\overline{DS1}$·DS2 is 1, the device is selected by a high at the output of gate A.

The data-latch clock is strobed two ways. When line MD is low, gate C is defeated and strobe line STB passes a pulse through gates D and E to the clock line. When line MD is high, gate D is defeated and gate A passes a pulse through gates C and E to the clock line. Similarly, the output buffers are also operated two ways. When line MD is high, gate B goes low and enables the buffers continuously. This is a necessary requirement for a latching-output port. When line MD is low, the selected pulse from gate A passes through gate B to enable the buffers briefly, after which they return to tri-state. This is a necessary requirement for an input port.

The truth table is simple to use if you keep in mind the port or application requirements. To illustrate, let us implement an input port. In this case, MD must be tied low (grounded). Strike out all rows or states listing MD as 1 in the Fig. 3 truth table. Since MD is assigned, strike out column MD. We know from port basics that the input port must not latch onto the data bus. This eliminates state 5 and all that remain are states 1, 2, and 6, as shown in the reduced truth table in Fig. 5.

Clearly, state 6 must be retained for device selection and data transfer. Recalling that the STB line must be used to strobe the latches when line MD is 0, state 2 is deleted so that STB can alternate between 1 and 0. This results in the final truth table shown. Check this truth table to be sure it accomplishes the application's requirements. In this case, state 6 enables the port, placing port data on the data bus. State 1 "deselects" the port and tri-states the output buffers as required.

In the final step, computer pulses are assigned to $\overline{DS1}$, DS2, and STB. Available computer pulses are $\overline{IN}$ and $\overline{A0}$, the latter assigned to this port and active low. Notice that STB and DS2 are active high. With $\overline{DS1}$ active low, connect $\overline{IN}$ to $\overline{DS1}$. Pass $\overline{A0}$ through inverter *IC6A* and then to both STB and DS2 (Fig. 6).

To use the 8212 as a latching output port, tie MD high (to V_{CC}). Port requirements include device select with data in (state 7 or 8) and device deselect with latching (state 3 or 4). STB is a "don't care" line. Connect computer output pulse $\overline{OUT}$ to line $\overline{DS1}$. Address line bit A0 is inverted by *IC7A* and connected to line DS2 (Fig. 6). The LED is off when D is high. If this is objectionable, add inverting buffers between port outputs and light-emitting diodes.

For the 8212 to serve as a straight-through buffer or line driver, requirements are device select, data out equals data in, and continuously enabled output buffers. State 8 will effect these requirements. Connect line MD and DS2 to V_{CC} and line $\overline{DS1}$ to ground. For use as a bi-directional bus driver, interrupting ports, etc., see the Intel 8080 User's Manual.

FIRST REDUCED TRUTH TABLE

STATE	STB	$\overline{DS1}$ · DS2	D OUT EQUALS
1	0	0	3-STATE
2	1	0	3-STATE
6	1	1	DATA IN

FINAL TRUTH TABLE

STATE	STB	$\overline{DS1}$ · DS2	D OUT EQUALS
1	0	0	3-STATE
6	1	1	DATA IN

Fig. 5. Reduction of the truth table for the 8212.

Computer Hookup. The TRS-80 accepts a special 40-contact card edge connector. However, you can substitute a standard 44-contact card socket, such as a Vector No. R644-2, after modifying it. To do this, fit a thin piece of hard plastic into the connector slot to cover the two top and bottom contacts at one end of the connector. You now have a 44-contact connector that for all practical purposes has been modified to serve as a 40-contact connector.

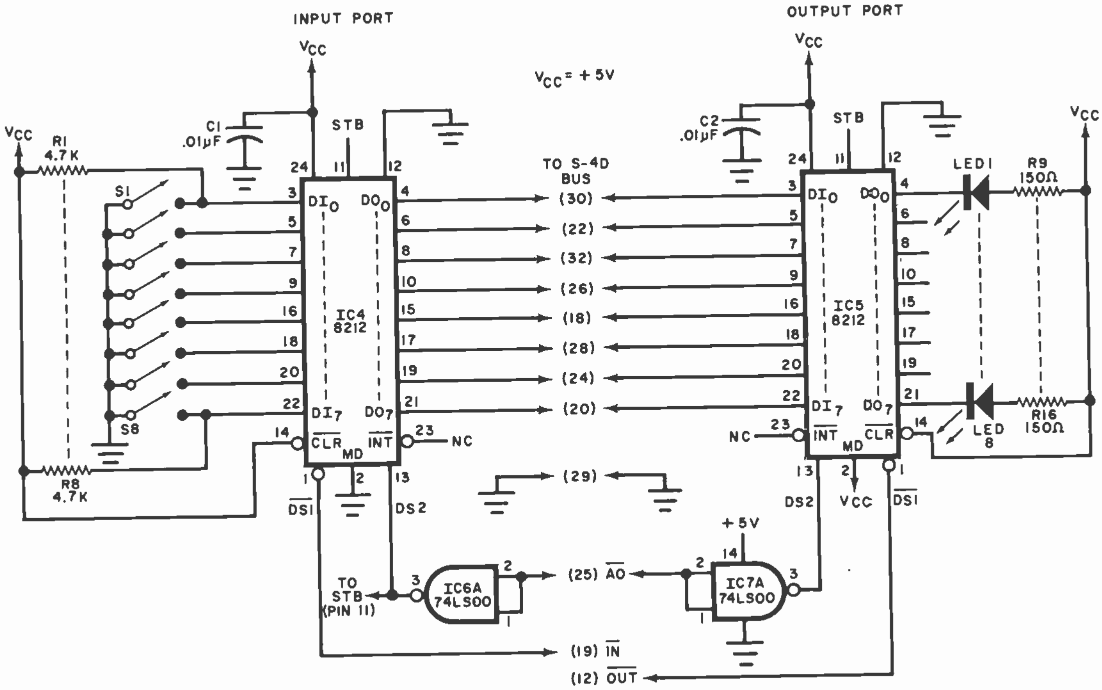


Fig. 6. An experimental I/O port using a pair of 8212s with switch inputs and light-emitting diode outputs.

PARTS LIST

C1,C2—0.01-μF disc capacitor
IC1,IC2—7475
IC3—74LS02 NOR gate
IC4,IC5—8212 8-bit I/O port
IC6,IC7—74LS00 low-power quad 2-input NAND gate
LED1 through LED8—Light emitting diode
R1 through R8—4700-ohm resistor
R9 through R16—150-ohm resistor
S1 through S8—Spst switch

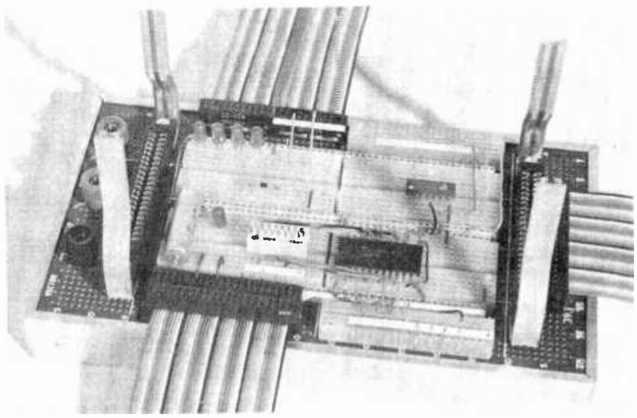


Fig. 7. Three computer links are provided on this patchboard using solderless circuit connections. Wire-Wrapping is used on connectors and under chassis.

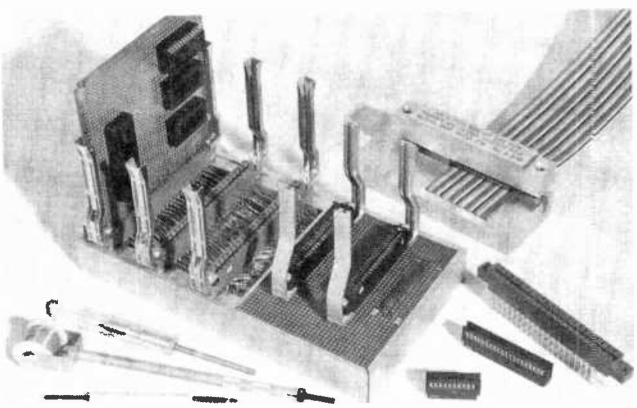


Fig. 8. Typical plug-in card chassis. Three large sockets are Vector Electronics R644-3 with mating BR27-D card guides. Smaller connectors are R644-2 with BR27 card guides. Wire-forming and chiseling tools are also shown.

Install the modified connector in the TRS-80, making sure that lateral play barely exceeds 1/64" (0.4 mm). Carefully remove the modified connector and cement the small plastic pieces solidly in place. Recheck connector fit before the cement sets. Then use a lettering kit to mark an UP label on the up side of the connector.

Solder a 12" to 18" (30.5 to 45.7 cm) length of color-coded 40-conductor ribbon cable, such as Vector's No. KW2-40, to the connector. Make a record of which conductor connects to and what signals are present on each pin. Refer to the TRS-80 Technical Reference Manual or User's Manual for pin assignments.

At this point, you can choose any of a number of conventional construction approaches. Perhaps the simplest is to use a solderless breadboard on which to experiment with the I/O port. A 40-pin IDC connector, such as a Vector No. KS2-40, can be fitted to the end of the cable, using a Vector No. P187 IDC fixture to make the connection. A mating connector can then be mounted on the solderless breadboard. Shown in Fig. 7 is this author's experimental setup, which includes wiring to a home-built card cage (Fig. 8) to support Wire Wrap circuit cards.

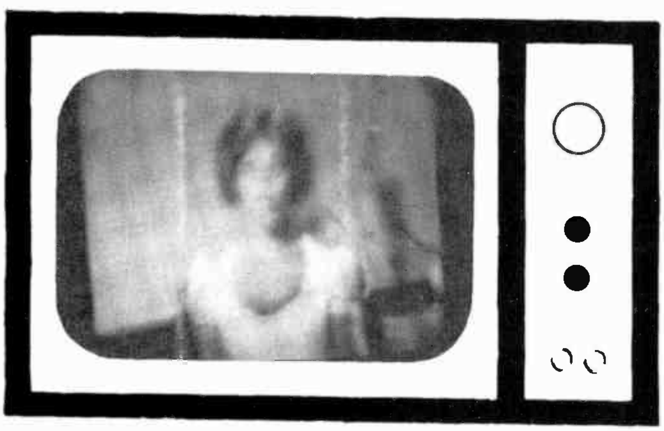
In Conclusion. From the foregoing, you can see that it is relatively simple to interface a computer with external devices to perform useful operations. You could conceivably use all 256 I/O ports to control everything in your home. ◇

TV-RECEIVER problems can cause the strangest video effects. Pictured here are ten mostly uncommon symptoms, each accompanied by a description of the usual cause.

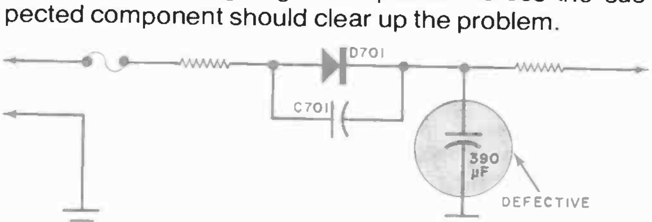
Before troubleshooting TV circuitry, one should bear in mind that servicing a TV chassis can be dangerous. Therefore, always remember to disconnect the ac line cord from the wall outlet and discharge all electrolytic capacitors in the chassis before attempting any work.

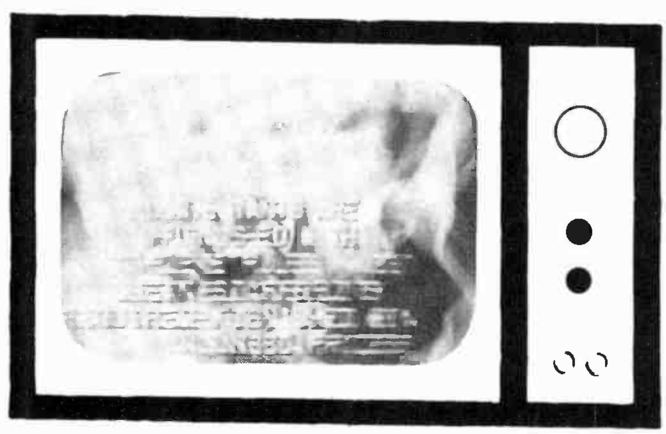
TEN UNCOMMON TV-RECEIVER PROBLEMS

BY HOMER L. DAVIDSON

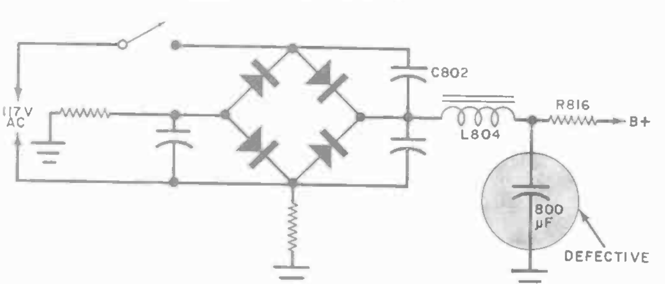


HERE WE have a typical filter-capacitor problem, with hum bars running through the picture plus insufficient width. The picture cannot be straightened out by operating the horizontal-hold control. The source of the problem can be found by examining the terminal connections of the suspected filter capacitors. Look for a white or black substance that has oozed out around the terminals or a bulge in the case of the capacitor. The first filter or voltage-doubling capacitors are the likely culprits. Reduced voltage and excessive "hash" on an oscilloscope waveform indicate a defective filter capacitor. Shunting a good capacitor across the suspected component should clear up the problem.





THIS "foggy" picture appeared on the screen of a J.C. Penney Model 2874 portable TV receiver. Its cause turned out to be a defective 800-μF, 180-volt filter capacitor. The partial schematic diagram gives the capacitor's location in the circuit.



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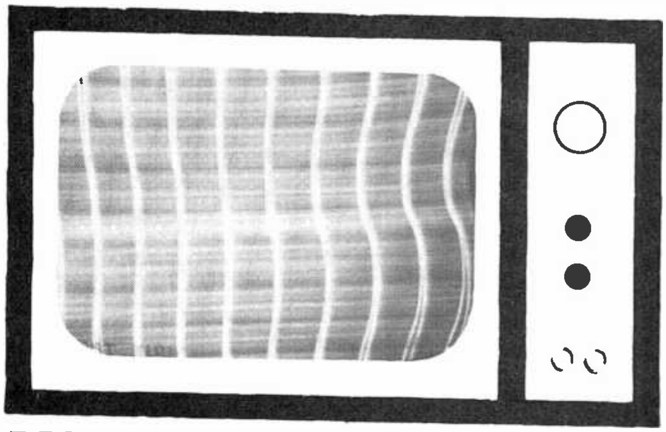
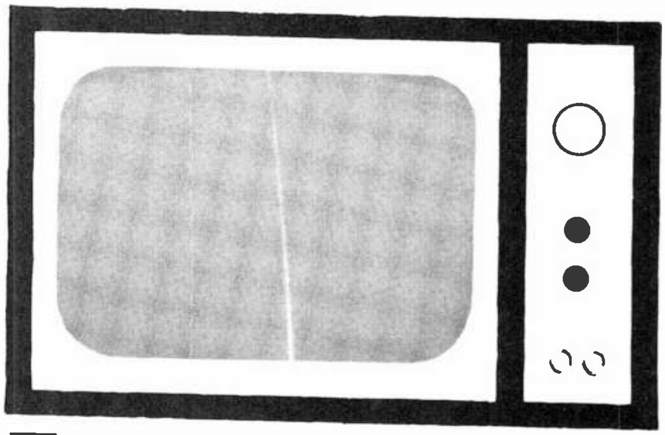
CIRCLE NO. 56 ON FREE INFORMATION CARD



WHEN THE picture pulls and squirms as shown here, try adjusting the horizontal and vertical controls. If this does not help, try shunting the filter capacitors, one at a time, with a new capacitor with a rating of at least 100 μF and no less than the voltage at which the suspected capacitor is rated. (Do not forget the precaution noted earlier when doing this.) When the hum-bar condition disappears, you have located the faulty capacitor and can replace it with a new component. If the defective capacitor is in one can with other capacitor elements, replace the whole unit because the other elements are likely to become defective soon.

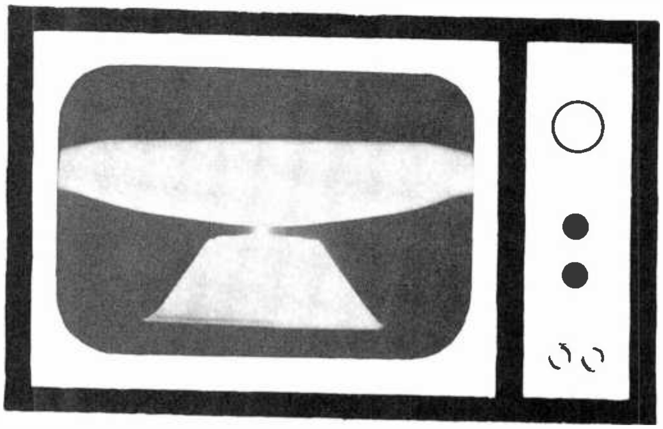


THE PICTURE illustrates what happened when a winding was open in the horizontal section of a deflection yoke. Since the line goes from top to bottom in the center of the screen, we know that high voltage and vertical height, both essential ingredients in obtaining a TV picture, are present. What is missing is horizontal sweep to spread the picture across the screen.

You can check continuity of a deflection yoke with an ohmmeter while it's on the neck of the picture tube. (Power must be "off," of course.) Most horizontal windings have a resistance between 10 and 50 ohms. Check the red, white, or orange wire going to the yoke. (Always disconnect the red wire to obtain correct continuity.) The vertical yoke wires are color-coded yellow, green, or black.

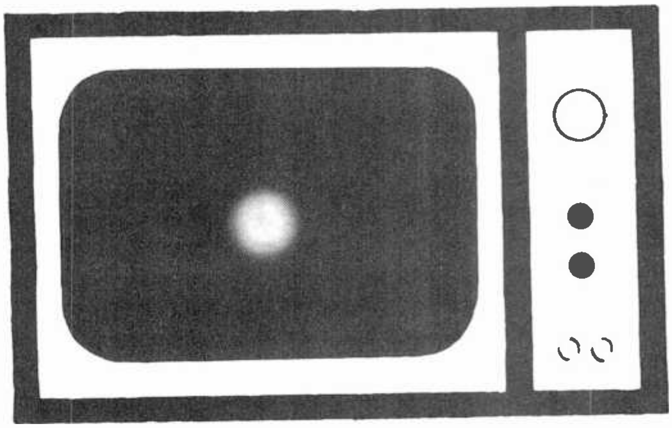
SOMETIMES when the brightness control is turned fully up, a picture may "bloom" or go out of focus. When the picture is out of focus all the time, no matter where the brightness control is set, suspect a defective picture tube, focus rectifier, or other component in the focus circuit. The first thing to do here is to locate the focus control on the rear apron and adjust for best focus. If that does not help, check for a defective component.

Look for a focus-rectifier tube near or on one side of the high-voltage cage. Typical tube numbers are 1V2 and 2AV2. If you cannot locate a rectifier tube, even after referring to the tube list on the side of the cabinet or high-voltage cage, the chassis uses a solid-state rectifier, which will be located inside or under the chassis. If you have access to a high-voltage probe, focus voltage should read 4.3 to 5.5 kV. A defective picture tube must be checked with a CRT tester.

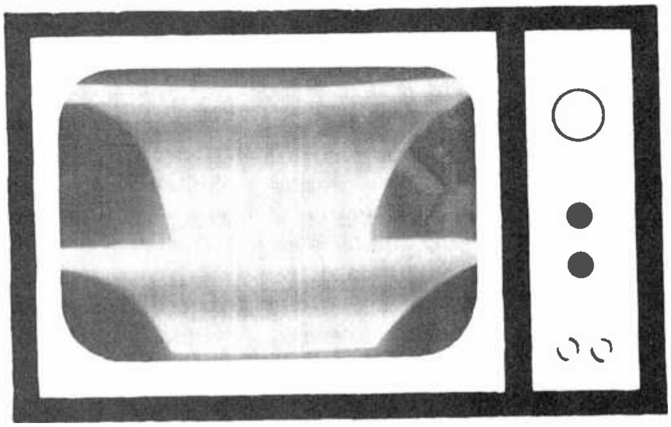


LARGE filter capacitors in a TV receiver chassis are particularly prone to breakdown. Most such problems result from drying out of the capacitors after being in service for years. Although the problem shown in this photo is capacitor related, it was not caused by drying out. It is the result of a broken trace on the printed circuit board at the base of the main filter capacitor in a Midland Model 15-023 monochrome TV receiver.

The problem was located when the capacitor was accidentally moved and the picture was restored to normal. Careful inspection revealed that the capacitor's ground lugs were torn loose from the pc board. Heavy, bare hookup wire and solder secured the capacitor into position. The partial schematic diagram shows where the filter capacitor is located in the circuit.



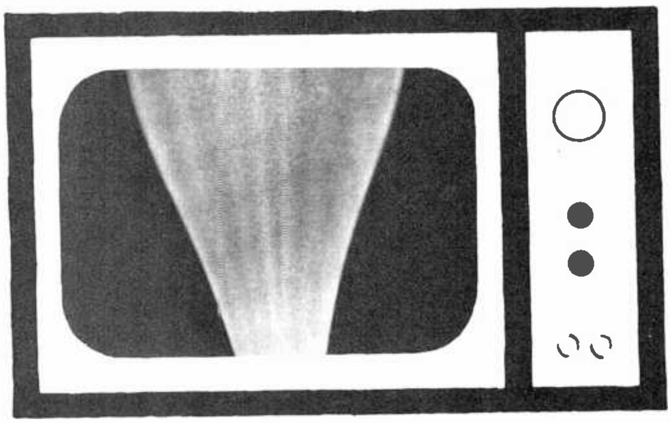
HERE IS a problem that usually crops up *after* you have performed some repairs on the chassis of a TV receiver. If you inspect the chassis, most likely you will find that you have forgotten to plug in the yoke assembly. This cannot occur on every TV chassis, because some have a low-voltage tie-in jack to prevent it from happening.



HERE WE see a video problem that occurred in a Panasonic ETA-3 portable color-TV receiver chassis. It resembles, perhaps, a double-tiered water fountain. Moreover, there was even a gurgling sound coming from the speaker. The source of the problem turned out to be filter capacitor *C853*, rated at 1200 μF and 160 volts. This tall capacitor is at the right rear of the chassis, behind the high-voltage cage.

This type of problem can be verified by shunting the suspected capacitor with a component of similar ratings. To prevent arcing and damage to transistors in the receiver, turn off the power, clip the new capacitor across the old, and turn on the power. If the filter capacitor was indeed the culprit, the picture should return to its normal condition.

PERHAPS you have seen this picture problem before, with very thin lines running across the screen. Here we find a whole section of the picture masked by noise. This is not a receiver problem. It was the result of interference from a microwave oven, but could also have been caused by any other electrical appliance or even a fluorescent-lighting fixture. Sometimes an ungrounded furnace motor will produce such picture interference. By grounding the appliance or motor and plugging it into a noise-eliminator socket, you can do away with or drastically reduce the interference.



WHENEVER you see a picture with the sides at an angle, as shown here, suspect a shorted deflection yoke. If it is the yoke, you might even see a curl of smoke coming from it, indicating arcing between windings, when power is turned on. When no telltale smoke is present, you may be able to pinpoint a shorted-yoke problem by turning on the receiver and operating it for about a half hour. Then turn off power, discharge the capacitors, and remove the picture-tube socket and yoke assembly. Feel the inside of the yoke assembly for warm or hot spots. If you locate a hot spot, you have located the point at which the yoke is shorted. Replacement of the deflection yoke is the only cure.

AS POWER amplifiers grow in output capability and audiophiles insist on realistic listening levels, the likelihood that loudspeakers will be overdriven and damaged increases, too. It is possible that a single large pulse of energy could send the speaker voice coil and whatever happened to remain attached to it on a ballistic trajectory across the room, but this is a rare failure mode. Loudspeakers are usually damaged thermally; too much power is dissipated in the voice coil for too long a time, raising the temperature to the point where a breakdown occurs. (See "The Importance of Power-Handling Capacity," POPULAR ELECTRONICS, March 1979.)

"Power" meters, often added to amplifiers to monitor output, can show when the *amplifier* is being overdriven, but they do not tell much about the thermal stress applied to the loudspeaker. This is because they measure the voltage applied to the loudspeaker and calculate the power on the assumption that the loudspeaker is a nonvarying pure resistance across the audio band, using the relation $P = E^2/R$, where P is power, E voltage, and R resistance. Meanwhile, the actual power delivered to the speaker (which causes the heating) varies with the magnitude of its impedance and the phase angle between current and voltage, both of which are functions of frequency.

The True Audio Power Meter project presented here gives an indication of the actual power delivered to the loudspeaker voice coil. (Since typical loudspeaker efficiency is of the order of 1% or less, it is reasonable to neglect the acoustic output power and assume that all the power is dissipated as heat.) This information is displayed on a peak-reading LED string and on an analog meter that can be switched between peak- and average-reading modes. The power reading is accurate to within a few percent, and is independent of variations in the loudspeaker impedance.

Operating Principles. The meter senses voltage and current and processes them into a signal whose amplitude is proportional to power. A block diagram of the meter is shown in Fig. 1. The heart of the project is a four-quadrant analog multiplier. This IC accepts input signals from voltage- and current-sensing networks and continuously generates their product. The resulting output signal is proportional to the instantaneous power delivered to the speaker. Variations in speaker impedance and phase angle are taken into account.

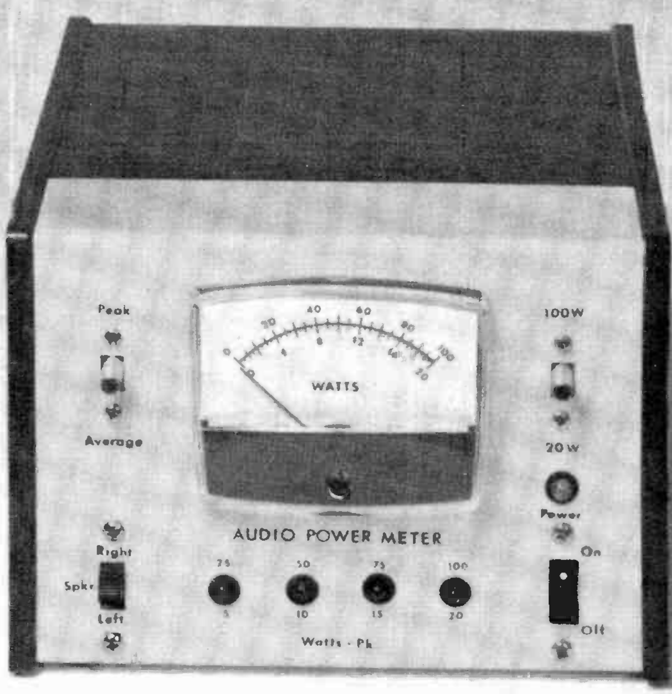
The rest of the circuit processes this constantly changing product signal to provide a readout of either average power or peak power. When the mode selector switch is in the AVERAGE position, the output voltage developed by the multiplier is fed directly to a meter-driving circuit that converts the voltage into current fluctuations. The inertia of the meter movement results in a readout of average power.

(continued on page 64)

Instrument indicates an audio amplifier's true output power

BY JOHN R. HUNT

Audio Power Meter



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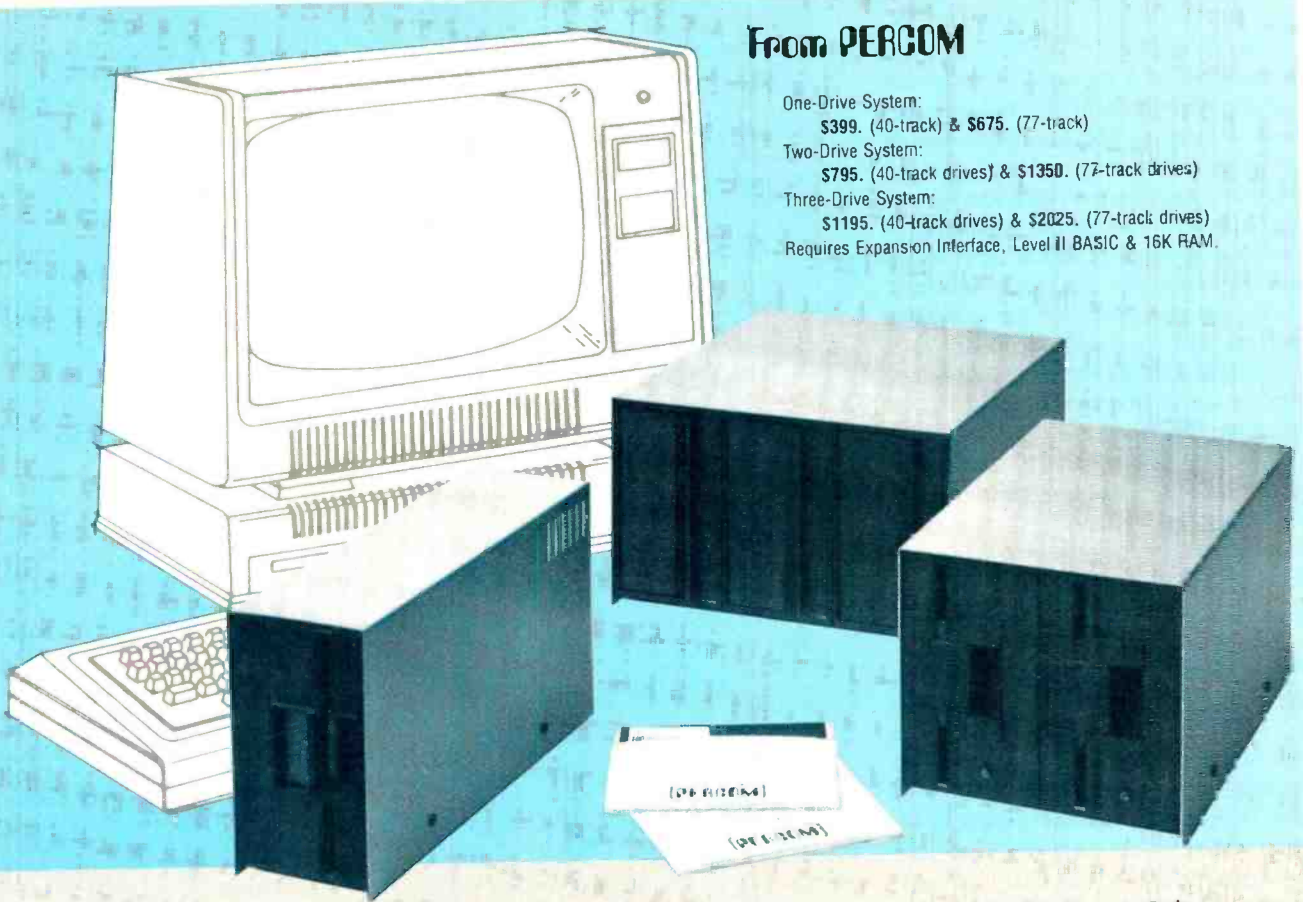

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The output of the multiplier is also fed to the input of a peak-detecting circuit that captures and briefly holds short-lived transients. With the mode switch set to PEAK, the output of the peak detector is routed to the meter-driving circuit to display peak power. The output of the peak detector is fed at all times to four comparators that drive indicator LEDs. The thresholds of the comparators are set to divide the range into successive 25% increments. Therefore, with the range select switch set for 20 W full-scale, the four peak-indicator LEDs turn on at 5, 10, 15 and 20 watts. The range selector controls sensitivity of both the meter and the peak display for either range. An analog meter is used because of its ability to convey signal trends to the observer quickly.

Circuit Details. A schematic diagram of the True Audio Power Meter is shown in Fig. 2. The relative complexity and cost of the circuits make it practical to monitor only one audio channel at a time. However, to maintain proper isolation of the audio power output lines from switching transients and from each other, separate current-sensing resistors are used for each stereo channel. Additional sense resistors and appropriate modifications to switch *S2* can be used to adapt the circuit for four-channel monitoring. Current sensor resistors *R1* and *R2* are in series with the speakers of their respective channels. The channel selector *S2* routes the voltages from either channel to the signal-processing circuits, where they are adjusted in level to be in the optimum range of the four-quadrant multiplier. The voltage appearing across the speaker is applied to divider network *R3/R4* and the attenuated signal is applied to the pin-1 Y input of multiplier *IC3*.

The low-level voltage across *R1* or *R2* is proportional to the current flowing through the speaker. Inverting amplifier *IC2A* raises the signal to a usable level and inverts it to bring it into phase with the voltage applied to the multiplier's Y input. The output of amplifier *IC2A* goes to the pin-6 X input. Potentiometers *R8*, *R9*, and *R10* permit multiplier *IC3* to be trimmed for optimum accuracy.

The output of the multiplier (instantaneous product of the X and Y input signals) is applied to mode switch *S3* and

(continued on page 68)

PARTS LIST

BTS1, BTS2—Four-conductor barrier terminal strip
C1,C2—470-µF, 35-volt electrolytic
C3,C4—10-µF, 25-volt electrolytic
C5,C6,C7—0.1-µF disc ceramic
D1,D2,D3,D4—1N4002 rectifier
D5,D6,D7—1N914 signal diode
F1—¼-ampere fast-blow fuse
IC1—RC4195 bipolar voltage regulator (Raytheon)
IC2—TL074CN BIFET quad operational amplifier (Texas Instruments)
IC3—AD533JH or AD530J four-quadrant multiplier (Analog Devices: see text and note below)
IC4—LM339N quad comparator (National Semiconductor)
LED1 through LED5—TIL220 or equivalent light-emitting diode
M1—0-to-1-mA meter movement (Radio Shack 22-052 or equivalent)
Q1,Q2,Q3,Q4—2N3904 npn switching transistor
The following are ¼-watt, 5% resistors unless otherwise specified.
R1,R2—0.1-ohm, 15-watt wirewound power resistor (Dale HLM-15 0.1 or equivalent)
R3,R12—22,000 ohms
R4—3900 ohms
R5,R7—1000 ohms
R6—12,000 ohms
R8,R9,R10—20,000-ohm, pc-mount trimmer potentiometer
R11,R15—10,000 ohms
R13,R33,R34—10,000-ohm, pc-mount trimmer potentiometer
R14—500,000-ohm, pc-mount trimmer potentiometer
R16, R26,R27—2200 ohms
R17—10 megohms
R18,R19,R20,R21—1000-ohm, 1% tolerance, metal-film precision resistor
R22,R23,R24,R25—15,000 ohms
R28,R29,R30,R31—1500 ohms
R32—5600 ohms
S1—Spst switch with 1-ampere (115 volts ac) contacts
S2—3pdt switch
S3—Spst switch
S4—Dpdt switch
T1—36-volt, 170-mA, center-tapped transformer (Signal Transformer No. 241-4-36 or equivalent; see note below)
Misc.—Printed circuit board, suitable enclosure, fuseholder, line cord and strain relief, 10-ohm, 100-watt resistor for calibration purposes (see text), hookup wire, solder, hardware, etc.
Note 1—Four-quadrant multiplier *IC3* is manufactured by Analog Devices Inc., Route 1, Industrial Park, Box 280, Norwood, MA 02002 (617-329-4700).
Note 2—Power transformer *T1* is manufactured by Signal Transformer Co., 500 Bayview Ave., Inwood, NY 11696.
Note 3—The following are available from Select Circuits, 1411 Lonsdale Rd., Columbus OH 43227: drilled and plated fiberglass pc board (#AWM-1) at $7.95; IC3 Analog Devices AD533JH at $9.95; mini-kit (#AWM-MK) consisting of the above plus IC1, IC2, IC4, LED1-LED5, R1, R2, R18 through R21, T1, and a 10-ohm, 100-watt noninductive resistor at $44.95. Prices include shipping in U.S., Canada and Mexico. Others add 20% for Air Mail.

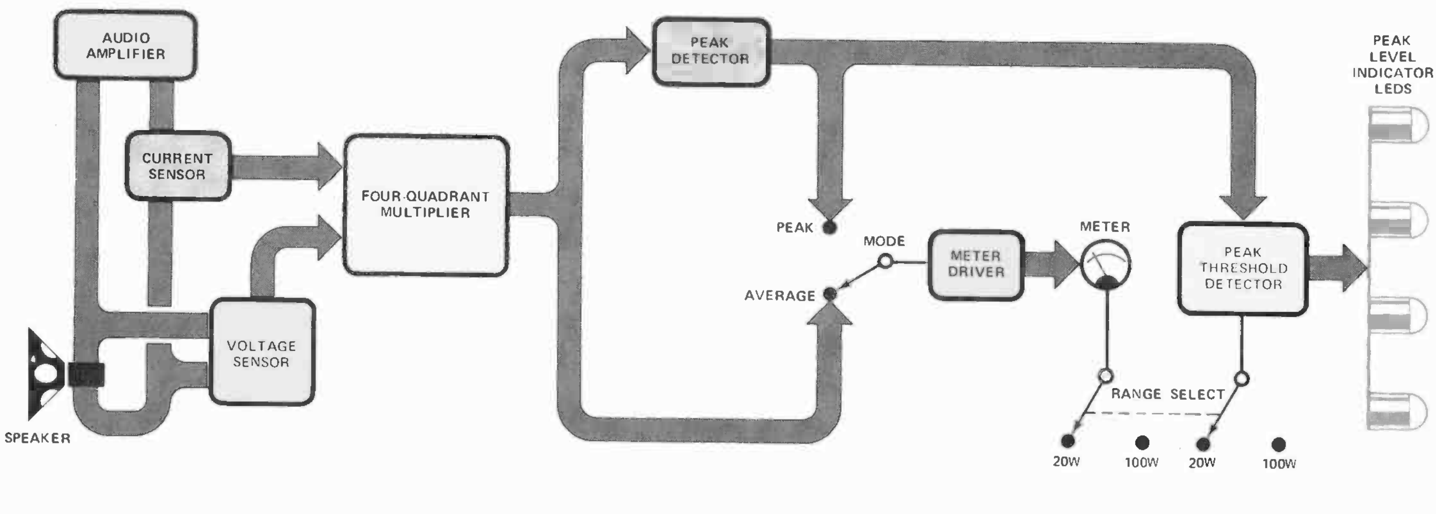
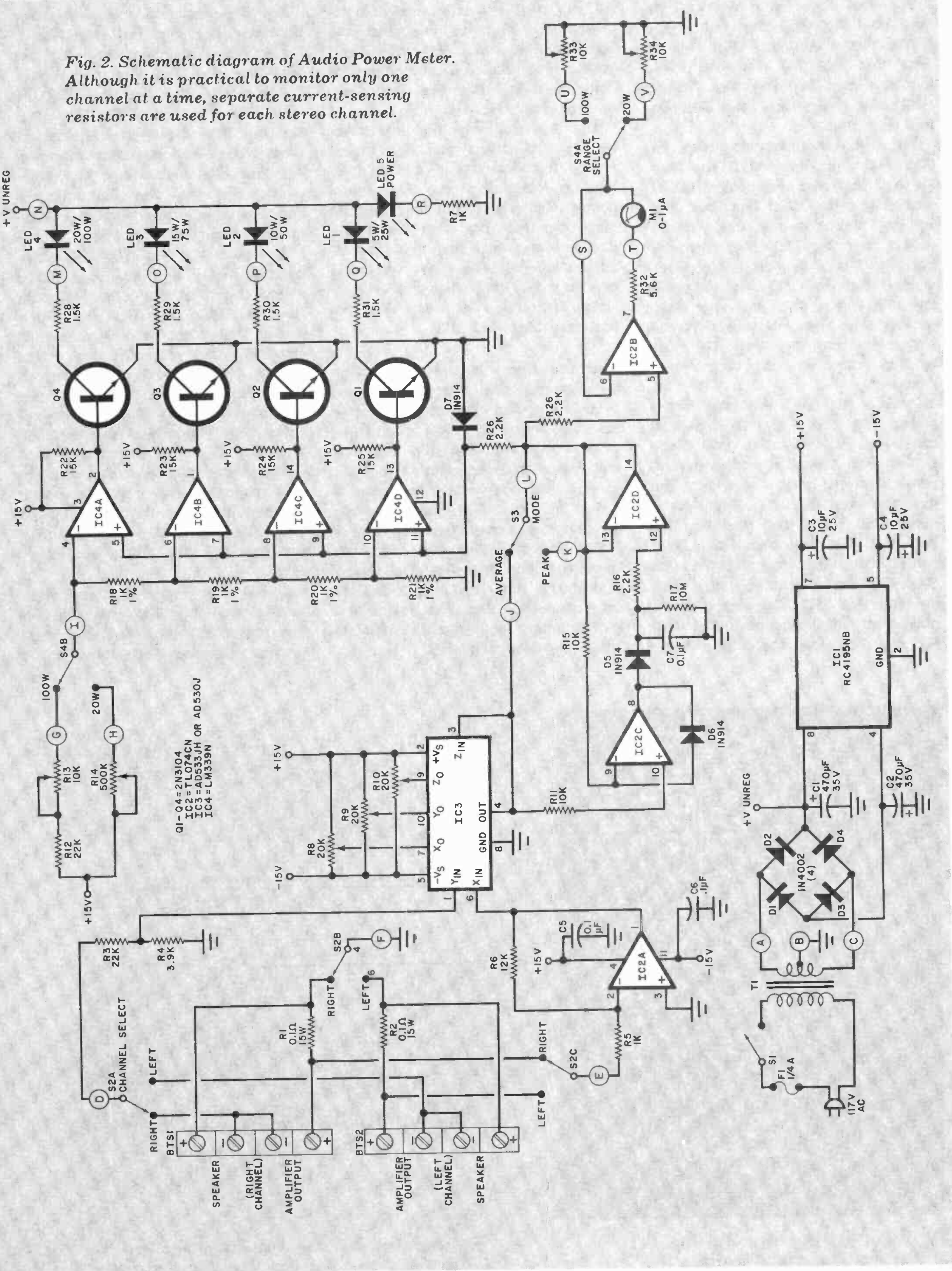


Fig. 1. Block diagram shows how four-quadrant analog multiplier is at heart of Power Meter.

Fig. 2. Schematic diagram of Audio Power Meter. Although it is practical to monitor only one channel at a time, separate current-sensing resistors are used for each stereo channel.



IC2C. When *S3* is set to AVERAGE, the output of the multiplier also goes to the noninverting (+) input of *IC2B*. This op amp has meter *M1* connected in its feedback loop. Potentiometers *R33* and *R34* serve as full-scale calibration controls for the meter.

The multiplier output also goes to the noninverting input of *IC2C*, the input stage of a buffered peak detector. Operational amplifier *IC2D* functions as a voltage follower for the positive peaks held by capacitor *C7*. Its output is routed back to *IC2C* by its feedback loop. Resistor *R15* allows *IC2C* to be clamped in its "off" state by *D6*, resulting in faster recover. Brief transient peaks in the music waveform rapidly charge *C7* which holds them long enough to be shown on the meter.

Resistor *R26* feeds the output of the peak-detecting circuit to the inputs of comparators *IC4A* through *IC4D*. Diode *D7* prevents the inputs of these comparators from going negative. The threshold level of each comparator is determined by divider resistors *R18* through *R21* in conjunction with calibration resistors *R12* through *R14*. Switch *S4* selects the full-scale reading of both the meter and LEDs. Depending on the position of *S4*, the upper end of *R18*-*R21* is set at the voltage determined by *R13* or *R14*. The voltages applied to the inverting (−) inputs of the comparators correspond to 25%, 50%, 75%, and 100% of full-scale. Each comparator controls a single LED to form a four-element bargraph display.

The power supply for the Audio Power Meter is a relatively simple ±15-volt source. It is based on a Raytheon dual-tracking regulator. The only external components required are input filter and output bypass capacitors (*C1*-*C4*). Because the current capacity of *IC1* is limited, an unregulated positive voltage is used to supply the LEDs and driver transistors *Q1* through *Q4*. A pilot-light function is provided by *LED5*.

Construction. Although circuit layout is not exceptionally critical, conventional circuit arrangement should be followed if point-to-point wiring is to be used. For those who prefer the ease of assembly and the reliability of printed circuits, a full-size etching and drilling guide is shown in Fig. 3. The corresponding component-placement guide appears in Fig. 4. Note that the connections to off-board components are identified by circled letters. Refer to Fig. 2 to identify each connection. Use of sockets or Molex Soldercons for the integrated circuits is strongly recommended.

A few words of caution are in order concerning component substitutions:

(1) Four-quadrant multiplier *IC3* can be either an AD533JH or an AD530J. The rated total error of the AD530J is ±1% and that of the AD533JH is ±2%. Both are manufactured by Analog Devices and were chosen for their simplicity of operation and low cost. They combine on one chip a four-quadrant transconductance multiplier, stable voltage reference, and output amplifier.

(2) Device *IC2* is a TL074CN, a low-cost, low-noise JFET-input operational amplifier with bipolar output and high slew rate. Although pin-for-pin compatible, it should *not* be replaced with a standard quad op amp such as an LM324. Amplifier *IC2A* must have a high slew rate to prevent the current-sense signal from lagging in phase with respect to the unamplified voltage signal. Stages *IC2C* and *IC2D* must also have high slew rates to allow the peak detector to respond quickly to brief transients. The high impedance of the JFET input circuit prevents *IC2D* from loading *C7* and bleeding off the charge accumulated in it.

(3) Although *R1* and *R2* do not dissipate as much as 15 watts, resistors with lower power ratings were found to be inadequate because of self-heating. At

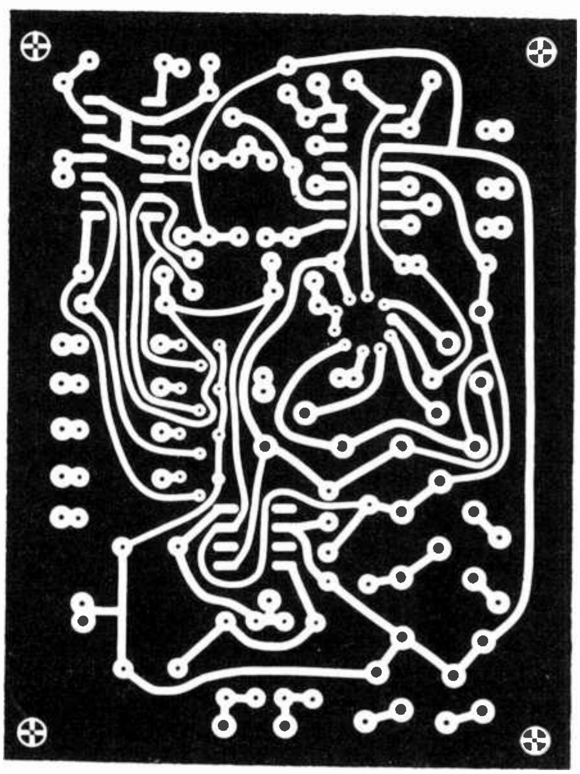


Fig. 3. Full-size etching and drilling guide for printed circuit board.

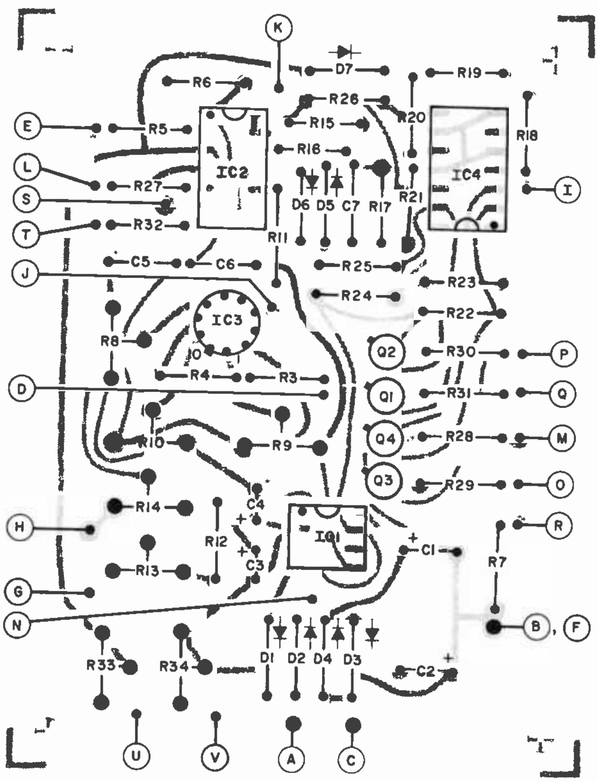


Fig. 4. Component layout guide for pc board. Circled letters connect to off-board components.

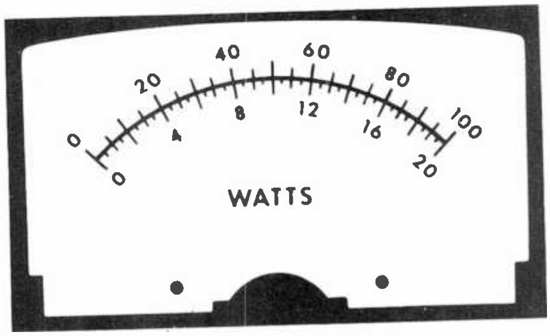


Fig. 5. You can make your own meter scale or cut this one out and glue it to the suggested meter.

medium power levels, 5-watt current-sense resistors changed value by several percent.

(4) Several other resistors, *R18* through *R21*, affect the accuracy of the discrete LED power-level indicators. The threshold at which full-scale level indicator *LED4* starts to glow is determined by the settings of *R13* and *R14*. The accuracy of the lower-level thresholds, however, is set by the tolerances of *R18* through *R21*.

Assembly. To prevent damage to expensive parts (especially the multiplier), verify operation of the power supply prior to installing *IC2*, *IC3* and *IC4*. For testing, the load presented by the completed project can be simulated by separate 680-ohm, ½-watt resistors connected across *C3* and *C4*. The potential across *C3* should measure +14.5 to +15.5 volts, while that across *C4* should be −14.5 to −15.5 volts.

You can make your own scale for meter *M1* or cut out and glue the one shown in Fig. 5 to the face of a Radio Shack No. 22-052 0-to-1-mA dc meter. To do this, carefully remove the protective plastic cover and the two screws that secure the metal plate on which the scale is printed. Take care to avoid bending the meter pointer when you slide out the scale plate. Spray the scale plate with a coat of black paint. This will prevent the original scale lettering and any printing on the other side of the cut-out scale from showing through when the new scale is glued in place. Allow the glue to dry and then reinstall the scale plate on the face of the meter and snap the plastic cover in place, taking care to align the lug attached to the zero-adjust screw on the cover with the corresponding slot in the meter movement. Finally, set the zero-adjust screw so that the pointer is centered over the zero line on the left end of the scale.

Calibration. The first step in calibration is to trim the settings of the potentiometers for multiplier *IC3*. This can be done using a signal generator capable of delivering a 20-volt peak-to-peak sine wave at a frequency of 50 Hz or, if such a generator is not available, a common 6.3-volt ac filament transformer. To use the transformer, connect the 6.3-V secondary across a 500-ohm potentiometer and tap the signal at the wiper (Fig 6).

Proceed by placing channel select switch *S2* in its RIGHT position, which grounds the RIGHT SPEAKER + terminal. Next, ground both voltage sense and current sense inputs by shorting the RIGHT AMPLIFIER + and − terminals to the RIGHT SPEAKER + terminal. Then set *S3* to AVERAGE and *S4* to 20 w. Close *S1* and the meter's pointer should momentarily deflect up-scale and any or all of the level indicator LEDs might glow briefly and then darken in descending order. Adjust *R10*, for a precise zero indication on the meter. (This is a dc null adjustment that can drive the meter above or below zero.) Open *S1*, and the pointer will again deflect up-scale and the LEDs may glow briefly.

The next adjustments will minimize ac feedthrough at the X and Y inputs. If one input is held at zero (ground), the output level should remain at ground regardless of the signal applied to the other input, but practical multipliers contain sources of error and can only approximate zero feedthrough. Do not disturb the connections made to ground for the dc null adjustment. If you are using a signal generator, set its controls so that it produces a 50-Hz sine wave with an amplitude of 17 volts peak-to-peak or 6.0 volts rms. If you are using a filament transformer, you will be supplying a 60-Hz signal taken from the wiper of the 500-ohm potentiometer, as was done previously. Adjust the potentiometer so that a 6.0-V rms (17-V peak-to-peak) output signal appears at the wiper. Set the switches as follows: power *S1* to ON; channel select *S2* to RIGHT; range select *S4* to 20 W; and mode select *S3* to PEAK. Apply the 6.0-V rms signal to the junction of resistors *R3* and *R4* and remove power from the project.

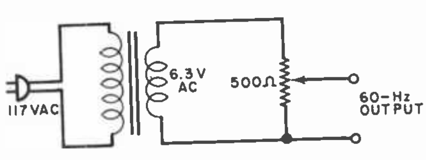


Fig. 6. Using filament transformer and potentiometer as signal source.

Next, disconnect the inverting input of *IC2A* from *R1*. Otherwise, any test signal would be shorted to ground by the low resistance of *R1*. This is most easily accomplished by disconnecting the wire running from the side of *R1* that is connected to the positive AMPLIFIER OUTPUT terminal to *S2C*. Unsolder the wire at *R1*, leaving it connected to *S2C*.

If you are using a signal generator, adjust it so that it produces a 50-Hz sine wave with an amplitude of 0.5 V rms (1.4 V peak-to-peak). If you are using a filament transformer, adjust the potentiometer so that 0.5 V rms appears at its wiper. Close *S1*, but do not disturb the settings of *S2*, *S3*, and *S4*. Connect the signal source to the free end of the wire

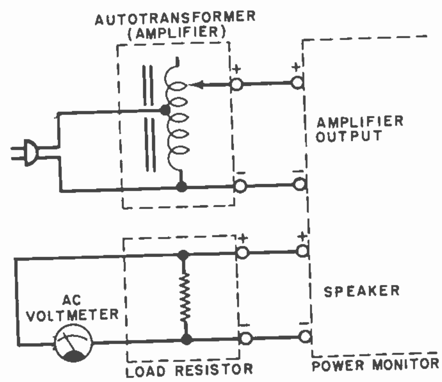


Fig. 7. Connections required for calibration of meter driver and the comparator string.

which you disconnected from *R1*. Now adjust the Y_O trim *R9* for the lowest reading obtainable on the meter. Then disconnect the signal source and remove power from the project. Reconnect the wire to *R1*.

Place *S3* in its AVERAGE position, close *S1*, and readjust *R10* for zero on the meter. Remove power from the project and disconnect the wires grounding the right channel's AMPLIFIER OUTPUT terminals. The multiplier IC is now trimmed for optimum accuracy.

The meter driver and comparator string can now be calibrated. There are three items necessary to perform these calibrations. The first is a variable autotransformer, usually referred to by the trade name Variac. The transformer

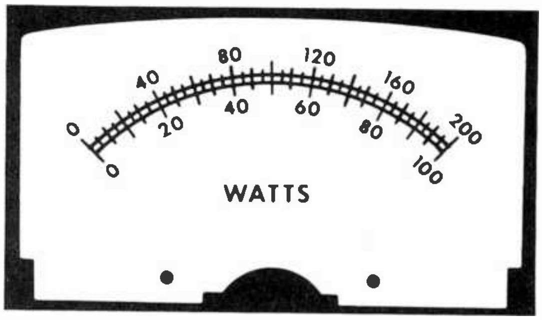


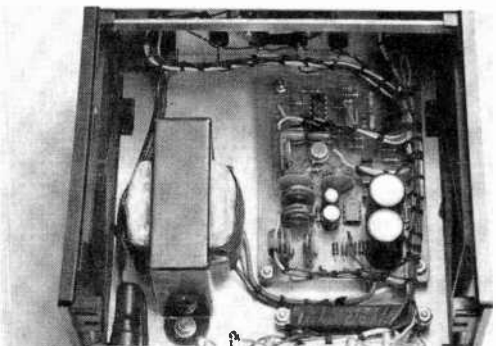
Fig. 8. Using this modified scale for your meter for operation up to 200 watts.

should be capable of supplying up to 50 V ac at 3.2 A. If such a transformer is not available, you can use a signal generator (or 6.3-volt ac filament transformer and 500-ohm potentiometer) and an audio amplifier capable of delivering 100 watts or more per channel of unclipped audio power into a 10-ohm load.

A wirewound load resistor is also needed. The type of power resistor most readily available is usually inductively wound; and at higher frequencies, the inductive reactance causes problems. Therefore, calibration is carried out at 60 Hz, where the effects of reactance are negligible. However, if you want to verify the project's accuracy at a higher frequency—say 1000 Hz—you should obtain a 10-ohm, 100-watt noninductive power resistor.

Also necessary for calibration is an accurate ac voltmeter. The value of the nominal 10-ohm load resistor should be known as accurately as possible, preferably to within 1%. Calibration will use the relationship $P = E^2/Z$. Any error in voltage will be squared when converted to a power value. Thus, an accurate voltmeter is critical. A 3½- or 4½-digit DMM is preferred for its superior resolution.

Line-powered autotransformers present a potential shock hazard. If possible, plug the autotransformer into an isolation transformer to reduce the likelihood of shock. Otherwise, remember that your power monitor is floating above ground—and be careful!



In prototype, resistors R1 and R2 are stacked at rear of pc board.

For calibration, the variable transformer assumes the role of power amplifier and the power resistor that of the speaker. (As mentioned earlier, a power amplifier driven by a source of 60-Hz ac can be employed.) Interconnect the various components, as shown in Fig. 7. Set *S2* to the position corresponding to the channel you are using for calibration (either will do). Set *S3* to AVERAGE, *S4* to 20 w, and *S1* to ON. You will be reading the power from the 0-to-20-watt scale.

Adjust the transformer (or amplifier) for a voltage equivalent to a 20-watt power level (14.1 volts rms across a 10-ohm load). Then adjust trimmer *R34* so that the meter reads 20 watts. Lower the voltage to equal 10 watts of power through the load (10.0 volts rms). If the meter does not read exactly 10 watts, the movement is slightly nonlinear. In that case, adjust *R34* for equal error at 10 and 20 watts.

With the transformer set for a power reading of 10 watts average, set *S3* to PEAK. The power meter should now read 20 watts peak. Now adjust *R14* so that all four LED peak indicators begin to glow simultaneously. Vary the transformer to verify that each level indicator comes on at its appropriate threshold as indicated by the power meter. Note that, for a sine wave, the peak power at any given voltage level is twice the average power at that same voltage level. Voltages corresponding to various power levels are given in the Table at right.

Repeat the above calibration procedure for trimmer potentiometers *R13* and *R33* with the range select switch set to 100 w.

In Conclusion. Now you are ready to hook up the True Audio Power Meter to your stereo system. The values of current-sense resistors *R1* and *R2* have been kept low to prevent audible degradation of the audio system's damping factor, although purists might raise eyebrows at the introduction of the resistance between the amplifier and speaker. Practically speaking, however, the effect of this small series resistance is not significant. Note that channel selector *S2B* connects one end of the selected current-sense resistor to project ground. To avoid shorting out the loudspeaker and damaging the sense resistor (and possibly the amplifier), make sure that the project ground is kept isolated from the amplifier or system ground if the amplifier's "hot" output is referenced to ground or returns to ground through a low-impedance path.

Unless you have a very powerful amplifier, very inefficient loudspeakers, and a penchant for very loud listening levels, you will probably find 100 watts to be more than adequate full-scale readings. However, should you desire to display higher power levels, you can easily

TABLE OF POWER VS. VOLTAGE ACROSS 10 OHMS

Power (watts)	Volts Peak	Volts Average
5	5.0	7.1
10	7.1	10.0
15	8.7	12.2
20	10.0	14.1
25	11.2	15.8
50	15.8	22.4
75	19.4	27.4
100	22.4	31.6
150	27.4	38.7
200	31.6	44.7

modify the power monitor to read 200 watts full-scale by making the following changes in component values: change *R4* to 2700 ohms and *R6* and *R12* to 10,000 ohms. You will have to make a new scale for your meter and calibrate it accordingly. A paste-on meter scale for 100-watt/200-watt operation is given in Fig. 8. If the 20-watt scale is replaced with a 100-watt scale, you will probably find it easier to calibrate the comparator string if you change the value of *R14* to 25,000 or 50,000 ohms.

Relating linear power measurements to listening levels is not easy or necessarily meaningful. Furthermore, the speaker is not uniformly efficient across its bandpass, so that 10 watts, say, represents different sound-pressure levels at different frequencies. The monitor does, however, keep track of the power your speakers are forced to dissipate, so that you can avoid driving them too hard for too long. ◇

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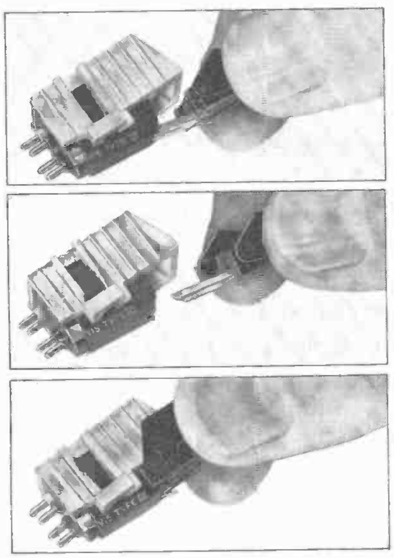

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Dial your scores into a two-player, double-digit scoreboard

GAMES in which the scores for individual players must be kept are a popular pastime. Not so popular is the usual search for paper and pencil needed for keeping the score. The Electronic Scorekeeper described here eliminates the search so you can get right to the game. As designed, the Scorekeeper can keep score for two players up to a maximum count of 99. However, with a couple of simple modifications, the number of players and the count range can be increased as desired. The circuit uses readily available and inexpensive TTL devices and seven-segment numeric LED displays.

About the Circuit. Since the circuit for each player is identical, only the circuit for player A is shown in Fig. 1. Player B's circuit connects to the pin-6 output of gate *IC1B*. Integrated circuits *IC4* and *IC5* and display *DIS2* make up a conventional 0-to-9 units decade counter whose carry output at pin 8 of *IC4* is fed to a similar tens counter made up of *IC2, IC3,* and *DIS1*. Seven-segment displays *DIS1* and *DIS2* are common-anode LED types.

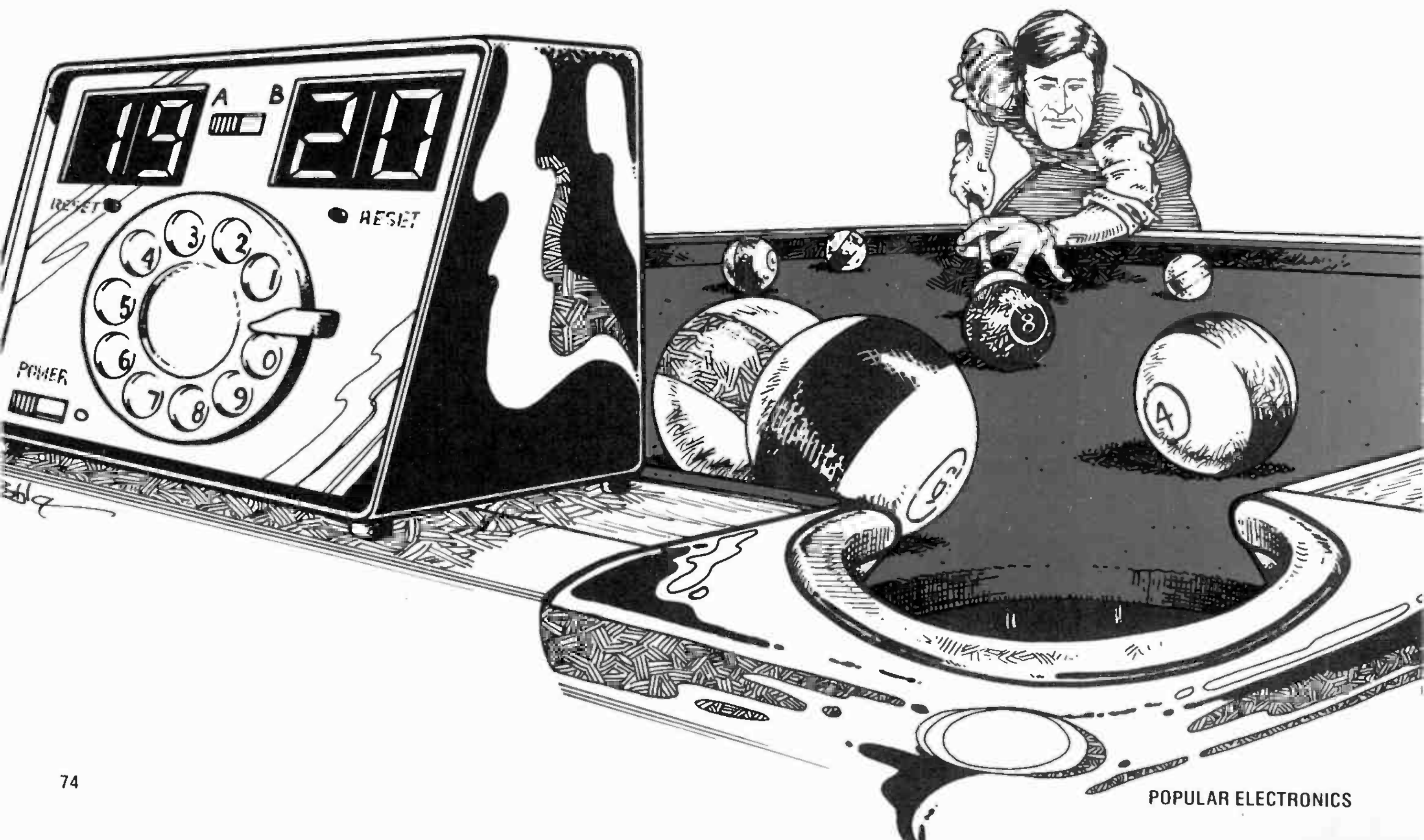
The count for the circuit shown in Fig. 1 can easily be increased as desired simply by adding extra decade counters. When the additional decade counters are used, the input of each successive counter is connected to the carry output of the preceding counter and the RESET lines are connected in common.

Both decade counters shown in Fig. 1 are set to zero by operating CLEAR pushbutton switch *S2* to momentarily raise the reset-to-zero (RST) input at pin 3 of *IC2* and *IC4* to high and then back to ground as the switch is released and pulldown is accomplished by *R2*. When *S2* is pressed and released, both *DIS1* and *DIS2* should display zeros.

SELECTOR switch *S1* permits the person keeping score to choose between player A and player B for score display

Electronic Scorekeeper for Recreation Rooms

BY JOSEPH FORTUNA



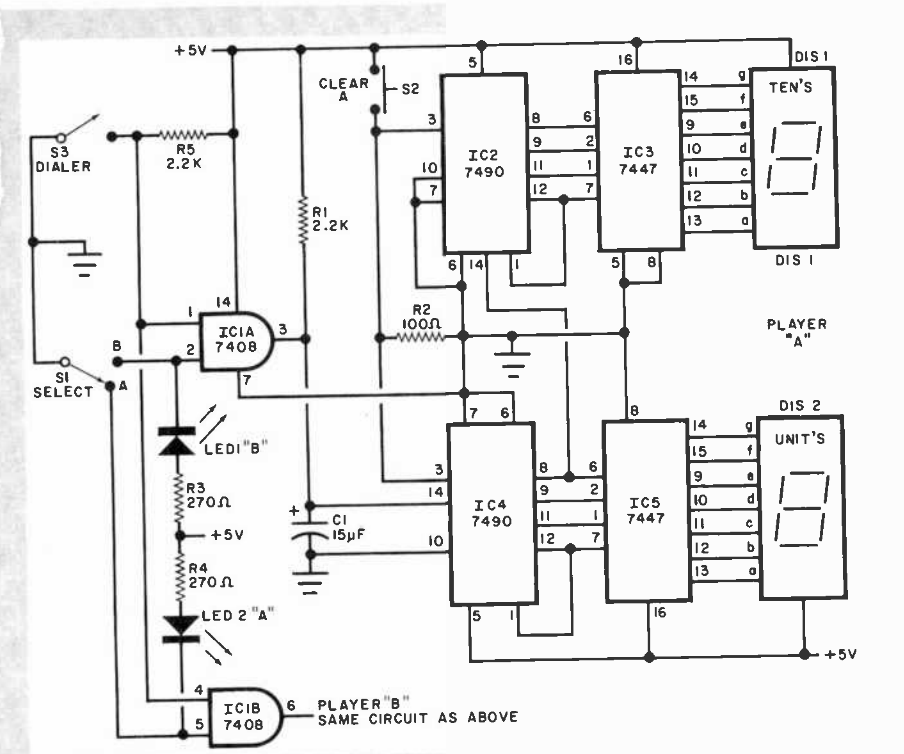
pulses, depending on the DIALER number selected, for player A's decade counter. (This assumes *S1* is set to A; operation is identical for player B, except that *S1* must be set to B.) Every time the *IC4* units decade overflows at the tenth pulse from *IC1A*, the carry output from *IC4* toggles the *IC2* decade counter.

The circuit in Fig. 1 can be expanded to keep score for more than two players, as shown in Fig. 2. Note here that separate player LEDs are not used. Using the AND gate and truth table shown, you can design further switching to increase the number of players beyond the three shown in Fig. 2.

Construction. Since component layout is not critical, you can use just about any wiring technique that suits you. Perhaps most convenient is a printed-circuit board of your own design, but perforated board and Wire Wrapping is equally suitable. In either case, it is recommended that you use sockets for the ICs.

Once you have assembled and checked the circuit, mount it in an enclosure so that the two pairs of displays can easily be viewed. Mount the LEDs and switches, including the DIALER mechanism, on the top of the enclosure. Finally, use a dry-transfer lettering kit to label the switches and LEDs according to function.

Power for the Scorekeeper can be obtained from any regulated 5-volt dc supply capable of delivering 1 ampere or more of current. ◇



PARTS LIST

C1—15-µF, 15-volt electrolytic
DIS1, DIS2—Common-anode 7-segment LED display
IC1—7408 quad AND gate
IC2, IC4—7490 decade counter
IC3, IC5—7447 BCD-to-7-segment decoder
LED1, LED2—Any discrete red LED
R1, R5—2200-ohm, ½-watt resistor
R2—100-ohm, ½-watt resistor
R3, R4—270-ohm, ½-watt resistor
S1—Dpst switch
S2—Normally open pushbutton switch
S3—Telephone dialer-switch mechanism (see text)
Misc.—Duplicate circuit for player B; regulated 5-volt, 1-ampere dc power supply; perforated or printed-circuit board and hardware; suitable enclosure; sockets for ICs (optional); machine hardware; hookup wire; solder; dry-transfer lettering kit; etc.

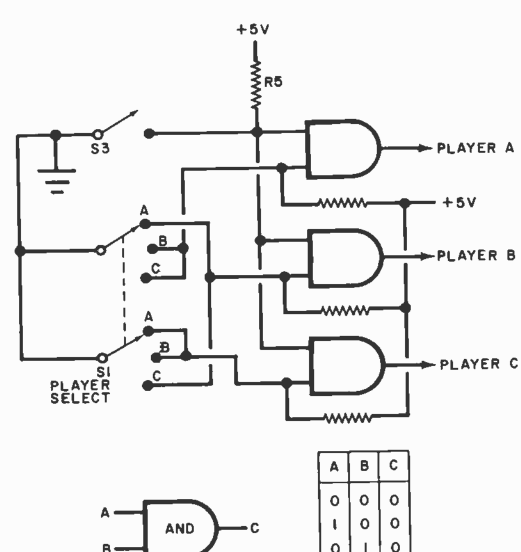
Fig. 1. Schematic shows scorekeeping circuit for only one player.

and incrementing. When the player-A position is selected, pin 5 of *IC1B* is grounded and held low, causing *LED2* for player A to come on. At this time, the output of *IC1B* is low and the gate is disabled. Hence, the player-B decade counters will not operate.

Pin 1 of *IC1A* and pin 4 of *IC1B* are made high by pullup resistor *R5*, and mechanical DIALER switch *S3* is connected from ground to this common point. (A surplus mechanical telephone-dial switch assembly can be used for *S3* to allow you to conveniently "dial in" the score updates. Alternatively, you can substitute an ordinary normally open pushbutton switch for this operation, but it will have to be operated for each and every unit increment in the scoring.)

Operating *S3* shorts the common *IC1A* pin-1 *IC1B* pin-4 point to ground the same number of times selected on the DIALER. As the DIALER is operated, IC1A turns on and off with each closure of *S3*. This generates one or more input

Fig. 2. A scorekeeper for more than two people can be made by using AND gates and switching as shown here as long as truth table is satisfied.



A	B	C
0	0	0
1	0	0
0	1	0
1	1	1

BY WILLIAM D. KRAENGEL

ACCURATE TIMEBASE FOR DIGITAL ELECTRONIC CLOCKS

Inexpensive circuit maintains digital counting automatically when power is lost.

IF YOU OWN a digital clock, its likely you expect it to maintain extremely high accuracy, especially if it displays seconds. Digital clocks, however, have a special problem not found in the ordinary electromechanical clock.

The problem is caused by a momentary power outage, lasting a second or two, that may occur at any time of the day or night. This outage may be brief enough to produce only a flicker of the display, yet brief as it is, the clock's digital counter circuit can generate a timing error. An electro-mechanical clock will integrate the outage and the clock dial may skip a second or so, with no real harm done.

The timebase described here is designed to overcome the problem in digital timekeeping and, in doing so, virtually eliminate the inaccuracies commonly encountered.

Power Line Vs. Crystal. If the ac power-line frequency is measured at any given instant, its frequency might vary from exactly 60 Hz by as much as 0.03%. This is the accuracy over the short term. The long-term accuracy, however, is actually much better than this by several magnitudes, as we shall see. A digital clock powered from a hypothetical glitch-free, uninterrupted commercial power line might show an error of only two or three seconds a year. Since there are 3.15×10^7 seconds in a year, this works out to an accuracy of better than ±0.00001%, a far cry from the ±0.03% specified.

This seeming paradox is resolved by the fact that the power-line frequency is periodically corrected to a frequency standard so that its long-term average frequency is maintained close to exactly 60 Hz.

Unlike an electromechanical clock whose mechanical inertia makes it extremely forgiving of glitches and transients, a digital electronic clock depends upon an uninterrupted, glitch-free timebase. Interrupt the timebase, even momentarily, and the clock loses its count. This is why filters and a large filter capacitor cannot do a complete job of maintaining accuracy during momentary power dropouts. Fast transients can be attenuated and the operating dc voltage can be maintained but there is no way to maintain the 60-Hz counting line frequency when power is interrupted.

The glitch problem is severe and has prompted many designers to turn to the crystal-controlled timebase. The crystal timebase, contrary to popular belief, is not a perfect cure for the problems mentioned above. Most crystals available to the hobbyist have rated accuracy of ±0.001% to ±0.005%, which is better than the short-term accuracy of the power line but nowhere near its long-term accuracy. Also, over the long haul, all crystals age. Hence, unless a crystal timebase is periodically recalibrated, this slow frequency drift adds to decreasing accuracy. Needless to say, going to a crystal timebase provides glitch-free operation and improved short-term accuracy but at the expense of greatly deteriorated long-term accuracy.

The low-cost Digital Clock Timebase, shown in Fig. 1 wired to part of a typical digital clock, uses the best of both techniques to meet all our requirements for an ideal timebase. It uses the power-line as the primary timebase for long-term accuracy. When a glitch or power outage is detected, two things occur. First, there is a rapid transfer to a crystal-controlled 60-Hz standby timebase, which takes over for the duration of the glitch. Second, smooth transfer is made to battery backup power when the power-supply filter capacitor in the clock can no longer support the system. The circuitry that does all this is low-power CMOS for minimum battery drain.

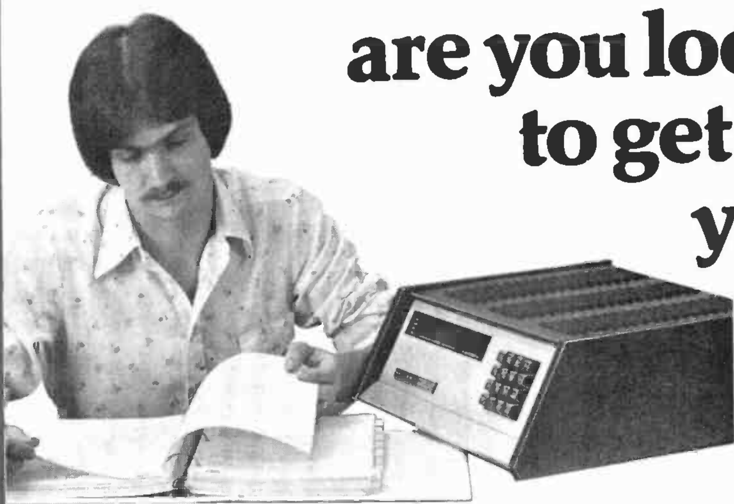
How It Works. The two functions of the timebase are shown in Fig. 1. When the clock's +V supply drops low enough to forward bias *D2*, rechargeable backup battery *B1* smoothly takes over. Battery *B1* also supplies V_{DD} for the standby timebase. The useful charge of the battery is extended if the clock's display and other nonessential loads are blanked when operating from the battery. Diode *D1* isolates these loads so they operate only from the clock's built-in power supply.

During a momentary power outage, the filter capacitor may not discharge to the transfer point immediately. Since the power-line counting frequency is lost for the entire duration of the outage, a faster way to sense power outages must be used, a function provided by *IC2*.

Retriggerable monostable multivibrator *IC2* is configured as a missing-pulse detector whose output pulse width (at pin 7) is set for 20 ms or slightly greater than the period of the 60-Hz line frequency. The detector is triggered once at the beginning of each cycle by the differentiated output of Schmitt trigger *IC1A*. Input to the trigger is the same 60-Hz primary timebase input to the clock IC. Since the detector cannot time out, its output remains low, keeping gate *IC1B* disabled. The output of gate *IC1B* is inverted by *IC1C*, sending a logic 0 to the OR gate.

During a glitch or other power outage, the line frequency, (and, hence, the retrigger pulse) lapses. Detector *IC2* is now free to complete its cycle to time out 3.3 ms after *not* receiving a retrigger pulse. Its output then goes high and enables *IC1B* to apply the standby *IC3* crystal-controlled 60-Hz timebase to the clock.

Crystal-controlled oscillator/divider *IC3* continuously generates 60 Hz from a commonly available 3.58-MHz color-TV oscillator crystal. When enabled by the detector, *IC1B* gates the standby timebase to the high-level OR gate made up of *D3*, *D4*, and *R5*. Either the high-level half-sinusoid primary timebase or the CMOS-level square-wave standby timebase is then gated to the 50/60-Hz input of the clock IC.



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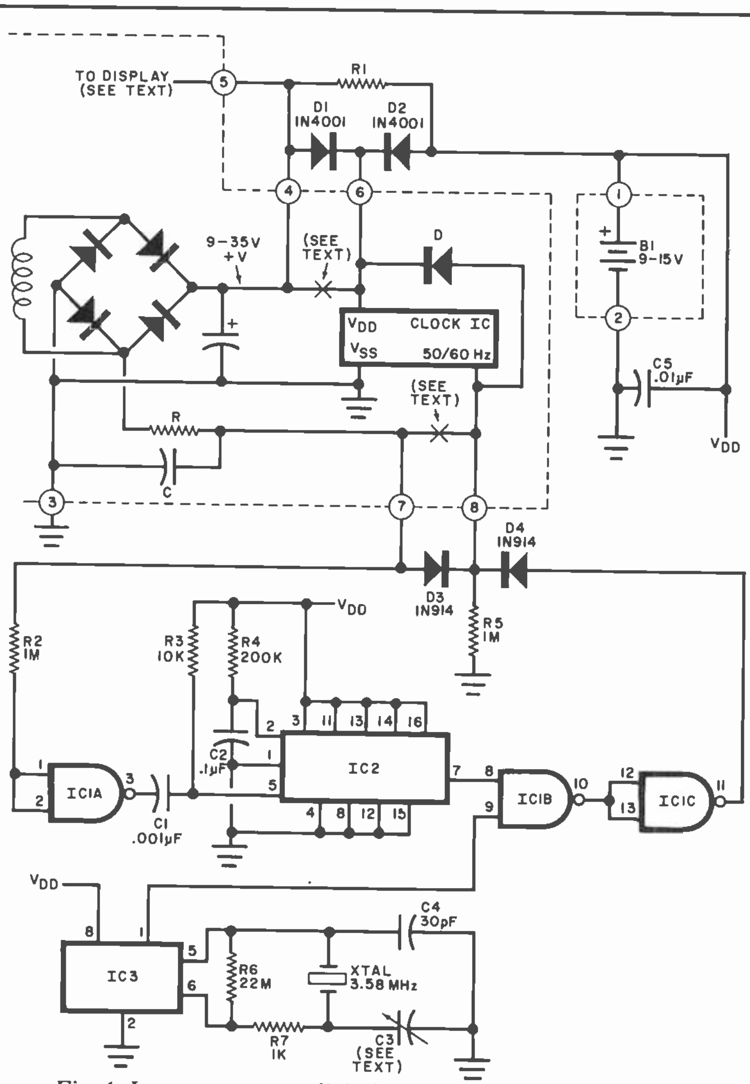


Fig. 1. In power outage, digital counter and rechargeable battery power supply automatically take over.

When primary power returns, almost a reverse action occurs. As the filter capacitor in the clock recharges, it again crosses the transfer point. Then the glitchless transfer is back to the power supply. The primary timebase, rising in step with the filter capacitor voltage, gated to the 50/60-Hz input of the clo IC and to detector *IC2* via Schmitt trigger *IC1A*. The detector output immediately goes low, disabling gate *IC1B* to remove the standby timebase.

Construction. The timebase is best assembled on a printed-circuit board,

PARTS LIST

B1—9-to-15-volt rechargeable battery (see text)
C1—0.001-µF, 50-V disc ceramic
C2—01-µF, 50-V Mylar
C3—20-pF, 50-V disc ceramic or 10-40-pF trimmer, see text
C4—30-pF, 50-V, disc ceramic
C5—0.01-µF, 50-V, disc ceramic
D1, D2—1N4001
D3, D4 — 1N914
IC1—4093B Schmitt trigger
IC2—MC14538B dual monostable (Motorola)
IC3—MM5369 oscillator/divider (National)
R1—see text
R2, R5—1-megohm, ¼-W resistor
R3—10,000-ohm, ¼-W resistor
R4—200,000-ohm, 5%, ¼-W resistor
R6—22-megohm, ¼-W resistor
R7—1000-ohm, ¼-W resistor
XTAL—3.58-MHz, color-TV oscillator crystal
Misc.—IC sockets or pins, battery holder, etc.

Note: The following is available from CM Circuits, 22 Maple Ave., Lakawanna, NY 14218: etched and drilled pc board at $3.25, plus $0.50, postage and handling. New York state residents, please add sales tax.

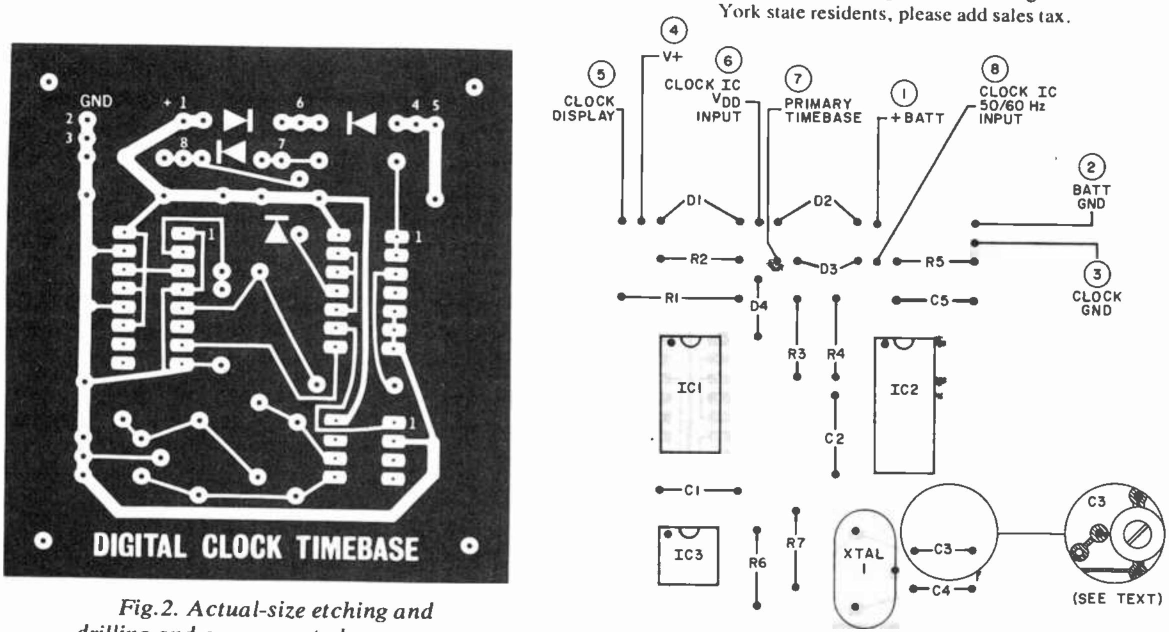


Fig. 2. Actual-size etching and drilling and component placement guides for Digital Clock Timebase.

but other wiring methods can be used. Illustrated in Fig. 2 are both the etching-and-drilling and component-placement guides. Sockets for the ICs are optional but highly recommended. The circled numbers in the schematic correspond to input/output points on the pc board.

The value of *R1* to be used in your system is calculated by Ohm's Law. For example, suppose your power supply has an output of 25 volts and you have previously determined that a 12-volt nickel-cadmium-cell with a capacity of 0.5 ampere-hour (AH) will do for backup. The battery is trickle-charged at a hundredth of the rated battery capacity, which in our case is 5 mA. Using the formula (power-supply voltage minus battery voltage) divided by (desired charging current plus standby timebase operating current), we obtain (25 - 12)/(0.005 + 0.0025), or 1733.3 ohms. You would then use an 1800-ohm (nearest standard value) resistor for *R1*. Determining the power rating of *R1* by I^2R reveals that a standard 1800-ohm, 1/4-W resistor will do nicely.

When selecting the backup battery to be used, keep in mind that many clock ICs will keep time at a lower potential than the minimum operating voltage specified on the data sheet as long as the display is not driven. (Mount the battery off the pc board.)

Installation. In the typical digital clock shown in Fig. 1, the clock chip's 50/60-Hz timebase input is usually filtered by RC and clamped to V_{DD} by diode *D*. Break this line as shown and wire it to gate input 7. Wire gate output 8 back to the 50/60-Hz input of the clock IC. Note that the timebase will keep accurate time only for 60-Hz systems.

The +V output from the filter capacitor usually drives all circuitry directly. Break this lead as shown and wire it to gate input 4. Reroute the display and other nonessential wiring to gate input 5. Wire gate output 6 back to the V_{DD} inputs of the clock IC and other essential circuitry.

Calibration. The accuracy of the crystal is usually much greater than the instantaneous accuracy of the 60-Hz line frequency. For most purposes this accuracy will suffice, but for those who want a more accurate calibration and have access to an accurate frequency counter, the oscillator frequency can be trimmed to exactly 60 Hz. Replace fixed capacitor *C3* with a 10-to-40-pF trimmer capacitor and adjust until pin 1 of *IC3* shows exactly 60 Hz on the counter. ◇

HOW TO Improve SW Receiver Tuning Accuracy

BY JAMES L. HALL

Frequency plotting on graph paper enables you to pinpoint frequencies within 5 kHz on inexpensive receivers

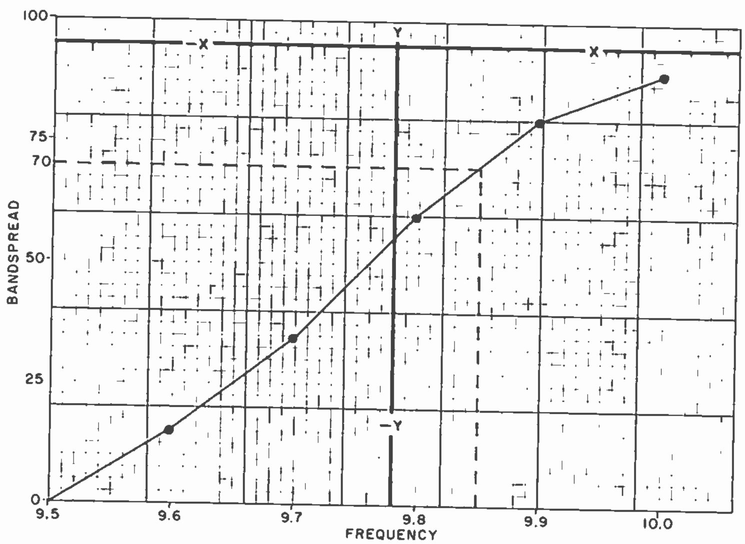
WITH MORE than 140 international radio services beaming English language programming to North America each week, SWL's have ample opportunities to bag some real DX. Seasonal propagation offers the shortwave listener a wide variety of DX from all over the world. And serious SWLs are never content to log only the super power stations such as Radio Moscow or the BBC External Services. They check frequency lists and broadcast times, and track the big DX Game.

Unfortunately, the DX hunter possessing an inexpensive receiver with poorly marked and inaccurately calibrated tuning dials has difficulty locating precise frequencies. Main tuning dials are marked for general frequency coverage and will put you in the DX hunting areas, but that's about all. Bandspread offers little help since interval indicators are meaningless without correlations with main tuning. How can you find DX with inexpensive receivers? Frequency plotting is the answer. By preparing simple frequency charts on common graph paper, you can track DX frequencies within a 5-kHz range.

Chart Preparation. A frequency calibrator, common graph paper, and a straight edge are all the materials you need for the project. If you don't have access to a frequency calibrator, take your receiver to a radio-TV repairman and have him align the tuning dials in 100-kHz increments. Age, moisture and dust can cause problems with belt-driven tuning mechanisms. Consequently, most receivers need periodic alignment. Also, this frequency plotting procedure is for linear-pattern tuning and not log-scale tuning. Most receivers will be clearly marked for tuning scale type. If in doubt, ask a radio-TV repairman to examine your receiver. He should be able to determine the tuning pattern by inspection.

Select graph paper with quadratic coordinates (*x* for horizontal and *y* vertical) for the frequency plots. It can be purchased at most office and school supply stores. If you cannot obtain quadratic paper, you can use any other linear graph paper. Simply strike accented lines horizontally and vertically across the center and down the middle. Label the horizontal line $-x$ on the left and x on the right and the vertical line y on the top and $-y$ on the bottom.

Now you are ready to track a DX frequency. Check frequency and broadcast times for the DX station you wish to locate on your receiver. There are several listings available but the most widely recognized single source is the annual World Radio TV Handbook.



Sample plot of frequency vs bandspread for locating a DX station.

Calibration Alignment. Suppose you find a listing for a DX service operating on 9.85 MHz. Use the following procedure to find 9.85 MHz on your receiver. Connect the calibrator to the receiver at the antenna terminal and turn on both. Set the bandspread to zero and tune the receiver to the calibrator signal at the low edge of the band. For this example, 9.5 is a good starting point.

Referring to the sample plot shown here, place the graph paper on a flat surface. Label the bottom left corner 0 and 9.5. Write "Frequency" in the bottom margin and "Bandspread" in the left margin. Next, tune the bandspread until you hear the next calibrator signal and record the interval number. The calibrated frequency is 9.6 and the corresponding bandspread marking for this example is 15. Continue this procedure until the bandspread has been covered or until the entire grid has been calibrated. Draw a line from 9.5 to 10.0.

Plotting Frequencies. Examine the frequency range on your graph. The DX station will be broadcasting on 9.85 MHz. By inspection, this point is located half-way between 9.8 and 9.9 MHz. With a straight edge, draw a vertical line from the 9.85 point until it intersects the calibrated frequency plot line. Then, from the point of intersection, draw another line parallel with the frequency base until it intersects the bandspread's vertical axis. Read the bandspread mark on the graph, which is, for this example, 70. The bandspread indicator (70) corresponds to 9.85 MHz.

Prepare charts for the remaining frequency ranges for the international broadcast bands by following the calibration procedure. By plotting frequencies and correlating them to your receiver's bandspread markings, you can locate any frequency in the international bands. Check a frequency list and broadcast times for a DX station. With patience and careful frequency tracking, your DX hunt will be successful. ◇

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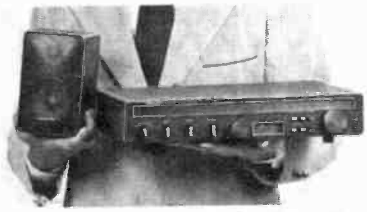

Receiver is briefcase-sized, a little taller than a credit card — just 3-1/2" high. Each speaker is about the size of two average books.

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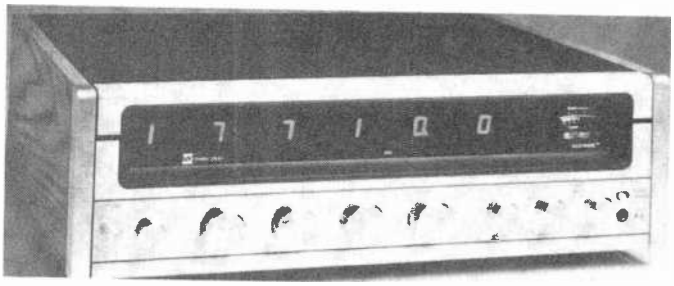
Product Test Reports

McKay Dymek Model DR33C Communications Receiver



A digital frequency-synthesized tuning range from 50 kHz to 29.7 MHz is featured in McKay Dymek's Model DR33C professional-quality general-coverage communications receiver. This triple-conversion superhet is designed for maximum immunity to overload and intermodulation; it employs an r-f power transistor to minimize overload in the front end and highly selective filters in each i-f conversion circuit.

Tuned frequencies are displayed on a six-digit 0.5" (12.7-mm) numeric LED display that extends across approximately two-thirds of the front panel. Other features include switchable selectivity with provision for two additional optional filters; a bfo suitable for reception of AM, USB, LSB, CW, and RTTY; built-in speaker; and audio output jack and level control for driving an external amplifier.

Any 50-ohm antenna can be connected to the receiver. An optional Model DA100 active antenna, specially suited to the DR33C receiver (but usable with most other communications receivers) is available as an extra-cost option. It is designed to operate over the entire range of the receiver and features a 56" (1.4-meter) whip element whose weather-sealed mounting base contains a full-range feedback amplifier with high overload immunity.

The receiver measures 17.5"W × 15"D × 5.1"H (445 × 381 × 130 mm) and weighs 16 lb (7.3 kg). Price for the receiver is $1500.

General Description. From left to right, the numbers in the display indicate frequency in tens of MHz, MHz, hundreds of kHz, tens of kHz, kHz, and tenths of kHz. Each decade in the display can be set individually via its own rotary switch. Tens of MHz can be set for only 0, 1, or 2. (Leading zeros are suppressed.) The tens-of-kHz switch has 20 steps of 5 kHz each, and each of the remaining switches has a 0-to-9 range.

The FINE TUNE control is a 10-turn potentiometer that can vary the tuning continuously to permit interpolation across the 5 kHz between switch settings. It affects the last two display digits, which are driven by a frequency counter, displaying kHz and tenths of kHz.

A small meter is calibrated in arbitrary S units up to S9 and in 10-dB steps from 0 to 80 dB. The IF FILTER switch provides a choice of a 4- or 8-kHz AM filter, separate 2.2-kHz LSB or USB filter, or any two user-installed accessory filters such as the 400-Hz CW and 1200-Hz RTTY filters offered as options.

The BAND control actually selects input filtering and attenuation for the receiver. Two 0.05-29.7-MHz positions cover the entire tuning range. One position inserts and the other bypasses an r-f amplifier stage. Two 2.5-29.7-MHz positions insert a 2.5-MHz high-pass filter into the input circuit for high-frequency reception near a powerful broadcast station and offer either amplified or unamplified r-f operation. Finally, the LOCAL position reduces sensitivity by 30 dB.

Appropriate bfo and detector circuits for AM, CW, RTTY, and SSB reception are selected via the MODE switch. (The optional external converter and printer are required for RTTY operation.)

On the rear apron are phono-jack and paralleled insulated binding-post antenna connectors; external-speaker binding posts and switch to disable the internal speaker; a normally shorted MUTE jack that silences the receiver when no signal is received; IF OUTPUT jack that provides access to the 455-kHz third i-f; TUNER OUTPUT jack and level control for driving an external amplifier; line fuse; and switch for selecting 117 or 220 volts ac.

The antenna input is protected by a 1/16-ampere fast-acting fuse. All incoming signals go through a 30-MHz low-pass filter to suppress image responses. After passing through the BAND switch system (and r-f amplifier, if required), the signal goes to a double-balanced mixer in which hot-carrier diodes are used to insure minimal intermodulation on very strong signals. The mixer combines the incoming signal and a signal from the synthesizer and delivers a 30-MHz first-i-f output. Phase-locked-loop (PLL) techniques are used to generate the first local-oscillator frequencies in 5-kHz steps from 30.05 to 59.7 MHz. Accuracy is determined by a single 8.000-MHz crystal oscillator. Just after the first mixer is a two-pole crystal 30.000-MHz filter whose 30-kHz bandwidth minimizes IM distortion from overload in the first i-f amplifier and subsequent stages.

After amplification, the 30-MHz signal goes to a second balanced mixer driven from the second local oscillator at 40.7 MHz. The 40.7-MHz signal is derived by tripling the output of a 13.566-MHz crystal oscillator. The frequency of this oscillator can be "pulled" over a limited range by a voltage-variable capacitor operated by the FINE TUNING control. Before amplification, the 10.7-MHz second-i-f output from this mixer goes through an 8-kHz bandwidth four-pole crystal filter.

Applied to the inputs of the dual-gate MOSFET third mixer are an 11.155-MHz signal from a crystal-controlled third local oscillator and the second-i-f signal. The 455-kHz third i-f at the output of this stage is channeled through one of several filters by dc voltages applied to FET switches. The 4- and 8-kHz filters, used primarily for AM reception, are ceramic types, while Collins 2.2-kHz-bandwidth mechanical filters are used for SSB. An envelope detector is used for AM, while an IC balanced modulator is used as a product detector for CW and SSB. Supplied by the logic board that controls the frequency synthesizer, the bfo signal to this detector is 455.0 kHz on SSB, 455.8 kHz on CW, and 457 kHz on RTTY.

Detected audio is passed through a 3-kHz low-pass filter and then a 5-kHz notch filter to remove carrier beats. (On the short wave broadcast bands, stations are often spaced only 5 kHz apart.) An IC audio amplifier delivers a 2-watt output.

Because the receiver performed with a degree of competence beyond that of our test instruments, the only quantitative measurements we made were of the response of the S meter. In the high-frequency range, a mere 0.5 μV produced an S3 reading, 1.2 and 2 μV producing readings of S6 and S9, respectively. On the decibel scale, 60 dB was indicated with an 8-μV input, 70 dB with a 100-μV input, and 80 dB with a 5000-μV input. Sensitivity was down by a factor of about 5 to 6 at 28 MHz and 100 kHz.

Agc action was far slower than average. The meter, driven by the agc voltage, responded in about two seconds when a 60-dB input was applied. It required some seven seconds to decay to its zero index at S1 when the signal was removed. This was done, according to the manufacturer, to prevent noise pumping on SSB reception.

User Comment. Obviously, the DR33C is not meant to be sweep-tuned in the conventional manner. One need only set the display for a known frequency to have the desired station pop right up. Moreover, no practice or development of a "touch" is necessary to obtain accurate results. A user wishing to search for unknown stations must examine 5 kHz of bandwidth at a time using the FINE TUNE control. The method, though a little tedious because of the slow action of the control and the agc response, virtually ensures a thorough search. For practical tuning of AM stations, FINE TUNE can be ignored until the signal is heard.

Tuning of this receiver is best accomplished by ear, also because of the slow action of the meter. An additional effect of the long agc time constant is that the receiver does not always handle normal signal fading well. On the other hand, the noise limiter (switchable) was very effective against impulse noise, albeit at the cost of considerable distortion in the audio. In view of the price of this unit, however, we would have expected that a noise blanker would be included.

Though the advanced circuitry of the DR33C would enable it to cope well with the demands of Amateur Radio and other specialized applications, its frequency coverage and general design mark it as a deluxe general-coverage receiver. Little effort has been spared to offer a user a maximum of convenience and accuracy in return for a minimum of skill. In particular, the synthesizer's accuracy and the stability of tuning can simplify the problem of identifying a station without a broadcast ID.

To sum up, the DR33C is one of the most advanced and versatile general-coverage communications receivers available to the consumer. In some respects it compares favorably with commercial and military receivers selling for several times its price. We suspect that an enthusiastic, well-heeled neophyte to short-wave listening who wants to spend time enjoying his hobby rather than "paying dues" will find this receiver much to his liking.

CIRCLE NO. 105 ON FREE INFORMATION CARD

Hobby Scene

By John McVeigh, Technical Editor

LONG TIME DELAYS AND THE 555

Q. I don't have a lot of experience in working with IC's, but I have been tinkering with 555 and 556 timers. I suspect that not all 555s are the same; perhaps 556s as well. I can achieve a long time delay with one (on the order of hours), but cannot with another. Can I expect reproduceable delays if I get a 555 to time out after 8 hours or so? Also, do the suffixes stamped on the IC's (555V, 555N, etc.) mean anything? —Mark McWilliams, South Charleston, WV.

A. Within given manufacturing tolerances (about 1%), all 555 timers should produce the same time delays when used in the monostable mode or the same frequency of oscilation is used as astable multivibrators. This means that if you assemble a circuit using an IC socket, Molex Soldercons, or a solderless breadboard, get it running and then replace *only* the timer IC, you should obtain almost identical results.

The problems you are experiencing can be traced to two factors, both of which are aggravated by the need for large amounts of timing capacitance in your long-delay circuits. The only practical way to get several hundred or thousand microfarads in a reasonably small volume is to use an electrolytic capacitor. The leakage resistance of an electrolytic is low as compared to that of other types of capacitors. In many circuits, this can be tolerated. But in timing circuits employing, say, 18-megohm resistors and 100-μF capacitors, the leakage resistance will make its presence known! Also, most electrolytics have very large tolerances (−50%, +100% is not unusual), and this variation in capacitance will have a direct influence on the behavior of the timer. That's why tantalum capacitors, with their tighter tolerances (± 10% or ± 20%), are preferred in timer circuits.

To obtain long delays with smaller capacitors, try experimenting with the Exar XR-2242CP programmable counter. This chip includes a 555 timer and an eight-stage programmable counter and can generate really long delays—on the order of days—and can be cascaded with other 2242's to produce delays in *years*! It's available from several mail-order companies who advertise in the Electronics Market Place section.

Finally, the suffixes at the end of the Ic number sometimes refer to package types or product grade. (Prefixes denote manufacturers.) For the 555, however, all manufacturers use the eight-pin mini-DIP and the suffix isn't really important.

SINE WAVE CONVERTER

Q. Can you show me a circuit that will convert a ramp, sawtooth or square-wave output of a VCO into a sine wave? I have tried a few simple designs (resistor-diode networks), but have not had success. —N.W. Greene, Bellport, NY.

A. A Fourier analysis of a ramp, sawtooth, square or any periodic waveform reveals that it comprises sine waves at a fundamental frequency and a certain number of harmonics, each at a specific amplitude. Therefore, a high-order, low-pass filter or a sharp bandpass filter will extract the fundamental sine wave from any of the waveforms you mentioned. A bandpass filter can also be used to extract a selected harmonic from the input signal. Because you are using a VCO, you should use a voltage-controlled filter (VCF). Apply a steady dc level to the control inputs of both the oscillator and the filter and observe the output of the VCF. Adjust the filter's control for the desired sinusoidal output. Then, if the same variable control voltage is applied to the filter and oscillator and if the two track each other properly, the VCF will continue to deliver a sine-wave input. This is so because the filter's cutoff or center frequency will change in step with the frequency ofr the ramp, sawtooth, or square-wave oscillator output.

SUBSTITUTING COMPONENTS

Q. Can a 100-volt, 8-ampere SCR be substituted for a 100-volt, 6-ampere SCR in a 5-volt, 3-ampere power supply? —Alan Martello, Turtle Creek, PA.

A. As a general rule, an overrated component can be used as a substitute in any electronic circuit. For example, a ½-watt carbon resistor can be used in place of a ¼-watt carbon resistor, or a 100-volt, 0.1-μF ceramic disc capacitor can be used in place of a 50-volt, 0.1-μF ceramic disc. In the case of active components, the same holds true as long as the substitute has comparable device paramters. So, a transistor with a maximum I_C of 800 mA can be used to replace one with a maximum of 400 mA if it has comparable current gain (β), f_T, V_{CE} max, power dissipation, etc.

The only potential trap for the unwary is an overrated substitute with, say, a *lower* β or, in the case of an SCR gate sensitivity. The higher-current SCR might require more gate current to turn it on. In most situations, however, either there will be sufficient gate current or the gate resistor can be decreased to compensate. In your power supply, the SCR is probably part of the protective circuit and a direct replacement can be made.

DIGITAL READOUT FOR SWLs

Q. I have just purchased a Realistic DX-160 shortwave receiver and would like to augment the dial with a digital frequency readout. Do you have a circuit for one?—Rory Sena.

A. In the February 1977 issue of POPULAR ELECTRONICS, an article entitled "Digital Frequency Readout for Shortwave Receivers" appeared. The project is essentially a frequency counter which could be preloaded with a number to compensate for the i-f of the receiver. This is done because the most easily sampled signal, the output of the local oscillator, is displaced from the frequency of the incoming signal by an amount equal to the i-f. The project was offered in kit form by Mattis Electronics, Box 162, Morton Grove, IL 60053. I suggest that you obtain a back issue to look at the circuit or, if you want to build the kit, write to the company to learn if it is still available, current prices, etc.

Have a problem or question in circuitry, components, parts availability, etc? Send it to the Hobby Scene Editor, POPULAR ELECTRONICS, One Park Ave., New York, N.Y. 10016. Though all letters can't be answered individually, those with wide interest will be published.

Tips & Techniques

CLEANING PC BOARDS

The next time you have to clean a printed circuit board, try a scouring pad marketed under the trade name Scotch-Brite. These green, nonmetallic pads can clean boards (or pots and pans) as effectively as steel wool, but don't rust or splinter, and are kinder to your hands. In fact, one well-known company includes in its pc etching kit a small pad for cleaning boards which closely resembles the product suggested here. —*Gane Wong, Vancouver, B.C.*

AMMONIA AND SOLDERING TIPS

It's wise to remove the threaded tip from your pencil iron periodically to prevent oxidizing. Otherwise, the tip will become so tightly bonded to the pencil that removal will be a tedious job. In severe cases, you will not be able to remove the tip without damaging the iron. In cases where this removal chore has been neglected, the tip can be extracted quickly and without damage to the iron by spraying a bit of household ammonia on the copper tip and the threaded recess of the pencil. When reinstalling the tip, first dab some powdered graphite into the recess. This will make tip removal easier the next time. —*Harry J. Miller, Sarasota, FL.*

TEMPLATE SIMPLIFIES SLIDE SWITCH MOUNTING

Slide switches which require rectangular panel slots can be easily mounted if the following procedure is followed. First, remove the metallic shell enclosing the switch by bending up the four retaining tabs. Using the shell as a template, scribe and drill the holes for the retaining screws. Now, using the shell as a jig, mount it on the panel. Then drill out and file the rectangular slot, letting the file bear heavily on the panel but *lightly* on the jig. File until the panel slot is evenly matched with the jig. Finally, remove the shell, reassemble the switch and mount it on the panel. Better yet, mount a *new* switch and save the shell-jig for making slots in the future. —*Clem Portman, San Clemente, CA.*

IDENTIFYING COMPONENTS

When sorting electronic components, especially those with strange markings in a grab-bag assortment, a method of labeling devices is necessary. An easy way to permanently label components is to use self-adhesive color-coding dots. They come in sizes small enough to fit the tiniest of components that the experimenter is likely to procure. Also, they can be written on to denote exact values. The dots are available in a wide variety of colors for group coding, and are available at most stationery and business supply stores.—*Radcliffe Cutshaw, Knoxville, TN.*

LOW VOLTAGE INDICATOR

This circuit can be used as a low-voltage battery condition indicator. The LED will glow when V+ drops below a certain value. Current drawn when V+ is above the threshold is only 100 μA at 20 volts. All parts are easily obtained at a total cost of about $2. The circuit will function over a range from 1.6 to 30 volts.

Here's how the circuit works. Potentiometer *R3* adjusts the base bias of *Q1*, which in turn determines the voltage drop across *R1*. Capacitor *C1* and *R1* act as an RC network to allow *Q1* to settle when new batteries are installed. The voltage developed across *R1* determines the gate drive for *SCR1*. When *SCR1* fires, the LED glows and continues to do so until new batteries are installed. Resistor *R2* can be changed to vary LED brightness. The voltage threshold is determined by the setting of *R3*. You will find that the potentiometer adjustment is insensitive. A 50,000-ohm potentiometer can be substituted for greater adjustment sensitivity. This will increase current by approximately 300 microamperes.—*S. Lay, Huntington Beach, CA.*

UNSOLDER SAFELY

Unsoldering and removing multi-pin components (especially IC's) presents a real problem. Here's a simple and safe way to do it. Dip one end of a scrap length of braided shielding into rosin soldering paste and apply it to the connection(s) to be unsoldered. Then place a hot soldering iron on the braid. Solder will be drawn into the braid by capillary action. Remove the component, and then the iron and braid. Clean the area with denatured alcohol before soldering the new component. The end of the braid should be cut off when it is saturated with solder, of course.—*Victor Mungary, Bakersfield, CA.*

Solid State

By Lou Garner

DOWN NOSTALGIA LANE

LOOKING back over the past quarter-century, one soon realizes that POPULAR ELECTRONICS and the solid-state industry have grown to maturity together. When the first issue of the magazine appeared in October 1954, the transistor itself was a mere infant scarcely over six years old, having been introduced publicly by the *Bell Telephone Laboratories* in June 1948. This was the early—and now obsolete—point-contact transistor. The junction transistor, still a viable type, was even younger, for it was not introduced by *Bell* until July 1951. It was less than two years earlier, late 1952, that transistors had made their first appearance in consumer products—expensive hearing aids.

In those days, the vacuum tube was the king, and that first issue, Volume 1, Number 1, featured but a single "solid-state" construction project—an AM Broadcast Band crystal receiver using the ubiquitous 1N34 germanium diode. There were, however, descriptions of several solid-state products, including a battery-eliminator charger kit using selenium rectifiers and a transistor experimenter's kit. In addition—shades of the current energy crunch—there was a feature story on solar batteries! The next two issues, November and December 1954, featured no further solid-state projects since the devices were not yet modestly priced.

There was GOOD NEWS for the experimenter in late 1954, however, for the *Raytheon Manufacturing Company* had cut the price of its fantastic experimenter's transistor, the CK722, to a mere $3.50, bringing it well within the reach of virtually every hobbyist. Introduced in early 1953, the CK722 was actually a selected "fall out" from the firm's premium-priced hearing-aid transistor line. A low-voltage, moderate-gain, low-power, audio-range, germanium pnp junction transistor assembled in a plastic case, the unit originally was priced at $7.60 each—not a bad price at the time, considering that other available transistors were $50.00 each and up! And those were "middle 50's" dollars, which had a lot more purchasing power than today's inflated dollars. POPULAR ELECTRONICS carried a newsstand price of only twenty-five cents, and a 12-ounce *Pepsi-Cola®* cost only a nickle, as did candy bars, packs of chewing gum, and two-ounce packages of potato chips. You can bet that experimenters and hobbyists were very, *very* careful with how they handled their transistors then!

Although the vacuum tube continued its dominance, transistor prices began to drop slowly with each passing month. More semiconductor manufacturers entered the field, increasing competition. New devices were introduced. Solid-state electronic projects appeared a little more often in these pages and experimenter interest waxed hotter and hotter. Before long, the editors decided that the young upstart, the transistor, needed special treatment. Consequently, they started a regular column entitled "Transistor Topics." A Contributing Editor since the magazine's first issue, I was asked to take over that column soon after it first appeared. By the time my first column was published in June 1956, the transistor was starting to come into its own as a viable experimenter's device. Raytheon was offering an *r-f transistor*, the CK768, at a mere $1.50, while the CK722 had broken the dollar barrier and was selling for only 99 cents.

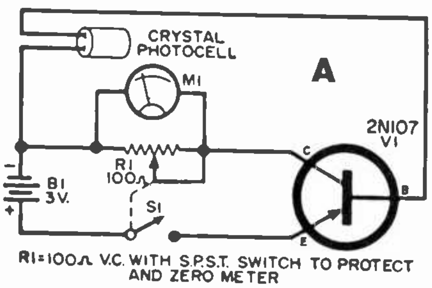
Despite dropping prices, however, transistors were still considerably more expensive than vacuum tubes by mid-1956 so most construction projects used only one or, at a maximum, four transistors. A four-transistor broadcast-band receiver was featured in the May issue, a couple of single-transistor Geiger counters in June, and a single-transistor power megaphone in July. The latter was one of the first hobbyist projects to use a multiwatt power transistor, the 2N68.

From this point, Time and Progress marched forward arm in arm. Prices continued to drop. Hundreds of new transistor types were introduced. Interesting new semiconductor devices made the scene—the silicon controlled rectifier (SCR), the unijunction transistor, the tunnel diode, the 4-layer silicon switch, the Gunn diode, the phototransistor, the triac, the Diac, the field-effect transistor (FET), charge-coupled devices (CCDs), the Darlington transistor, VMOS devices, integrated circuits, light emitting diodes (LEDs), and that fabulous "computer on a pinhead," the microprocessor. The trickle of semiconductor devices became a flood and, all the while, POPULAR ELECTRONICS and its readers kept pace. The vacuum tube was driven from its throne by the semiconductor legions, and "Transistor Topics" became "Solid State."

You've Come A Long Way, Baby! From the very beginning, POPULAR ELECTRONICS readers have been more sophisticated than most other electronics enthusiasts, enjoying advanced as well as elementary projects. Over the years, they have assembled not only a wide variety of conventional audio amplifiers and radio receivers and transmitters, but laser systems, electronic musical instruments, ultrasonic gear, test equipment, household and automotive alarms, lightbeam communicators, calculators, electronic games, and minicomputers and peripherals.

"Reader's Circuits" was introduced originally as part of my first "Transistor Topics" column and later became a regular feature, continuing when the name was changed to "Solid State." Through this section, readers are able to share their pet designs with other experimenters and hobbyists. Early contributions tended to be relatively simple one- to three-device designs, and this trend has continued to the present. But while the specified devices in the early designs generally were single transistors and diodes, later designs often include one or more IC's (integrated circuits), each of which may contain the equivalent of from a half dozen to a hundred or more transistors.

Two early Reader's Circuits, from the June and July 1956 column, are shown in Fig. 1A and 1B. In those days, there was still some question regarding the proper reference symbol for a transistor, so you'll note a "V" (for *valve*) reference designation in one circuit, and a "TR" in the other. Today, of course, "Q" is the standard letter symbol for a transistor.



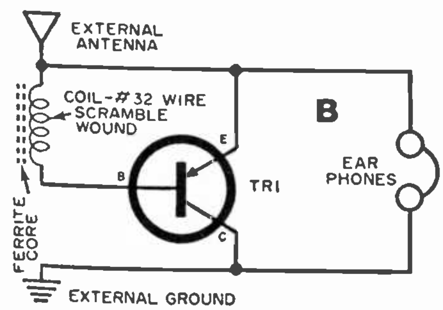


Fig. 1. Early reader circuits from PE June and July 1956: (A) light meter, (B) receiver.

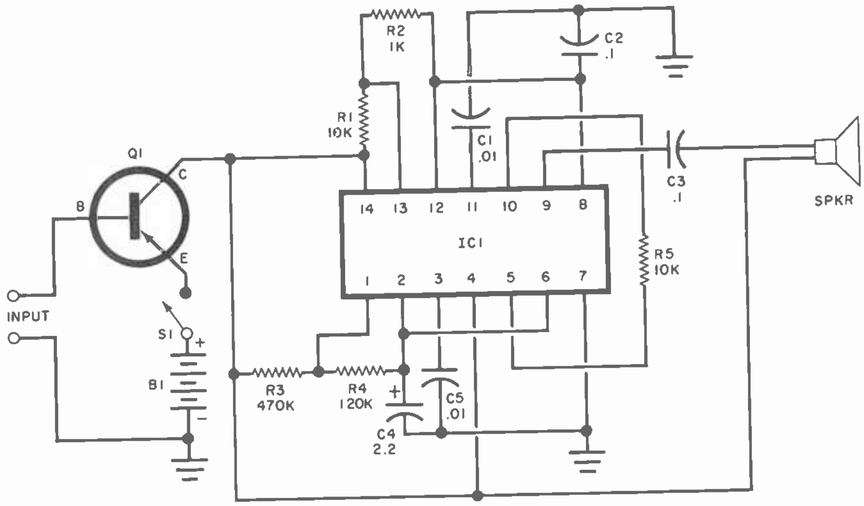


Fig 2. Circuit for a general-purpose alarm. Many applications are possible, depending on the sensor used.

Figure 1A was submitted by Joe Gabus and features a Clairex type CL-1 cadmium-sulphide photocell direct-coupled to a GE type 2N107 pnp transistor, serving as a common-emitter dc amplifier. A 500-microampere meter, *M1*, is used as an output indicator, shunted by a 100-ohm potentiometer, *R1*, for calibration adjustment and meter protection.

The extremely simple receiver circuit contributed by Matthew Mandl, can use virtually any type of pnp or npn transistor. Designed for single-station reception, it uses a hand-wound coil on a ferrite core. The number of turns is determined experimentally (by guess and by golly) for best reception of the strongest local station. Unless the user lives near a broadcast station, an external antenna and ground system are mandatory.

The Past Is Prologue. Many years ago, in the 1800's, an important official suggested that the Patent Office be abolished, for "there was nothing left to invent." But look at what's happened not only since then, but just in the last quarter century: pocket calculators, electronic watches, electronic language translators, home computers, and on and on!

Predicting future developments is a fun game and one which I, a science-fiction aficionado, really enjoy. Here, then, are my predictions for the next quarter century:

In energy:

- Development of low-cost photovoltaic cells, making solar-generated electric power competitive with conventional sources.
- Development of economical fuel cells for vehicular use, making the electric car feasible for long as well as short trips.
- Development of small-scale nuclear power plants suitable for individual buildings and larger vehicular (trucks/buses) applications.

In computers:

- Development of begabit memories (i.e., a *billion bits* per module).
- Development of full aural interactive computer systems which not only respond to voice commands but which can answer questions.
- Similarly, development of microcomputer controlled test instruments and systems which react to voice commands and provide an audible response.
- Development of full-capacity computer systems with flat-screen displays and hard-copy printouts no larger than a standard attache case.

In general electronics:

- Continued development of specialized large-scale integrated circuits, leading to equipment and instrument design using systems engineering techniques.
- Continued development of more advanced discrete devices despite the increasing use of IC's.
- Breakthrough in solid-state or liquid-crystal imaging devices, leading to flat, large-size TV screens and displays.
- Comparable breakthrough in solid-state transducers, including sound generators (i.e., loudspeakers), sensors, and prime movers.
- Full integration of solid-state and microwave technologies, leading to lower priced instruments and equipment.
- Similar integration of solid-state and fiber-optic technologies, with fiber-optic light-beam communications and data transmission systems becoming as common as today's hard-wired networks.

Reader's Circuit. With literally dozens of potential practical applications, the general-purpose control/alarm circuit in Fig. 2 was submitted by high school student, Edwin Goei (111 Tophill, San Antonio, TX 78209). Depending on the type of sensor switch used, the circuit may serve as a water-level, freezer-failure, fire, intrusion, theft, or power-failure alarm. It requires no standby power, assuring long battery life and, once activated, emits an attention-getting "beeping" sound. Easily assembled in one or two evenings and requiring no special construction skills, the design uses standard components.

Two sections of a 556 dual timer, *IC1*, are used as interlocked low- and high-frequency multivibrators to generate the required "beep" signal, which drives a loudspeaker directly through dc blocking capacitor *C3*. To achieve control and minimize the need for standby power, pnp transistor *Q1* is used to switch the dc power source, *B1*. With switch *S1* closed, the circuit is inactive as long as the input terminals are open, for *Q1* is operating without base bias and thus behaves as a

(Continued on page 92)

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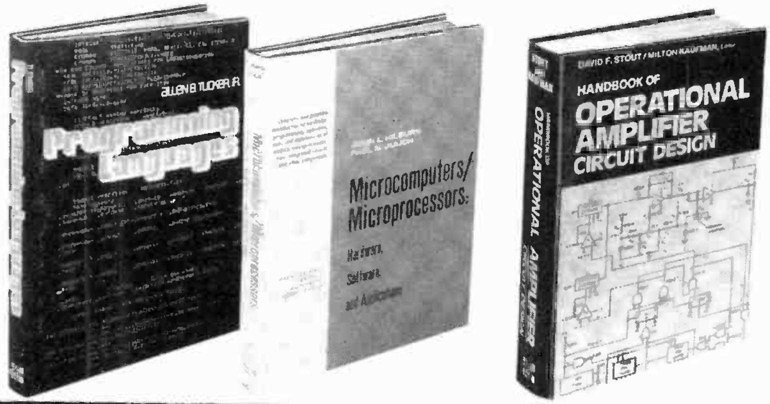

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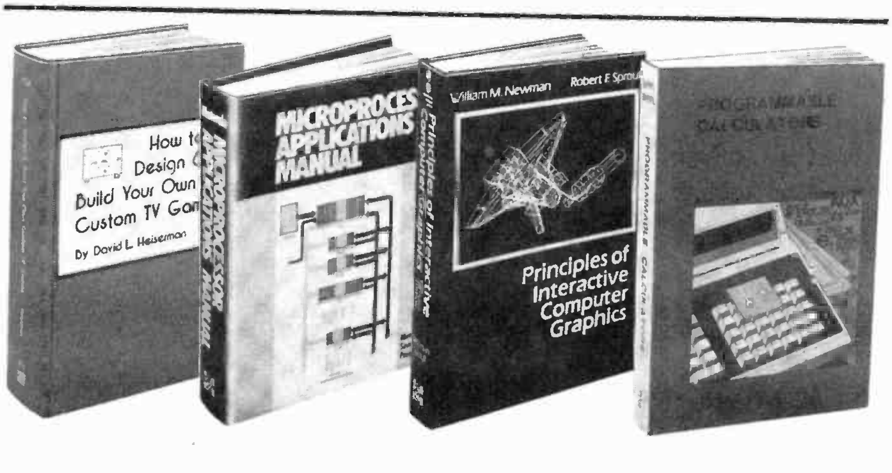

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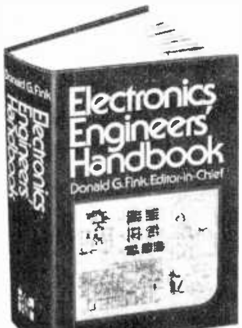

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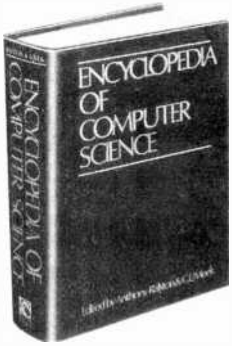

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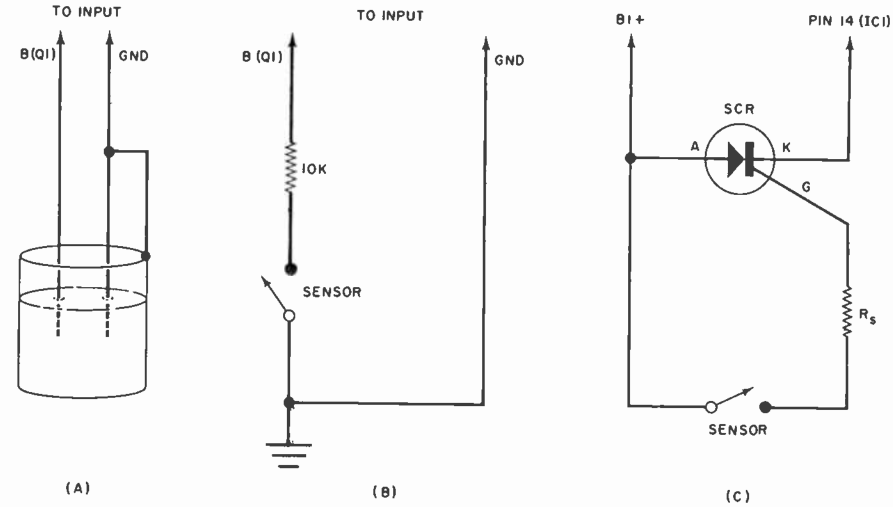


Fig. 3. Techniques for using reader's alarm circuit: (A) as water-level alarm; (B) with sensor and thermostatic switches; (C) in "latch-on" alarms.

high impedance or "open" circuit. If the input terminals are connected through a moderate resistance, base bias is applied to *Q1*, which shifts to a low-impedance state, thus supplying power to *IC1* and activating the alarm.

Neither parts layout nor lead dress is critical and the circuit can be assembled using any construction technique. The power source, *B1*, is a standard 9-volt transistor battery, but six series-connected penlight or flashlight cells can be used instead. Switch *S1* is a spst toggle, slide, rotary or pushbutton type, *Q1* is a general-purpose pnp transistor, and *IC1*, of course, is a type 556, although a pair of 555s can be used by making the necessary changes in pin connections. The resistors are all one-quarter or one-half watt types and the capacitors are conventional low voltage units.

Several techniques for using the basic design in different applications are suggested in Fig. 3. For a water tank or sump level alarm, simply mount two metal probes, such as heavy bus wire, rods, or tubes, so that they are contacted by the water at the level at which an alarm is to be sounded (Fig. 3A). The probes should be close together, but insulated from each other, with an exposed lower surface to make contact with the water. The probes are connected *directly* to the alarm's input terminals.

For applications using a simple switch sensor, such as a "Microswitch" or bimetallic thermostatic switch, as in a freezer door or fire alarm, a 10,000-ohm, half-watt resistor should be connected in series with the "hot" input lead to limit the transistor's base current (Fig. 3B).

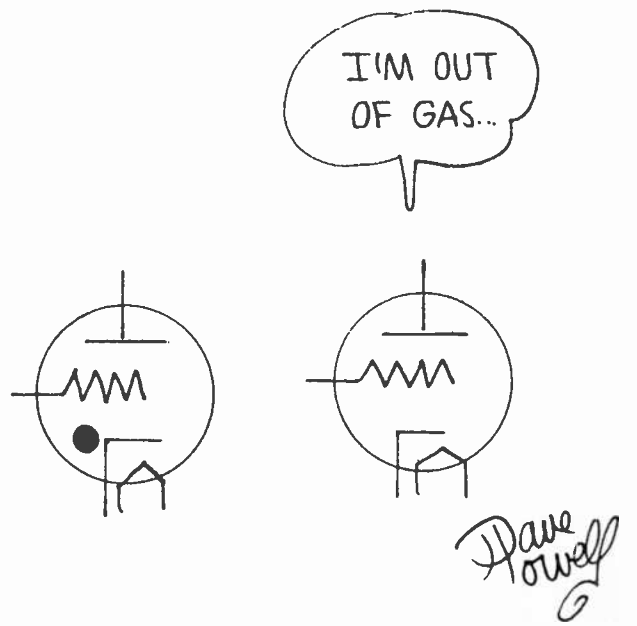
Finally, for burglar, theft, intrusion or similar applications requiring a continuously sounding alarm once tripped (until deliberately reset, of course), transistor *Q1* should be replaced with a low-voltage sensitive-gate SCR, as shown in Fig. 3C. Depending on the installation, the sensor switch might be a normally open magnetic door switch, a pressure sensitive mat switch, a "Microswitch," or some similar device. The value of the series gate resistor, *Rs*, will depend on characteristics of the SCR used in the circuit. In operation, the alarm will sound continuously once the sensor switch is closed, even momentarily, until the system is "reset" by opening and closing the main power switch (S1, Fig. 2).

Device/Product News. Back when POPULAR ELECTRONICS—and the solid-state industry—were still infants, the word *hybrid* was used to describe electronic equipment, principally audio amplifiers and radio receivers, which used both transistors and vacuum tubes. A hybrid receiver generally used vacuum tubes in the r-f and i-f stages and transistors in the audio section. In hybrid audio amplifiers, transistors were used in the low-level voltage amplifier stages and vacuum tubes as power output amplifiers.

Today, hybrid is used to describe integrated solid-state circuits manufactured by assembling what are essentially discrete components, including resistors and capacitors, on a single substrate. The MWA Series of wideband r-f amplifiers are good examples of modern hybrid circuit design. Introduced recently by Motorola Semiconductor Products, Inc. (Box 20912, Phoenix, AZ 85036), these are single-stage amplifiers suitable for applications in r-f, i-f, agc, and isolation circuits as well as in-line drivers. With 50-ohm input and output impedances, the devices offer typical gains up to 14 dB and, depending on type, frequency responses from 100 kHz to 1 GHz. Thin-film hybrid construction on an alumina substrate is used with gold metallization and laser-trimmed nichrome resistors.The units are supplied in metal TO-39 hermetically sealed packages.

In addition to the wideband r-f amplifiers, Motorola has introduced a number of new discrete devices with potential applications in hobbyist projects, including a line of fast-switching npn power transistors and a family of plastic packaged high-power triacs. Designated the MJ8500 Series, the new power transistors offer maximum $V_{CEO(sus)}$ ratings of 800 V and IC ratings as high as 10 A, depending on type. Suitable for use in switching-mode power supplies, inverters, converters, and similar applications, the new devices are packaged in special metal TO-3 cases. Comprising sixteen different types, the new triac family features a 25-A current rating, with a 250-A surge capability. Identified as the MAC223/223A Series, they are offered with voltage ratings from 100 V to 800 V, depending on type. The highest voltage types are capable of handling loads in excess of 10 kW. Designed for lighting, heating, and motor control applications, the units are supplied in special TO-220 plastic packages.

The International Rectifier Corporation (233 Kansas St., El Segundo, CA 90245) is marketing a line of high-power MOSFET's. With high input impedances, high gain, and switching speeds to over 200 kHz, the new devices are offered with V_{DS} ratings from 60 to 400 V at continuous I_D ratings from 4 to 16 A, depending on type. The devices, therefore, can handle power levels in excess of 1 kW. Potential applications include audio amplifiers, switching power supplies, motor controls, induction heating, and ultrasonic systems. ◇



Amateur Radio

By Karl T. Thurber, Jr., W8FX

HOSE GOLDEN OLDIES

NYONE who has attended a hamfest or swap meet or perused the shelves of one the larger amateur radio distributors (one at takes used ham gear in trade toward the ırchase of new) knows there has been a lot equipment produced over the years to fill e needs and wants of the amateur radio ımmunity.

Many amateurs like to "hit" every big hamst within reasonable distance to attend the chnical forums, chat with other hams, and ok over the manufacturers' displays and ›oths to examine new, state-of-the-art ›odies. More fascinating, however, to many nd easier on the budget) is to rummage ough the flea-market areas of these ham:ts, eyeing others' castoff gear, and exining the trade-in shelves of the local ham oorium. You will find familiar and unfamilrand names, surplus salvage, and home- equipment of every description.

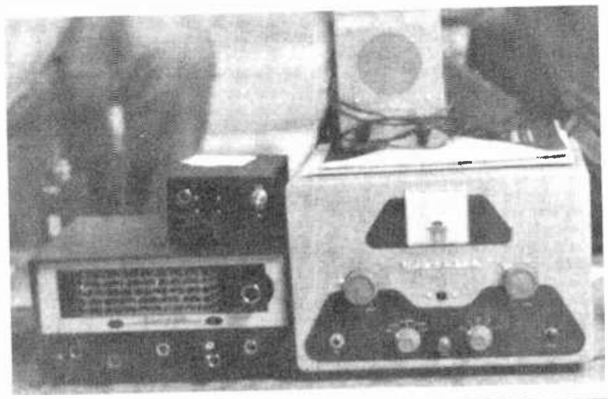
specially interesting is the equipment pro-ed by famous and once-famous manufac-rs, many of whom are no longer in exis-e or who have long since abandoned the trade. You may find names such as Hal-fters, Hammarlund, Collins, Lafayette, National, Eico, Johnson, and B&W, that were familiar long before Yaesu, Kenwood, Icom, Ten-Tec and Dentron equipment appeared. And you just might come across some not-so-familiar names such as Hunter, SBE, Eldico, Lakeshore, Gonset, Central Electronics, Multi-Elmac, Squires-Sanders, Elenco, Stancor, Globe, Galaxy, and Morrow. If you're lucky, you may even find some almost-forgotten, dusty rigs made by such old favorites as Harvey-Wells, Lettine, Palco, Geloso, RME, Lysco, Cosmos, Pierson-Holt, and Bud Radio. Occasionally, you'll see some gear by Jelectro, Temco, Aquadyne, Knight-kit, and Black Widow. Do you recognize any of these classic names of the 50s and 60s?

What did the typical beginner use for equipment, circa 1954? Very likely, the Novice (who then had to earn his license by taking both code and written exams in person before an FCC examiner) may have acquired a slightly used but sturdy Hallicrafters S-76 receiver from a newly-upgraded General who went on to purchase one of the "all new" Hallicrafters models for that year. The S-76 that our beginner purchased cost under $200 when new, and perhaps two-thirds of that from his friend. The set was a 9-tube-plus-regulator-and-rectifier job that touted "pencil-thin" (500-cycle) selectivity and 2-microvolt sensitivity—not bad for a set of that era with only one r-f stage. Having a "double-conversion" superhet scheme, the S-76 eliminated the "image" problem exhibited by its cousin, the S-40, as well as other single-conversion receivers. The S-76's 5-position selectivity control helped to separate signals that lesser sets could not. A giant, 4" S-meter, calibrated in units to "80 dBs above S-9," graced the front panel. It was an all-wave receiver, meaning it covered all the hf bands (including the standard broadcast band) to 34 MHz in four ranges, and it had a separate electrical bandspread tuning knob with calibrated dial to fine-tune the ham bands, which were crowded even then. Calibration accuracy, frequency stability, and sensitivity on the higher bands of most moderately priced sets such as this left a lot to be desired, however.

Building Your Own. Most amateurs bought ready-made receivers, not because they were afraid to build them, but because of the alignment problems once they were built. Many hams did build their own gear, however, especially transmitters, though most Novices compromised and built a kit. After all, how could one go wrong with Heath or Knight-kit instructions?

Very likely, our rank beginner tested his skills on one of the Heath Company's early ham-kit designs. The Heath AT-1 CW transmitter kit, probably filled the bill. It was a single-knob band-switching rig (no old-fashioned plug-in coils in 1954, please!) that covered the 80-, 40-, 20-, 15-, 11-, and 10-meter bands (eleven was a ham band then). The compact little set had a power input of 25-30 watts, well under the Novice maximum of 75

:ns 75A-4 receivers adorned
y first-class amateur stations
:ade or so ago. This set
for about $600 when new.



Typical Novice station of the early 60s featuring a Heath transmitter built from a kit.

The Hammarlund "Super Pro" SP-600 was one of the best of the old-line receivers. This set, when new, was over $1000 but was going for $195 at a recent hamfest.

watts then allowed. The AT-1 was designed for crystal-controlled operation, since Novices were then restricted from using VFO (variable frequency oscillator) control. Sporting a three-tube lineup—a 5U4G rectifier, a 6AG7 oscillator-multiplier, and a mighty 6L6 power amplifier with a link-coupled output tank circuit—the set was billed by Heath as the "best dollar-per-watt buy on the market." Priced at $29.50, FOB Benton Harbor, it probably was. The accessory AC-1 single-wire antenna tuner was all of $14.50.

Once upgraded to General, the ex-Novice almost certainly put together the accessory VF-1 VFO kit, which afforded him across-the-bands flexibility for an additional $19.50 (the VFO was designed to simply plug into the AT-1). TVI was a problem for our beginner, especially when he attempted to operate on the three highest of the AT-1's bands, which the 6L6 final amplifier reached by "doubling" the input frequency. Efficiency was thus reduced, and copious harmonics that fell into the TV channels were generated.

Our now more experienced ham soon realized the operating drawbacks of his equipment. Shortly after he shucked his 1-year nonrenewable Novice ticket, he saw that a deeper investment would be prudent. So he searched the local ham shops, checked out the rigs of neighboring amateurs, and scoured the mail-order catalogues of such outfits as World Radio Laboratories, Walter Ashe, Allied Radio, and Fort Orange Radio Distributing Company for gear more fitting his new status as a General ticket-holder. Extremely popular receivers of this period were several of Hallicrafters' popular SX-series; the Hammarlund HQ-line; the RME 4300 and 6900; and better National sets such as the NC-300 "dream receiver," to highlight but a few. Well-heeled hams plunked down greenbacks for sets like the Hammarlund Super Pro or Pro-310, the National HRO-60 or NC-400, or the TMC (Technical Materiel Corp.) GPR-90. All these sets used tubes, and many of the top-of-the-line receivers compete favorably even today with the current crop of imported, solid-state sets.

Once the receiver was upgraded, the next step was a better transmitter (few transceivers were around then). The E. F. Johnson Company entered the market about this time with several very impressive transmitters—probably the first that could be purchased either as kits or as fully-assembled, ready-to-go rigs. Beginning with the Viking I and Viking II, Johnson rapidly added high-quality AM and CW transmitters such as the Valiant, Pacemaker, Challenger, Adventurer, Invader and many others that could take care of almost any ham need. Very likely, the new General operator settled on the Viking Ranger, Johnson's compact, 75-watt CW, 65-watt AM phone transmitter—a good buy, as it turned out. With bandswitching from 160 through 10 meters, the set had a stable, built-in VFO (one of the first), and smooth break-in CW keying circuitry. The kit came complete with tubes for $229.50, and the wired and tested version cost $100 more.

Still Good Today? Is this equipment hopelessly antiquated, suitable only for nostalgic recollection and a place on a closet's top shelf? Not at all! In good condition, much of the tube-heavy gear of the 50s and 60s *does* have a place in the newcomer's hamshack.

(Continued on page 96)

(Continued from page 94)

He can, indeed, save a great deal of money by purchasing older equipment, which sells for but a small fraction of its showroom ticket. Using 50s equipment and accessories, he can likely get on the air for $100 or 150; perhaps less. Of course, most of the older AM-only transmitters and cheapie "clunker" receivers are passe, but many of the "quality gear" of the era are suitable for use today.

This is especially true of older CW transmitters, particularly those having built-in VFOs and a fair amount of power. Most of them were well-engineered and are still good "first rig" buys for the Novice or Technician who wishes to "get his feet wet" on CW. Perfectly suitable for CW work (forgetting any of the rig's AM capabilities) would be transmitters such as the Heath DX-100 and TX-1, the Collins 32V2 and 32V3, the Ranger I and II, Valiant I and II, the Navigator, Globe Scout, and Globe King 500. Also usable are several of the Allied Radio/Knight-kit rigs such as the T-50, T-60, and T-150.

As for receivers, the best, most expensive ones were far ahead of their times and are still good bets despite major technological advances. Among these are the National HRO-60 and NC-400; the Hammarlund SP-600, Pro-310, and HQ 145, 170 and 180; the Hallicrafters SX-88, SX-100 and SX-101; and the Collins 75A3 and 75A4.

What to Look For. If you're interested in outfitting your shack with some of the older gear, be sure you know what you are getting and that the price is fair and reasonable. Realize that most older sets will need some work to get them on the air (at least an alignment and tube-check) and that the separate transmitter and receiver set-up will require a TR (transmit-receive) switch or relay.

The best way to buy is probably from a friend who is a ham or through an established dealer. Other possibilities are the "for sale" columns in the various ham magazines, swap-and-sale newsletters, hamfest swap meets, and radio-club auctions. Don't buy what is obviously butchered or junked, and be especially cautious about kit-constructed gear. Check out the "insides" before clinching a deal, and ask for a service manual in hopes that the seller still has one. Finally, rely on the advice of an older, more experienced amateur; he may have at one time owned and operated exactly the equipment you're looking for.

A good way to learn about the specs of these old sets is to read the ads and product reviews in the back issues of the ham magazines. Scan the back issues at your local library, or better yet, scan the hamfests for back issues of the old magazines yourself, and build your own file. Old issues can usually be obtained for 5 or 10 cents a copy and they make for good reading as well.

If some of the "Golden Oldie" equipment strikes your fancy, don't feel outdated or embarrassed. In fact, once you start to look around, you'll find that the best of the old gear is being chased by those who recognize a good buy. Moreover, some may even be in short supply. Many hams take the same pride in operating "classic" equipment as do old-time car buffs, and you may be surprised to find that the payoff in operating satisfaction and downright "fun" is far greater than with modern equipment. Old gear may give your hobby a new twist. ◇

Experimenter's Corner

By Forrest M. Mims

·GE-TO-FREQUENCY CONVERTERS

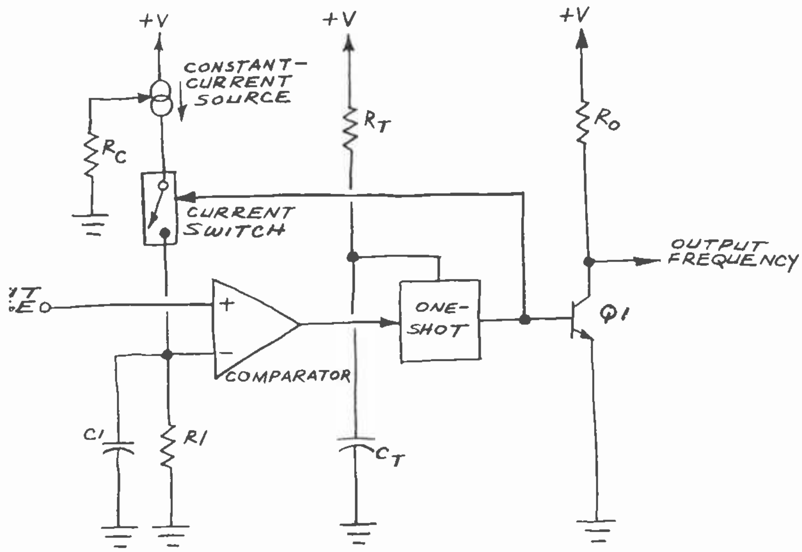
INTERESTING circuit applications
· been made possible by some rela-
v monolithic ICs that convert volt-
plied to their inputs into pulse trains
frequencies vary in step with changes
input voltages. In the past, voltage-
·ency or simply V/F converters were
le only as expensive hybrid modules
t-yourself patchwork versions made
· timers and op amps. This month,
ok at several straightforward applica-
·r two new V/F chips. Because these
·an also function as frequency-to-volt-
/V) converters, those applications will
ered in a future issue.

onverter Basics. Figure 1 is a sim-
block diagram of a basic V/F convert-
· circuit functions as a relaxation oscil-
·hose frequency is determined by the
· applied to the noninverting input of
mparator. If capacitor *C1* is initially dis-
·d, the output of the comparator will
to the positive supply voltage as soon
· input voltage becomes positive. This
·s a one-shot timer that closes a switch
·nect a constant current source to *C1* for a fixed time interval determined by the values of timing components R_T and C_T. Depending on many factors, this one injection of charge might develop a voltage across *C1* that is more positive than the input voltage. If this happens, the one-shot will not be triggered again and will remain in its "off" state. The comparator will continue to monitor the input.

This charging cycle will be repeated any time the input voltage becomes more positive than that across *C1*. In the meantime, *C1* is gradually discharged by *R1*. Should the voltage across *C1* fall below the input voltage, the charge sequence will be repeated—even if the input voltage has not changed.

This automatic tracking process, known as *charge balancing*, enables the circuit to generate a pulse train whose frequency is precisely proportional to the input voltage. The output pulses developed by the one-shot timer are buffered by transistor *Q1*.

This is a highly simplified description of how most V/F converters work. For more details, see Walter G. Jung's "IC Timer Cookbook" (Howard W. Sams and Co., 1977, pp. 184-192). The data sheets for the various V/F ICs also include good explanations of how they operate.



Functional diagram of a typical voltage/frequency converter.

Teledyne 9400 V/F Converter. This 14-pin DIP incorporates both CMOS and bipolar circuitry on a single silicon substrate. The result is very low current comsumption, typically 3.5 mA when the IC is powered by a single 9-volt battery. The chip can, however, be powered by either a dual- or single-polarity supply. Figure 2 is the schematic of a V/F converter made with a 9400 and some external parts. The circuit, which is powered by a single-ended supply, was adapted from one appearing in the manufacturer's data sheet.

A breadboard version that I assembled began to emit an output signal with a frequency of 0.3 Hz when the input voltage reached 0.25 volt. The maximum input voltage to which the circuit would respond was exactly 8 volts when the circuit was powered by a 9-volt alkaline battery. The output frequency corresponding to this input voltage was 13.53 kHz. A plot of the output frequency versus the

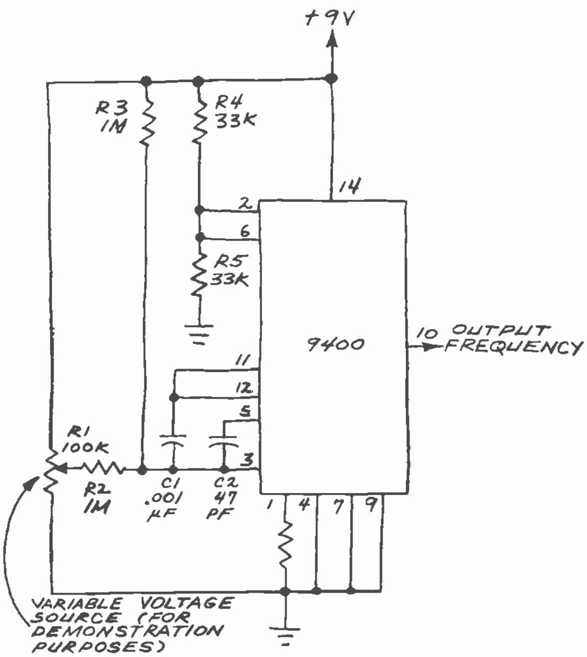


Fig. 2. Voltage-to-frequency converter using a 9400 IC.

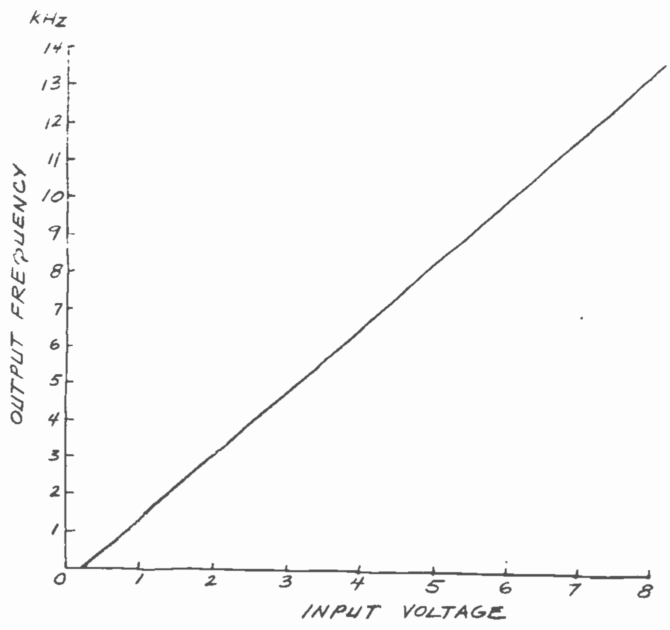


Fig. 3. Output frequency vs. input voltage for 9400 V/F converter circuits.

input voltage at half-volt intervals for the prototype circuit is shown in Fig. 3. The striking linearity of this chip's output-frequency/input-voltage characteristic, which in this case extends over a five-decade frequency range, is characteristic of V/F ICs.

The output frequency of the circuit in Fig. 2 can be increased to a maximum of 100 kHz by reducing the values of *C1*, *C2* and *R2*. The 9400 data sheet gives detailed information.

9400 Digital Data Transmission. Frequency shift keying (FSK) is a complicated name for a very simple way to transmit digital data. In most digital electronic circuits, the logic 0's and 1's of a binary signal are represented by two voltage levels. FSK data transmission assigns one audio-frequency tone to logic 0 and a second (usually higher) frequency to logic 1.

This permits a stream of bits to be transmitted over a pair of wires, by radio, or by light. At the receiver, a frequency-to-voltage (F/V) converter transforms the received tones back into two distinct voltage levels.

A block diagram of a basic FSK data transmission system is shown in Fig. 4. Potentiometer *R1* in the transmitter input network permits the quiescent output frequency to be preset to any convenient value. This permits many different FSK transmitters, each with different 0 and 1 frequencies, to share a common transmission channel. Of course, each information (*not* transmission) channel will require a separate FSK receiver.

TYPICAL TRANSMITTER OPERATION		
C2 (FIG. 2)	OUTPUT FREQUENCY	
	LOGIC 0 IN	LOGIC 1 IN
47 pF	3943 Hz	17,671 Hz
0.1 µF	1000 Hz	1665 Hz

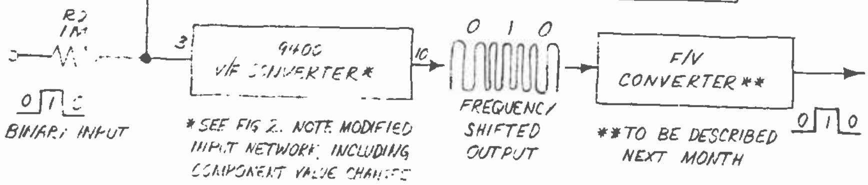


Fig. 4. A 9400 FSK binary data transmission system.

9400 Frequency Modulator. Several articles in this magazine have described ways of transmitting information over a pulse/frequency-modulated beam of infrared radiation emitted by a LED or injection laser. This method of light-beam modulation is superior to amplitude modulation because each pulse transmitted has the same amplitude, usually the maximum signal power the transmitter can radiate. The received signal is not as subject to fading as that in an AM system when propagation conditions change or when the transmitter-to-receiver distance changes.

The 9400 and other V/F converters can be used as exceptionally linear frequency modulators. Figure 5, for example, shows a basic FM transmitter that will transform an audio signal such as voice into a train of variable-frequency pulses suitable for driving a LED or modulating a radio transmitter.

Note that the duration of the pulses in the output signal is variable. For several reasons, it's desirable to drive a LED with pulses of uniform duration, especially in a long-range voice-communication system in which the LED is driven by ampere-level current pulses.

The circuit shown in Fig. 5 can easily be modified to accomplish this purpose. One possibility is to connect its output to a one-shot that delivers a pulse of uniform duration to the LED each time a pulse is generated by the 9400. Another is to trigger the gate of an SCR which, in turn, dumps the charge that has accumulated in a capacitor through the LED. Still another method is to trigger a transistor which then dumps charge from a capacitor through the LED. Whichever means you select, it's important to make sure that the pulses from the one-shot are not too wide. Otherwise, some of the closely spaced pulses generated by the 9400 will be missed, resulting in distortion.

The frequency modulated signal must be demodulated after it is received. One way to accomplish demodulation is to connect a one-shot to the receiver output, the method employed in the P/FM laser receiver described in the *1979 Electronic Experimenter's*

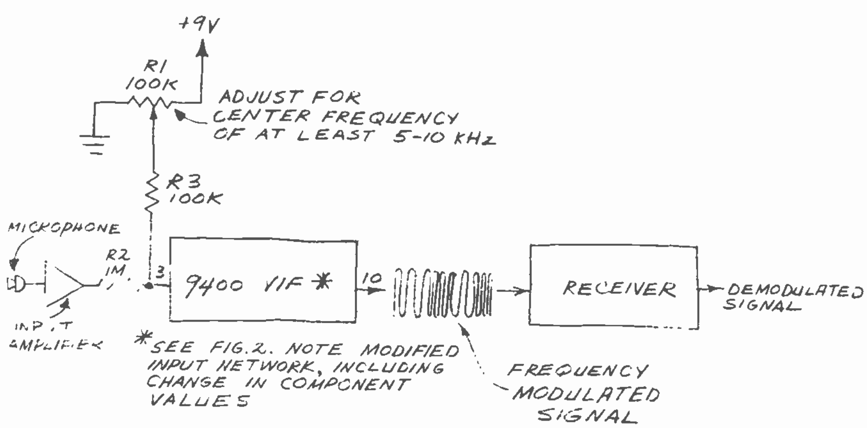
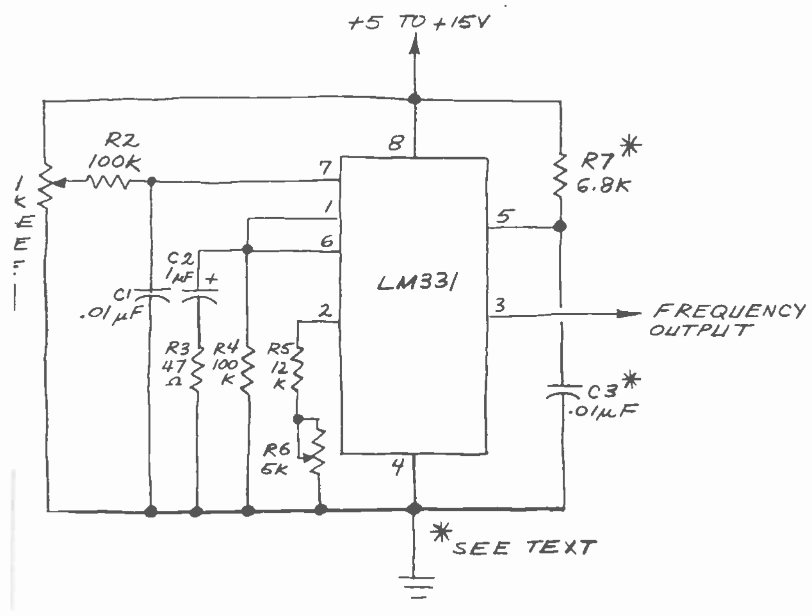


Fig. 5. A 9400 frequency-modulated transmitter.



with the 9400, I received a few sample LM331 V/F converters from Robert A. Pease, a staff scientist for National Semiconductor. The LM331 has a guaranteed linearity of at least 0.01 percent when connected in the V/F mode. Like the Teledyne Semiconductor 9400, it can be operated from a single-ended or dual-polarity supply, and can generate an output frequency of up to 100 kHz.

Figure 6 shows a basic V/F converter adapted from the LM331 data sheet. Potentiometer *R1* serves as a voltage divider that delivers a variable input voltage to the V/F circuit. A breadboard version of this circuit yielded the plot of voltage versus frequency shown in Fig. 7. The increasing nonlinearity in V/F operation when the input voltage exceeded 8 volts is probably due to my use of standard-tolerance components. For ±0.03% linearity (typical), use 1% tolerance resistors for *R4* and *R7* and a low-temperature-coefficient capacitor for *C3*.

One of the simplest applications for the LM331 is the ultra-stable oscillator shown in Fig. 8. This circuit, which Don Pease of National Semiconductor described in *Electronic*

...oltage-to-frequency converter using an LM331.

...(F. Mims, "Semiconductor Laser ...cations System," pp. 64-73). ...demodulation system employs a ...cked loop, a method covered in a ...allment of "Experimenter's Corner" ... Modulation and Phase-Locked ...May 1976, pp. 101-102). That col... described a simple two-transistor ...O transmitter.

...s insufficient space in this column to ...00 V/F frequency modulators in de...u would like to see a construction ...column describing in detail a P/FM ...e communication system that em...400 or similar V/F converter, send a ... with your comments to this column ...f POPULAR ELECTRONICS. If there is ... reader interest, I will probably un...such a project.

...al LM331 V/F Converter. After ... a good deal of time experimenting

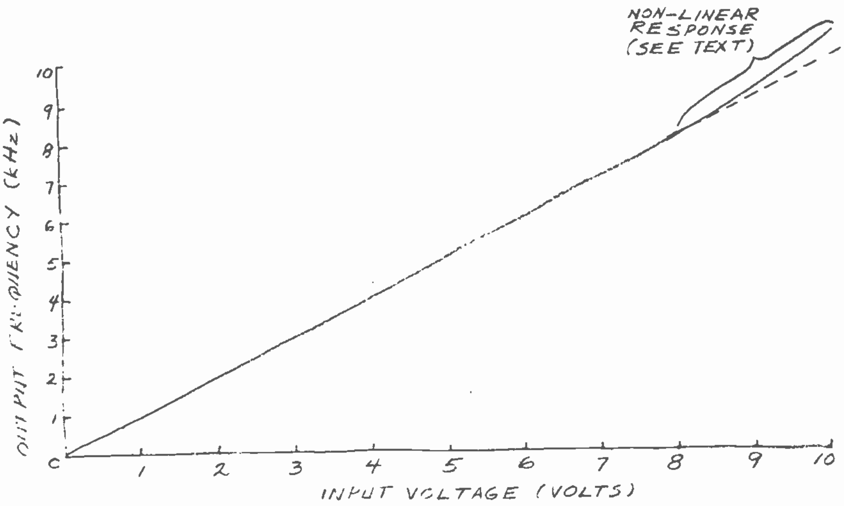
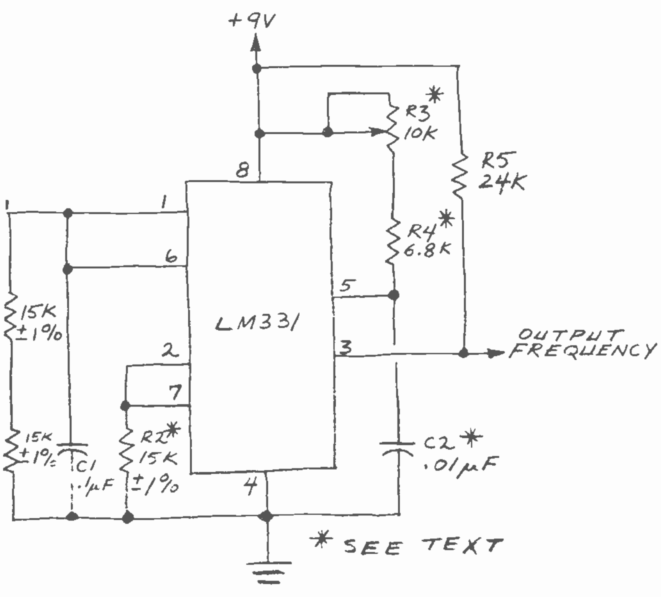


Fig. 7. Output frequency vs. input voltage for LM331 V/F converter.

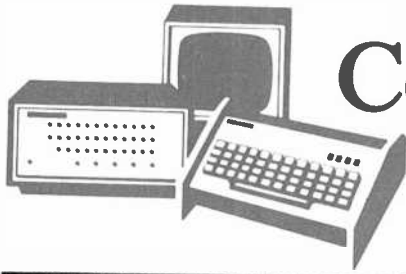


LM331 operated as stable frequency oscillator.

Design (December 6, 1978, pp. 70-76), has a frequency stability of ±25 parts per million per degree Centigrade (ppm/C) if low-temperature-coefficient parts are used for *R3*, *R4* and *C2*. These components determine the output frequency of the oscillator.

Note that *R1* is composed of *two* 15,000-ohm resistors in series. Don recommends that these resistors and the one used for *R2* be from the same production batch. This makes the circuit from five to ten times more immune to temperature changes than it would be if *R1* were a single 30,000-ohm resistor. Incidentally, although these resistors should have a tolerance of no more than 1% for best results, the circuit *will* operate (but with less accuracy) if standard 10% tolerance resistors are used.

Like the 9400, the LM331 is not yet readily available from many of the hobby distributors who advertize in this magazine, but it will be as soon as the demand exists. Until then you can get the LM331 from Hamilton/Avnet, Schweber, Hall Mark, Sterling or any of the dozens of major industrial distributors who handle National Semiconductor parts. ◇



Computer Bits

By Leslie Solomon
Technical Director

MODERN MUSIC

WE HAVE recently had opportunities to test many computer "plug-in" music systems. Like so many other computer peripherals, music boards have been evolving rapidly and have come a long way from those that could handle only a couple of octaves in a single raspy "voice" and play only one melody for a minute or so. Now, the number of voices has increased, and the duration of the melodies depends only on the amount of RAM available. Software has also become more complex so that just about all musical parameters can be controlled. Some music programs have the appearance of high-level language and require no computer expertise.

One of the newest music systems is the ALF Music Synthesizer, which is compatible with the Apple II and is $265 from ALF Products (1448 Estes, Denver, CO 80215; Tel: 303-234-0871). Available from Apple dealers, this single-board plug-in is a three-voice synthesizer with hardware control of pitch and volume. All other effects are controlled by software. It also takes advantage of Apple graphics in a unique manner. Audio range is eight octaves.

The system requires a 32K Apple II, a cassette recorder and an external hi-fi audio system. Stereo provisions are made and up to nine voices (using three boards) can be handled. The cassette furnished with the board contains two (integer) BASIC programs, four two- and three-voice melodies, programs for use with a disk, and an extended playing program.

The first program, called "Introduction," explains basic music synthesizer terminology, and provides some hands-on experiments to illustrate the concepts. The second program, called "Entry," is used to enter and play melodies—either from the cassette or created by the user. When "Entry" is run, a high-resolution graphics display appears on the monitor. Since the image does not require color, a good monochrome CRT is suggested.

Unlike older music systems where nonmusical combinations of letters, digits and other symbols are used to specify a particular note or other parameter, the ALF board actually displays the treble and bass staffs. Along the bottom of the display is a set of seven musical notes (from a whole note to a 64th) a dot (time) modifier, and a "3" modifier that causes the selected note to be multiplied by ⅔. Also shown are the three incidentals (sharp, flat, and natural), a rest symbol, right and left arrows, and a speaker symbol.

An up-arrow cursor, controlled by paddle-0, can be positioned under the desired symbol, while a "flying saucer" symbol, controlled by paddle-1, can be positioned as desired on the staffs. The display is completed by three editing commands: DEL (delete), INS (insert) and TIE (tie two notes together).

To create a melody, a key is determined by typing in (for example) "KEY:3F" and the three flats appear correctly positioned on each staff. The tempo might then be selected by typing in "TIME:¾" and the large ¾ would appear in the correct position. All other parameters are determined by typed-in editing commands.

Paddle-0 is positioned to the desired note or other command, and paddle-1 is used to

The ALF Music Synthesizer displays treble and bass staffs and various music symbols.

pos stal in t use ten has fror que me pla ma mu the \ alc rec dic er of sp Tr de ca au pr lo cc be br C lic bi m m c e a v it p s a t c r \ ; ; (: i

"flying saucer" as desired on the ther voices are entered by typing number. Paddle pushbuttons are jer the data. Thus, music is "writ- conventional way. Once a melody iither created by the user or taken assette, each measure can be se- lisplayed and, if desired, any ele- be modified. Other than the dis- enu," there is another set of com- : can be typed in for more detailed ations. The manual explains all of nands.

ed the system on our 32K Apple, a monochrome monitor, a cassette nd a hi-fi audio system. A good au- should be used since the comput- ystem can produce a wide variety effects—comparable in many re- an expensive music synthesizer. has full control over attack, sustain, l other music parameters.

the four melodies provided on the vas loaded and played in turn. The tion is surprisingly excellent and new world of sound effects from a omputer plug-in. The video display f two to six (depending on the num- ces used) horizontal lines having a t to indicate the position of middle melody progresses, small blocks of ice" in step with each voice. The s of each dancing block is deter- y the voice amplitude. Although ess as far as the music is con- e display is fascinating to watch.

aying the prerecorded melodies, we nted with our own music. Within hour, we had scored our first two- ue (from sheet music). After playing perimented with the various musical rs and came up with some really ynthesized tones. If you are serious nputer music, we suggest the use of even three) ALF boards so that you six voices in stereo.

is no doubt that, because it requires uter know-how, the ALF synthesizer eatly appreciated by music students hers with access to an Apple II. ALF kes available a 16-song cassette that is not only excellent from a mu- point, but also provides a good train- n illustrating the use of six indepen- ces.

sers Group. Since the demise of or Technology, many SOL users en lacking a source of hardware, soft- nd maintenance information. These available from the Proteus Group, Sokolow, 1690 Woodside Rd., Suite Redwood City, CA 94061 (Tel: 3-3331).

EYE'S." According to Case Western ity Robotics Lab., you can use a 1K RAM chip (of the 4008 family) as a t image sensor. Carefully pry off the tal lid, being careful not to damage the ernal wiring. Focus an image on the urface and write 1's into the RAM. you read the RAM, where light fell on ay, there will be 0's and where the ar- s dark, the 1's will remain. The 4008 is npatible with the 2102, but it needs lts on the ground pin.

m 68. A ferroresonant constant-voltage power supply drives this new computer system. It has an SS-50 motherboard that contains 15 50-pin and eight 30-pin gold-plated connectors. Built around a 6800 CPU, it can accommodate up to four 2708 PROMs and three independent programmable software timers. It comes with up to 16K of software-addressable static RAM board organized into four separately controlled 4K blocks. DIP switches are provided to permit use of existing SWTP and MSI software. Output is video, and the system uses the GMXBUG 3K ROM monitor that contains standard utility functions and routines that facilitate software development. Address: Gimix Inc., 1337 West 37 Pl., Chicago, IL 60609 (Tel: 312-927-5510).

Multiple A/D Conversion. The AIM161 features 16 100-microsecond conversion-time 8-bit analog inputs. It has a three-state output and requires one 8-bit computer output port for control and one 8-bit input port for data. Interfaces are available for PET, KIM, and TRS-80 microcomputers, with others soon to be available for other computers. The A/D converter can be provided with a number of peripherals. These data-acquisition modules (DAMs) are available for $159 each. Address: Connecticut Microcomputer, 150 Pocono Rd., Brookfield, CT 06804 (Tel: 203-775-9659).

Video Monitor. The Video-100 is a solid-state video black-and-white monitor using a 12" CRT. Video bandwidth is 12 MHz, and resolution is 650 lines minimum in the central portion of the CRT and 550 lines minimum beyond the central 80% of the screen. Video input is 0.5 volt composite sync at 75 ohms. The monitor is 11½" high, 16¼" wide, and 1½" deep. It weighs 14 lb, and is equipped with all conventional controls. $149. Address: Leedex Corp., Elk Grove Village, IL 60007 (Tel: 312-364-1180).

Graphics Board. The CGS-808 is a color graphics board for the S-100 bus, or it can stand alone. It contains its own on-board microprocessor, requires no memory space, and eliminates the need for software driver routines. It generates an 8-color display with 12 different programmable and software-selectable modes simultaneously. The alphanumeric mode has an internal character generator to display 32 characters on 16 lines, with two colors per character and inverse video. There is room for an EPROM for custom characters or graphic symbols. Up to 128 different 8-×-12-dot characters can be displayed. Two semigraphic modes have display densities of 64 × 32 and 64 × 48 elements in 8 colors. Eight different graphic modes up to 256 × 192 in two colors are available. Output is composite video at 75 ohms. R-Y, B-Y and Y signals are available for connection to a color monitor. The board comes with software. Address: Biotech Electronics, Box 485, Ben Lomond, CA 95005 (Tel: 408-338-2686).

Selectric Interface. The MP-WP Selectric Interface allows the connection of an unmodified IBM Model-50 Selectric typewriter to an SS-50 bus. Interfacing is made through a cable assembly that plugs into a connector provided on the typewriter. No solenoids or typewriter modifications are required. The typewriter is used as input and output. Interface and cable, fully assembled, are $59.95, postpaid in USA. Address: Southwest Technical Products, 219 W. Rhapsody, San Antonio, TX 78216 (Tel: 512-344-0241).

Multi-System. The Cluster-One is a time-sharing disk system that uses an 8K PET as a host, and is capable of talking to as many as 30 independent and different microcomputers at the same time. Its disk storage features over 630K bytes single-sided and over 1.2 megabytes double-sided. As opposed to conventional time-sharing systems, Cluster-One allows each user to take full advantage of his own computer, so there is little degradation when the system is heavily used. Address: Nestar Systems Inc., 430 Sherman Ave., Palo Alto, CA 94306 (Tel: 415-327-0125).

Winchester Technology. Several readers have asked about the origin of the word "Winchester" when used to describe a particular disk drive. Apparently, early in the development of high-speed hard-disk system, the head was allowed to "float" 31 microinches above the magnetic surface on a cushion of air produced by the disk motion. When the disk stopped, the air cushion vanished, and the head landed on the disk, often causing damage and loss of data.

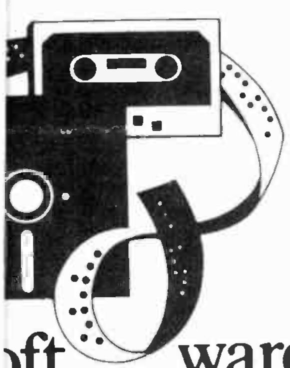
In 1973, a new design, using a trimaran head structure, allowed the head to float only 19 microinches above the disk, with the entire structure (including hard disk) enclosed in a hermetically sealed package to avoid the possibility of external contamination (dust, grease, etc.). The head loading is so light that it actually rests on the disk when it is motionless and it takes off and lands in an area of the disk reserved for that purpose.

The first such drives of this type from IBM were dual 30-megabyte configurations and called "30-30" systems—thus the name "Winchester." Now, even though the drive capacity has been raised to 70 megabytes, the name persists.

PET Disk. The PEDISK provides both a floppy disk and an S100 expansion chassis in one unit. The expansion feature allows extra I/O, memory, printer, telephone interface, modems, etc. to the PET, while the floppy disk portion allows up to four full-size disk drives (1 megabyte capacity). Prices range from $799.95 up. Address: CGRS Microtech, Box 368, Southampton, PA 18966 (Tel: 215-757-0284).

SS-50 Video. The Electric Window, a memory-resident and programmable video board that can display up to 80 characters on 24 lines, is now available for 6800 system using the SS-50 bus. It has two character generators—one standard and the other for special characters (APL for example). It also features dual intensity, scrolling, descenders on lower-case letters, programmable display positioning, and programmable interlaced or non-interlaced scan. $249.95. Address: Percom Data Co. Inc., 211 N. Kirby, Garland, TX 75042 (Tel: 214-272-3421).

Correction. The price of the Pascal Microengine described in our column of August 1979 should have been $2995, and the correct company address is Computer Interface Technology, 201 W. Dyer Road, Unit C, Santa Ana, CA 92707. ◇



oft ware Sources

By Leslie Solomon
Technical Director

e Management. INDEX (INter- EXecutive) operates fast because I/O by interrupts rather than poll- evices and other system peripher- ated as disk files so new devices Jed without modifying the operating esides the 19 built-in commands, n be expanded by adding utility s and driver routines. These reside kette and are loaded into memory needed. Files can be assigned an lue as a parameter of file name and l and binary. Disk files are automa- ated, allocated and de-allocated. referenced by names and parameters are added for name extension, drive number, directory level and include a file protection flag. You can also copy files, and any standard ASCII terminal is supported. There are more than 60 system entry points for program linkage, and up to 16 simultaneous active data control blocks are accommodated. Versions are available for PerCom LFD-400, SWTP MF-68, Smoke Signal BFD-68 disk systems and for the Motorola EXORciser development system. INDEX comes on two diskettes with user manual for $99.95. Percom Data Company, 318 Barnes, Garland, TX 75042 (Tel: 214-272-3421).

Apple/8080. The Apple-80 software (on cassette) enables any Apple II computer to emulate an 8080. Running on any 16K or more Apple, the software provides single-step, trace and run modes. It also runs 8080 object code and all 8080 registers are displayed on the screen. Trace speed is dynamically variable and can be controlled by paddle-O. The 8080 I/O ports are arranged in a table for ease of assignment. Up to 8 nondestructive breakpoints may be used for easy debugging. Eight 8080 interrupts are available and the 6502 subroutines can be called to enable use of the conventional Apple monitor. The Apple-80 cassette contains two programs. The first is a BASIC program that forms the Apple-80 manual. The second program is the Apple-80 itself. This machine-language program enables the Apple (6502) to emulate the 8080. An 8080 time-of-day clock program is also included for study. $20 plus $1.50 shipping and handling. California residents please add 6% sales tax. Dann McCreary, Box 16435-Y, San Diego, CA 92116.

CP/M Software. An extensive 8080/Z80 disk software line in four formats has just been made available. These include North Star Double Density, Processor Technology Helios II, MITS Altair hard sector and Ohio Scientific C-3 disk systems. Formats previously implemented and still supported include North Star Single Density Micropolis, iCom, SD Systems, Dynabyte DB 8/2 and 8" IBM. Other formats are available on request. A new addition will be available for the Heath H8/H17 system. Running on CP/M, all software is $145 and includes text editor, assembler, debugger and various other system utilities. Other packages such as FORTRAN, BASIC, COBOL, and CBASIC-2 are available as are payroll, general ledger, accounts payable and receivable, word processing and mail list packages. Lifeboat Associates, 2248 Broadway, New York, NY 10024.

LABEL-BASIC. Designed for the 6800, this language acts as a pre-processor to translate programs written in LABEL-BASIC into programs using a BASIC interpreter or compiler. As an extension of BASIC, it also provides the capability of descriptive line labels and variable names. Because line numbers can be matched, programs built from LABEL-BASIC subroutines can be appended to the main program. This procedure is similar to loading FORTRAN subroutines from a library, although using an editor at source code level is not required. The language is available for 6800-based Chieftain computers and SSB disk systems and costs $59.95. Smoke Signal Broadcasting, 31336 Via Colinas, Westlake Village, CA 91361 (Tel: 213-889-9340).

Apple Stuff. A catalog of 50 Apple II programs includes business accounting, accounts receivable, inventory, BASIC teaching and other special business programs. The applications support disk or tape systems and are available in both Apple BASICs. Charles Mann and Associates, Micro Software Division. 1926 South Veteran Ave., Los Angeles, CA 90025 (Tel: 213-473-0244).

TRS-80 Mail List. MAILROOM PLUS is a record keeping and mail-list program written for the TRS-80. Record size can be from 1 to 255 characters, and there is no need to specify field dimensions. It can sort 500 records by category number, zip code, or last name. A standard TRS-80 diskette (with DOS) will hold approximately 2000 records. The program will selectively search, display or print records. Print option will output in either tabular form or mailing labels. Any part of a record can be used as a search code. Thus, records can be displayed or printed by states, zip codes, names, cities or categories. Large files can be selectively separated and saved as smaller files by state or any portion of the zip code. Small files can be merged to create one large file. The program requires 32K of memory and one or more disk drives. The program is supplied on diskette for $49.95. The Peripheral People, Box 524, Mercer Island, WA 98040.

6800 Programs. A considerable number of 6800-based software packages including many games, text editors, assemblers and disassemblers, and de-bug programs are among the many offered by catalog. Technical System Consultants, Inc., Box 2574, W. Lafayette, IN 47906 (Tel: 317-463-2502).

TRS-80 Programs. A very complete line of TRS-80 programs with a broad variety of games, financial programs, chess, languages, statistics, ham radio plus a listing of hardware accessories. Catalog available from TRS-80 Software Exchange, 17 Briar Cliff Drive, Milford, NH 03055 (Tel: 603-673-5144).

Apple Assembler/Text Editor. The ASM/ED complements the facilities provided by the Apple monitor routines. It allows you to enter assembly language programs, edit them and assemble them into memory. the editor is line-numbered and allows adding new lines, deleting lines, resequencing line numbers, text listing, locating a line having a specific string, and storing the edited text on tape or disk. The assembler is one-pass (mods are provided for two-pass operation) that accepts free-format input containing labels up to six characters, the complete 6502 opcode set, and a comment field. Multiple source files may be assembled using a common symbol table. The assembler operates on a memory resident source file and produces memory resident object code. The complete package is provided on Apple cassette and requires 16K of RAM. $29.95. Inclu pin shi 114 30 lish

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)-page manual and includes shipping the U.S. Add $4 for first-class utside the U.S. ARESCO, Box olumbia, MD 21044, (Tel: 186). This company also publainbow, an Apple II newsletter.

ssembler/Text Editor. Written 2-based PET, APPLE-II and SYM his software package is written in language and occupies 8K of arting at 2000 hex. It provides 27 , 20 pseudo ops and features conditional assembly support, ext editing commands including aue numbering, string search and ree load/save and append comctors for disc system interface, free sembler source input, source synto MOS Technology specs, and re functions. User manual and ', Apple II, or SYM (HS) cassette pecify) available for $35 plus $2 andling. C. W. Moser, 3239 Linda on-Salem, NC 27106.

oss Assembler. Designed to oper the FLEX disk operating system, -assembler is fully compatible with) and 6809 mnemonics. Existing ce listings can be directly reassemoduce executable 6809 object code. 3801 compatible. All standard mnend directives are supported, as well g messages which may be enabled ssed. Available in binary form on (8") or FLEX 2.0 (5¼") diskette. and disk available for $100 from Systems Consultants, Inc., Box Vest Lafayette, IN 47906 (Tel: -2502).

ftware. Series-One is a collection grams for the 8K PET. There are 16 ncluding Space Wars, Motorcycle aucer Attack, Ping Pong, etc., and 9 programs, including Mortgage Loan, l Calendar, Elementary Math, and Account. $24.95. ADP Systems, 95 0 South, Logan, UT 84321 (Tel: -2770).

rphic Mailist. Designed for a 2-2K System 8813, this program allows to organize information according to irements of the specific mail list. The mat may be organized to store spea associated with the mailing name ress, which may never appear on the nailing label. Not only does the user e the entry format, he also indicates which information is to be printed in der. This allows letter merge. The can also be used as a general data ganizer in which the user defines a ne needs. PolyMorphic Systems, 460 rive, Santa Barbara, CA 93111 (Tel: 7–0468).

O Electric Secretary. Written for S-80 single or multiple disk systems, minimum of 32K or memory, this word sing program features a word hying dictionary. Long words at the end e need not produce large gaps in the When this might occur, the program e user to hyphenate the word which is tored in the dictionary with the correct hyphenation points. The text is then printed, hyphenated and justified. File coupling permits lengthy text without memory overload, and the program is well suited for form letter generation. Available on a formatted disc at $75. Upper/lower case conversion information is free upon request. The Peripheral People, Box 524, Mercer Island, WA 98040.

PET Software. Four new PET programs, each costing $24.95, are now available: ENTRY used as a general-purpose data entry program has user-definable entry format and may be used for a mail list, daily journal, general ledger, record keeping, etc.; PROCESS which is a general-purpose data process program includes SORT, EDIT, DELETE, INSERT and MACRO and is useful for merging large amounts of data from different input sources; DCE TEXT EDITOR/FORMATTER features full-screen editing including cursor movements with repeatable cursor scrolling of pages up and down, and user definable output margins and justification. Programs are written in machine language with 4K bytes free for user text data; and INVENTORY that includes item number, description, quantity on hand, reorder limit and prices. It generates inventory and low inventory reports, and can handle up to 60 items on an 8K PET. Home Computer Centre, 6101 Yonge St., Willowdale, Ontario, Canada M2M 3W2, Canada (Tel: 416–222–1165).

Program Aids for Apple. Programmers Aid #1 package is a ROM-based library of routines whose capabilities include high-resolution graphics, program renumbering and linking, tape verification, tone generation, RAM testing and machine-language relocation. It is designed for use with the Apple II integer BASIC. The high-resolution graphics allow drawing from 53,000 screen locations in one of four colors (black, white, green or violet). Simple BASIC commands can create figure size, orientation and color. Additional commands plot points, clear screen and create background color. The Applelodeon portion uses a note table stored in memory and covers five timbres spanning four octaves. The package costs $50. Apple Computer, Inc., 10260 Bandley Drive, Cupertino, CA 95014, or your local computer store.

PET Workbooks. "Getting Started with Your PET" (WB-1, $3.95) covers PET BASIC, calculator and program modes, data input/ouput, data representation, and cassette storage. "PET String and Array Handling" (WB-2, $3.95) covers string and substring search, concatenation, replacement and manipulation, limitations and features of arrays, subscripted variables and parallel sequences. "PET Graphics" (WB-3, $4.95) covers cursor control and special graphics to create plots, histograms and sketches. "Pet Cassette I/O" (WB-4, $4.95) covers the cassette I/O system. "Miscellaneous PET Features" (WB-5, $3.95) covers clock, random number generation, upper- and lower-case characters, saving memory, etc. "PET Control and Logic" (WB-6, $3.95) covers testing and branching, subroutines, logical operations. Binary-to-decimal and decimal-to-binary programs are used to demonstrate logical operations. All six books for $19.95 plus $1.50 shipping/handling. Total Information Services, Box 921, Los Alamos, NM 87544. ◇

Operation Assist

If you need information on outdated or rare equipment—a schematic, parts list, etc.—another reader might be able to assist. Simply send a postcard to Operation Assist, POPULAR ELECTRONICS, *1 Park Ave., New York, NY 10016. For those who can help readers, please respond directly to them. They'll appreciate it. (Only those items regarding equipment not available from normal sources are published.)*

Solar model CBB capacitor analyzer. Need schematic and operation instructions. Guy Edwords, 104 Hancock, San Francisco, CA 94114.

Lloyds model TJ1 stereo receiver and **Emud** model T7 AM/FM shortwave receiver. Schematic needed. Andy Karpen, 2519 Manning St., Ambridge, PA 15003.

Mathatron power log. Need instruction, operation manual and schematics. W. Kolb, 4610 7th Rd., N., Arlington, VA 22203.

Tektronix model 512 oscilloscope. Need manual and any available information on calibration. Wayne Torrey, 8354 Thunderhead Dr., Boulder, CO 80302.

DeVry Technical Institute model 1-1S oscilloscope. Need schematics and operations manual. Andrew J. Sprull, 624 Lee St., Port Allen, LA 70767.

Delta Graph model EQ-10 octave-band equalizer. Need assembly manual. Edward J. Bawolek, 6912 Young Court, Woodridge, IL 60515.

Kintel Electronic model 204A galvanometer. Need schematic and operations manual. Robb Craig, 16650 Morrison St., Encino, CA 91436.

Unitrex model 14PPMD printing display calculator. Schematic and operation manual needed. Dave Pressman, 1237 Chestnut St., San Francisco, CA 94109.

Western Electric power supply. Need tubes 313C-2A3 and operation manual and schematic. John C. Leonard, R.R.#1, Box 131, Yarmouth, ME 04096.

Sansui ZC-94 CD-4 super demodulator. Need service manual, parts list and test record. JVC CD-4 test record RG 1256, RG 1257 for setting internal variable resistors of a CD-4 demodulator. D.S. Battershill, 5208 Vallance Cres. NW, Calgary, Alberta T3A 0T6 Can.

Grundig model #2083-115 multisonic receiver. Need any service manuals that can be provided. Ken Long, GND Electronics, NAS Miramar, San Diego, CA 92145.

Knight K6-625 VTVM. Need schematic or any available information. Jim Miller, 70 New St., Mercerville, NJ 08619.

Jackson model 648-S tube tester, serial #NR 27341. Need schematic, manual and source of current tube chart. Avery Comarow, 524-B Springvale Rd., Great Falls, VA 22066.

Tektronix model 533A oscilloscope. Need manual and schematic. Ed Juzumas, 88-57 75th St., Woodhaven, NY 11421.

Triplett model 3432-A signal generator. Need operations manual. R. Maslow, 100 Richard St., West Haven, CT 06516.

Mast Development Co., model 725-3C serial # GT 393 strip-chart recorder. Need operating and repair manuals and schematic. Grant Fair, RR. #1, Pickering, Ontario LIV 2P8, Can.

Dumont type 322 serial 1A10 beam cathode-ray oscillograph. Need any information available. Robert Hayes, 1061 Rio Ave., Jensen Beach, FL 33457.

Hallicrafters SX-62 shortwave radio. Need manual, schematic and any other information. Steve Lindberg, 12900 S.E. Division #6, Portland, OR 97216.

Hallicrafters SX-28. Need parts. **Johnson Viking** 6N2 transmitter and **Beckman Instruments Co.**, FR-67 frequency meter. Schematics needed. Harold D. Donaldson, WB6SKV, 8850 Phoenix Avenue, Fair Oaks, CA 95628.

BSR TD 1020 7" tape deck. Need owner's manual and schematics. John E. Jurus, 36 Pembrook Dr., Yonkers, NY 10710.

Precision Apparatus signal generator series #-200-C M1179. Need schematic and operating instructions. Edward H. West, 57 Eastlake, Tuscaloosa, AL 35405.

Ardco Electronics model BC-610 or BC-669 transmitter. Need any information available. Ray Nanney, R1, Box 658, Hardin, KY 42048.

Sanwa Electric Instrument Co., Ltd., model 380-C multimeter manufactured in 1964. Need circuit diagram or address of company. L.R. Hillman, Box 635, Littleton, NC 27850.

Philco model 40-180 code 121 console radio. Need schematic and service manual. R.J. Klaus, 1345 Highland Dr., Carroll, IA 51401.

RCA Victor model 3-BX-671 AM-SW portable. Need schematics and owner's manual. Allen Black, Box 386, N. Myrtle Beach, SC 29582.

Triplett model 3432-A signal generator. Need operating manual. R. Maslow, 100 Richard St., West Haven, CT 06516.

RCA model CTC-5 color TV. Need parts list. **Philco** model 40-180 receiver. Need technical data. Richard Bozeman, 6006 N. Hale Ave., Tampa, FL 33614.

Akai X-2000 cassette open-reel recorder. Need manual and electronic diagram. Fermin Herena, Eulogio Parra #6, Tepic, Nayarit, Mexico.

Marconiphone model T26A radio. Need service manual. Edward H. Joseph, 20701 Reef Lane, Huntington Beach, CA 92646.

Delta Graph model EQ10SP audio graphic equalizer. Need assembly manual. Edward J. Bawolek, 6912 Young Court, Woodridge, IL 60515.

Webcor model #375638 tape recorder. Need schematic. Bob Ausman, 1110 Dary Rd., Havertown, PA 19083.

Lloyds model #D614-07A hi-fi. Need schematic. Don Gross, Rd. #1, Cameron Mills, NY 14820.

Marantz model #26 receiver. Need circuit diagram and service manual. Carlos Peres da Costa, Av. Rui Barbosa 471, Gracas, Recife PE 50.000 Brazil.

Hewlett-Packard model 400H ac voltmeter. Need operating and service manual. Jacques Blais, 1698 9e Ave., Charny, Que. G6W 4H2.

Philco model S8202 oscilloscope. Need schematic. L. Truetken, 10601 Dunkeld Circle, St. Louis, MO 63137.

Sycor, Inc., model 303 key cassette. Need schematics, operating manual or instructions. Jim Cook, 11451 Olson Dr., Garden Grove, CA 92641.

RCA model WO-56A oscilloscope. Need calibration and operation manuals. Bob Brandel, Rose-Hulman Institute of Technology, Box 927, 5500 Wabash, Terre Haute, IN 47803.

Denon model MX-1010 AM/FM record player. Need schematic. M. DaCosta, 5675 No. 8th, Fresno, CA 93710.

Hallicrafters model S-120 receiver. Need schematic, operations manual and alignment data. Shawn Sterling, 12319 Bank Box Pl., Dallas, TX 75234.

Stark model 9-11 tube tester. Schematic and operations manual needed. Russell Campbell, Box 141, Thessalon, Ontario, Can. P0R 1L0.

Solar model CE capacitor tester. Need operations manual. D. G. Daube, 912 Lebanon Ave., Castle Shannon, PA 15234.

Starkit model 5A-2 AM radio. Need operations manual. Fred R. Woeppel, Box 1653, Edson, Alberta, Can. T0E 0P0.

Telequipment model S 51A oscilloscope. Need schematic and owners manual. Gianni Restaino, 5811 South Moody, Chicago, IL 60638.

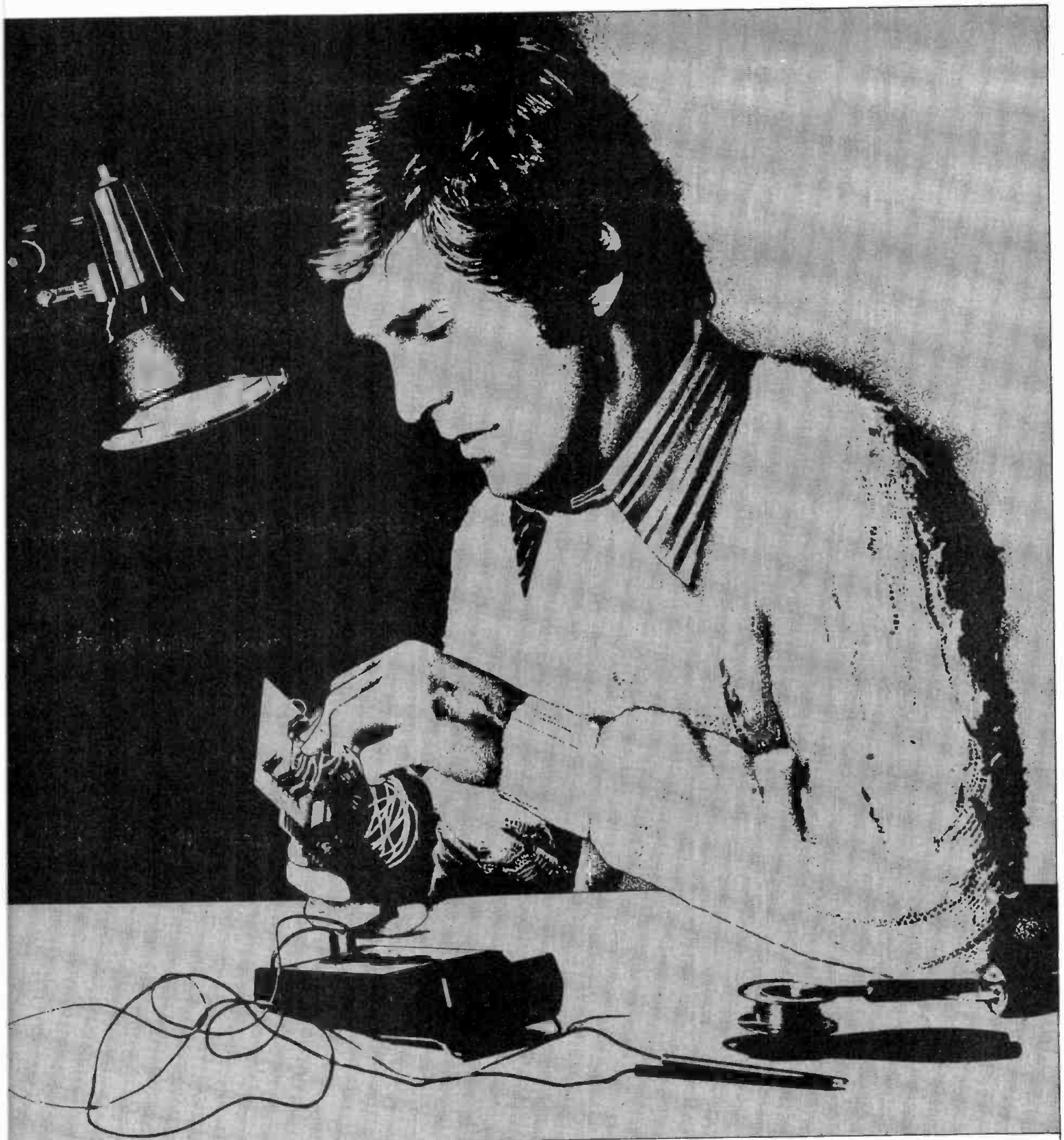
BP Radio Equipment type CFN-46ADT rf to if converter. Need any available information. James O. Dickinson, W4LLF, 1408 Monmouth Court West, Richmond, VA 23233.

Bullet Electronics model PS-14 power supply. Need schematics and parts list. David G. Mason, 66 Mint Circle, Middleburg, FL 32068.

AN/USM-32 oscilloscope. Need schematics, service manuals or USAF technical order 33A1-13-52-1. Wayne A. Murningham, 3101 Portage Blvd, Apt. 6, Fort Wayne, IN 46804.

Instrument Electronics model 53-1 VTVM. Need instruction manual, schematic or any available information. J. Dunlap, 325 N. Ridgeland Ave., Oak Park, IL 60302.

Precision model #400 generator. Need operation manual. Ken Miller, 10027 Calvin St., Pittsburgh, PA 15235.



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TIME[1] CDT	TIME UTC/GMT	STATION	QUAL.[2]	FREQUENCIES, kHz[3]
4:00-4:15 a.m.	0900-0915	BBC	A	11955, 9640, 9510, 6195
4:00-4:15 a.m.	0900-0915	R. Japan[4]	B	9505
4:00-5:30 a.m.	0900-1030	R. Australia	B	9670
4:15-6:00 a.m.	0915-1100	BBC	B	17790, 17695
4:30-5:30 a.m.	0930-1030	V. of Germany	B	17780
5:00-5:05 a.m.	1000-1005	UN Radio	A	9565, 5955 (Tue-Sat.)
5:00-5:30 a.m.	1000-1030	R. Japan	B	9505
5:00-5:30 a.m.	1000-1030	R. Korea	C	11725, 9580 (frequent changes)
5:00-5:30 a.m.	1000-1030	V. of Vietnam	C	12035, 10040, 9840
5:00-fade out	1000-	R. Australia	B	5995
5:00-6:00 a.m.	1000-1100	AFRTS	A	6030
5:00-8:00 a.m.	1000-1300	R. Moscow (via Cuba)	A	9600
5:00-11:02 a.m.	1000-1602	ABC, Perth	B	9610
5:30-6:30 a.m.	1030-1130	Sri Lanka Br. Corp.	C	17850, 15120, 11835 (not all Eng.)
5:30 a.m.-6:00 p.m.	1030-2300	CBC Northern Service	B	9625 6065, (not all Eng.)
5:55-6:55 a.m.	1055-1155	R. Thailand	C	11905, 9655
6:00-6:15 a.m.	1100-1115	R. Japan	B	9505
6:00-6:56 a.m.	1100-1156	R. RSA	C	25790, 21535
6:00-7:45 a.m.	1100-1245	TWR-Bonaire	A	15225 (Sat-1330, Sun-1415)
6:00-7:50 a.m.	1100-1250	R. Pyongyang	C	9977
6:00-8:00 a.m.	1100-1300	R. Australia	A	9580
6:00-8:30 a.m.	1100-1330	BBC	A-B	25650, 21710, 21660, 21550, (11775, 1100-1130 + 1300-1330 only) 11750, 9510, 6195
6:00-9:00 a.m.	1100-1400	4VEH, Haiti	B	11835, 9770
6:00-9:00 a.m.	1100-1400	AFRTS	A	15430, 15330, 11805, 9700
6:00-9:00 a.m.	1100-1400	VOA	A	11715, 9730, 9565, 5955
6:30-6:45 a.m.	1130-1145	R.R.I. Yogyakarta	C	5046
7:00-7:15 a.m.	1200-1215	Vatican R.	B	21485
7:00-7:15 a.m.	1200-1215	R. Japan	B	9505
7:00-7:30 a.m.	1200-1230	Kol Israel	C	25625, 21495, 17685, 17565
7:00-7:30 a.m.	1200-1230	R. Tashkent	C	15460, 15125, 11925, 11730
7:00-7:45 a.m.	1200-1245	V. of Germany	B	21600, 17875, 17765, 15410
7:00-7:45 a.m.	1200-1245	R. Berlin International	C	21540, 21465, 17700, 15165
7:00-7:55 a.m.	1200-1255	R. Peking	C	11685
7:00-8:00 a.m.	1200-1300	HCJB, Ecuador	A	15115, 11740
7:15-7:30 a.m.	1215-1230	V. of Greece	B	21655, 17785, 11730
7:20-7:50 a.m.	1220-1250	R. Ulan Bator, Mongolia	D	12070, 9575 (not Sun)
7:30-7:55 a.m.	1230-1255	Austrian R.	C	17860 (frequent changes)
7:30-7:55 a.m.	1230-1255	R. Tirana	C	11965, 9515
7:30-8:00 a.m.	1230-1300	R. Sweden	C	21690, 21635
7:30-8:00 a.m.	1230-1300	BBC (English by radio)	B	21695
8:00-8:15 a.m.	1300-1315	R. Japan	B	9505
8:00-8:30 a.m.	1300-1330	R. Finland	C	15400
8:00-9:00 a.m.	1300-1400	R. Australia	B	9770
8:00-10:50 a.m.	1300-1550	R. RSA	B	25790, 21535, 15220
8:00-9:30 a.m.	1300-1430	HCJB, Ecuador	B	17890, 15115, 11740
8:00 a.m.-6:00 p.m.	1300-2300	CBC Northern Service	B-C	11720, 9625 (not all English)
8:15-8:45 a.m.	1315-1345	Swiss R. International	C	21570, 21545-SSB, 21520
8:30-9:30 a.m.	1330-1430	R. Finland	C	15400 (Sun. only)
8:30-10:00 a.m.	1330-1500	All India R.	C	15335, 11810
8:30-11:00 a.m.	1330-1600	BBC	B-C	25650, 21710, 21660, 21550, 15400 (from 1430), 15070
8:30 a.m.-5:00 p.m.	1330-2200	R. Moscow (via Cuba)	A	11840
9:00-9:30 a.m.	1400-1430	R. Japan	B	9505
9:00-9:30 a.m.	1400-1430	R. Sweden	B	21615
9:00-9:30 a.m.	1400-1430	R. Norway	B	21730, 17840 (Sun only)
9:00-9:30 a.m.	1400-1430	V. Rev. Party, N. Korea	D	4557, 4109
9:00-9:30 a.m.	1400-1430	R. Tashkent	C	15460, 15125, 11925, 11730
9:00-9:45 a.m.	1400-1445	R. Berlin International	C	21540, 21465, 17700
9:00-10:00 a.m.	1400-1500	VOA	A	11715, 9565
9:00-10:00 a.m.	1400-1500	V. of Indonesia	C	15200, 11789
9:00-11:00 a.m.	1400-1600	AFRTS	A	15430, 15330, 11805, 9770
9:00 a.m.-12:30 p.m.	1400-1730	R. Australia	B	11880, 9770
9:30-10:00 a.m.	1430-1500	R. Finland	B	15400, 17785
9:30-10:25 a.m.	1430-1525	R. Nederland	B	21480, 17855
9:30-11:00 a.m.	1430-1600	HCJB, Ecuador	A	17890, 15115
9:30-11:00 a.m.	1430-1600	Burma Br. Ser.	D	5985, 5040
9:30 a.m.-5:00 p.m.	1430-2200	UN Radio	A	21670, 15410 (also French; when in session)
10:00-10:15 a.m.	1500-1515	R. Japan	C	9505
10:00-11:00 a.m.	1500-1600	V. of Rev. Ethiopia	D	9560
10:00-11:00 a.m.	1500-1600	BBC	B	17830, 11775 (Sat, Sun)
10:15-10:30 a.m.	1515-1530	V. of Greece	B	21455, 17830, 11730 (last two, not Tues.)
10:30-11:00 a.m.	1530-1600	R. Afghanistan	D	4775
10:30-11:00 a.m.	1530-1600	R. Yugoslavia	C	15300, 15240
10:30-11:00 a.m	1530-1600	Swiss R. International	B	21570
10:30-11:15 a.m.	1530-1615	NSB, Tokyo	C	9595, 6055 (exc Sun)
10:30-11:30 a.m.	1530-1630	V. of Vietnam	C	15012, 14990, 10040
10:45-11:00 a.m.	1545-1600	R. Canada International	A	21695, 17820, 15325 (Mon-Fri only)

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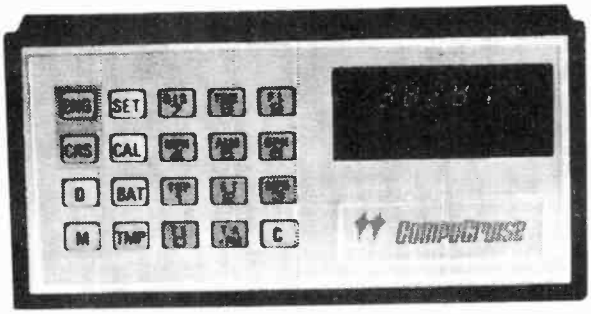
;reakthrough

This amazing new, yet thoroughly tested, car computer performs 44 different functions as simply as touching a button; and mounts easily in or on the dashboard of your car.



The command module is 3" x 6" x 1-3/16". Backlighted keyboard and bright 5-digit blue florescent display make night operation easy.

ur evaluating team looks at hun- ; of new products each year and on one they told us: "It's the most :ing product we've ever seen!" We ; with the engineers . . . the Compu- .e is an amazing on-board computer gives you up to the minute infor- on. Easy to operate and easier still ıstall with 44 functions at your fin- ps. The Compucruise does so much ad to put the features in catagories. ruly amazing.

:L MANAGEMENT: The most im- ant of the 44 functions available Compucruise is its ability to give up to the moment fuel management rmation. With push-button ease you miles per gallon, gallons per hour average fuel use for the entire trip. "distance to empty" function lets know exactly how many miles you be able to travel on the fuel pre- ly in your tank. Imagine knowing ctly how far you can go on the fuel have. As an informational feature can also know distance traveled and used since last fill-up or amount of left in tank. With Compucruise you know the most efficient speed at ch to travel, the most efficient brand grade of fuel for your car, the effect various brands, types and pressures of on fuel efficiency and when tune- are needed.

ME: With your Compucruise in- led, you have all the regular time ctions of a quartz digital clock accu- e to within 30 seconds per month. A lt-in alarm can be set for up to 24 urs in advance. Did you ever wonder the short cut saves time or fuel? By rging distance, time and fuel use in- mation, Compucruise can make your omobile trips (whether to the office cross country) much more enjoyable. at's right, you can now plan your trip ht to the minute based on rate of ed and distance to be traveled. The mpucruise time feature also gives you e length of time that you can travel the fuel presently in your tank, time ent on the trip thus far and time to ival at your destination. There's also elapsed time function that you reset the touch of a button.

'EED: Since speed is nothing more an a function of distance and time, ompucruise offers accurate speed aintenance and control. Simply cali- ate it by driving a known distance etween mile markers on a federal ghway for instance). You will now have the most accurate speedometer available flashing your speed digitally and automatically taking into considera- tion tire size and pressure. With a touch of a button you can observe your aver- age speed on the trip.

CRUISE CONTROL: With the cruise control feature you can take speed maintenance one step further. Just set the computer to engage at a specific speed or allow it to engage at your pre- sent speed. If you wish to increase your speed, simply touch the "cruise" button and your speed will increase in incre- ments of two miles per hour. A touch of the brake takes you out of cruise. To re-engage, simply push the "cruise" button again and the car will return to the pre-programed speed.

TEMPERATURE: Two temperature sensors come with this unit. Mount one inside the car and one outside and you will be able to read either temperature in degrees, Fahrenheit or Celsius. Or mount one sensor inside the radiator and monitor coolant temperature and you will have the most accurate infor- mation available to prevent overheating.

HOW IT WORKS

Space age technology makes it possi- ble to install Compucruise as easily as any traditional cruise control device. A strip of four magnets installed around the drive shaft together with a magnetic sensor switch supplies information to the computer for speed and distance functions. The fuel sensor is easily in- stalled into the rubber fuel line. All adaptors and hose fittings are supplied. Vacuum sensors are mounted close to the carburetor for the optional cruise control feature. Temperature sensors can be installed wherever you wish to monitor temperature. Simply hook up to the car's 12 volt battery and you're ready to go...OR...easiest of all, take Compucruise to any service station and have the mechanic install it.

NOTE: Compucruise will not work on fuel injection or diesel engines. A model for diesel and fuel injection engines will be in production later this year.

THE 44 FUNCTIONS

. . . time of day - elasped time - stop watch - trip driving time - time to arrival - time to empty - alarm - miles or kilo- meters traveled since fill-up - miles or kilometers traveled on trip - miles or ki- lometers to arrival - miles or kilometers to empty - gallons or liters of fuel used since fill-up - gallons or liters of fuel used on trip - gallons or liters of fuel to arrival - gallons or liters of fuel to empty - miles or kilometers per hour (current) - average miles or kilometers per hour for trip - current gallons or liters of fuel used per hour - average gallons or liters used on trip - current fuel efficiency in miles per gallon or kilometers per liter - average fuel efficiency for trip in miles per gallon or kilometers per liter - inside and outside (or coolant) temperature in degrees Fahrenheit or Celsius - battery voltage - cruise control - night time dis- play dimming . . .

HUMAN ENGINEERED: The Compu- cruise has back-lit buttons that are easy to read at night and a florescent display that can be seen easily in the day-time and can be dimmed to eliminate night- time distractions. Each button is marked to indicate function, for exam- ple "Dist" for distance and "TE" for "to empty". A few minutes and you'll be familier with your Compucruise. If you do make an error, the display will read "Error" and the alarm will buzz. Simple, isn't it!

TRY IT NOW

You could wait until automobile makers include all 44 computer func- tions as standard features on new cars. Or, if you want to start driving with full knowledge of car and fuel efficiency, time management and the convenience of cruise control, order your Compu- cruise now. Also if you're not 100% sat- isfied and agree that this is the most useful and practical automotive acces- sory since the foot brake, return the complete unit within 30 days for a full refund.

Complete computer with cruise con- trol and all parts necessary for installa- tion is only **$199.00**. If your car is al- ready equipped with cruise control, the computer alone (with installation acces- sories) is available for **$159.00**. Add $3.50 for shipping and handling. You can send a check or charge it to your Master Charge, VISA or American Ex- press account. Don't delay the conven- ience and enjoyment of driving with knowledge. Give us a call at 414/377-5050 or send your order to:

ECHO®

ECHO COMMUNICATIONS, INC.
One Echo Plaza Cedarburg, WI 53012
OR CALL: 1 (414) 377-5050

Phone toll free, 800-558-5151

CIRCLE NO. 63 ON FREE INFORMATION CARD

11:00-11:15 a.m.	1600-1615	R. Japan	C	9505
11:00-11:15 a.m.	1600-1615	R. Pakistan	C	21755, 21595, 21485, 17665, 17640
11:00-11:30 a.m.	1600-1630	R. Korea	C	11830, 9720
11:00-11:30 a.m.	1600-1630	R. Norway	8	17755, 15175 (Sun only)
11:00-12:00 a.m.	1600-1700	VOA	A	26040, 21485, 17870, 17710, 15445, 15410
11:00 a.m.-12:45 p.m.	1600-1745	BBC	B	21710, 21550, 17880, 17830, 11775
11:00 a.m.-1:00 p.m.	1600-1800	AFRTS-Washington	A	17765, 15430, 15330, 11805
11:05-11:55 a.m.	1605-1655	R. France International	B	21705, 21595, 21580, 17860, 17850, 17720 (1705-1755 from October)
11:10-11:55 a.m.	1610-1655	8RT, Belgium	C	21475, 17745(frequent changes) (1710-1755 from October)
00:00-11:30 a.m.	-1630	R. Singapore	C	11940 (fade-in time varies)
11:45-12:00 a.m.	1645-1700	R. Canada International	A	21695, 17820, 15325
12:00-12:15 p.m.	1700-1715	R. Japan	C	9505
12:00-12:15 p.m.	1700-1715	Vatican R.	B	17900
12:00-12:30 p.m.	1700-1730	R. Pakistan	C	15470, 11675
12:00-1:00 p.m.	1700-1800	HCJ8, Ecuador	B	21480, 17825 (frequent changes)
12:00-1:00 p.m.	1700-1800	VOA	A	26040, 21590, 21485, 17870, 17710, 15445, 15410, 15195
12:45-3:00 p.m.	1745-2000	BBC	C	15400, 15070, 12095 (11820 from 1800)
12:45-5:30 p.m.	1745-2230	All India R.	C	11620
1:00-1:15 p.m.	1800-1815	R. Japan	B	9505
1:00-1:30 p.m.	1800-1830	R. Canada Interhational	B	17820, 15260
1:00-1:30 p.m.	1800-1830	R. Norway	C	15175 (Sun only)
1:00-1:45 p.m.	1800-1845	R. Korea	C	15255, 11830
1:00-2:00 p.m.	1800-1900	V. of Revolution, Guinea	B	15308, (varies) (Mon, Wed, Fri; Sunday 1815-1900)
1:00-2:00 p.m.	1800-1900	V. of Nigeria	C	15119, 15185
1:00-3:00 p.m.	1800-2000	R. Australia	C	11800
1:00-4:00 p.m.	1800-2100	R. Kuwait	C	11690 (frequent changes)
1:00-5:00 p.m.	1800-2200	AFRTS-Washington	A	21570, 17765, 15430, 15330, 11790
1:00-5:00 p.m.	1800-2200	VOA	A	26040, 21590, 21485, 17870, 17785, 17710, 15445, 15410, 15250, 15140
1:15-1:45 p.m.	1815-1845	Swiss R. International	C	21585
1:15-2:15 p.m.	1815-1915	R. Bangladesh	0	15285, 11765 (both vary, freq. changes)
1:30-1:35 p.m.	1830-1835	UN Radio	A	21670, 19505-SSB, 15410 (Mon-Fri)
1:45-2:15 p.m.	1845-1915	Sri Lanka Br. Corp.	C	17850, 15120, 15115, 11870
1:45-3:00 p.m.	1845-2000	R. Ivory Coast	C	11920
2:00-2:10 p.m.	1900-1910	R. Tahiti	C	15170, 11825 (exc Sun)
2:00-2:15 p.m.	1900-1915	R. Japan	C	15270
2:00-2:30 p.m.	1900-1930	R. Canada International	A	21695, 17750, 15325
			B	17820, 15260
2:00-2:30 p.m.	1900-1930	R. Afghanistan	C	15075 (frequent changes)
2:00-3:00 p.m.	1900-2000	B.S.K. Saudi Arabia	C	11855
2:00-3:00 p.m.	1900-2000	HCJB, Ecuador	C	21480, 17765, 15420 (freq. changes)
2:45-4:10 p.m.	1945-2110	R. Free Grenada	C	15104 (time varies)
3:00-3:15 p.m.	2000-2015	R. Japan	B	15270
3:00-3:30 p.m.	2000-2030	V. of Iran	C	9139 or 9022 (frequent changes)
3:00-3:30 p.m.	2000-2030	R. Algeria	C	11633, 9510
3:00-3:30 p.m.	2000-2030	R. Canada International	A	21695, 17820, 17750, 15325
3:00-3:30 p.m.	2000-2030	Kol Israel	B	17645, 15415, 11655
3:00-4:15 p.m.	2000-2115	BBC	A	21710, 17840, 15260, 15070, 6175
3:10-4:40 p.m.	2010-2140	R. Habana Cuba	A	17855
3:30-4:20 p.m.	2030-2120	R. Nederland	B	21640, 17695, 17605, 11740, 11730
3:30-4:30 p.m.	2030-2130	V. of Vietnam	C	15012, 10040
3:50-4:40 p.m.	2050-2140	R. Habana Cuba	C	17750, 9770
4:00-4:15 p.m.	2100-2115	R. Japan	B	15270
4:00-4:50 p.m.	2100-2150	R. RSA	B	21535, 17780, 15155
4:00-5:00 p.m.	2100-2200	V. of Nigeria	C	15185, 15119
4:00-6:00 p.m.	2100-2300	CBC Radio	A	17820, 15325 (Mon-Fri)
4:15-5:00 p.m.	2115-2200	BBC	A	21710, 15420, 15260, 15070, 11750, 6175
4:15-7:00 p.m.	2115-2400	R. Free Grenada	B	15045 (time varies)
4:30-5:00 p.m.	2130-2200	R. Canada International	A	17750, 15150, 11945 (Sat & Sun also 17820, 15325)
4:30-5:00 p.m.	2130-2200	KGEI, San Francisco	C	15280
4:30-5:00 p.m.	2130-2200	HCJB Ecuador	C	21480, 17765, 15295 (frequent changes)
4:30-5:00 p.m.	2130-2200	R. Sofia	B	15135, 11750 (frequent changes)
4:30-5:30 p.m.	2130-2230	R. Baghdad	C	9745
4:30-6:00 p.m.	2130-2300	V. of Turkey	C	11955, 11880, 9515, 7170
4:40-5:40 p.m.	2140-2240	V. of Free China	C	17890, 15345, 11745
5:00-5:15 p.m.	2200-2215	R. Yugoslavia	C	9620
5:00-5:15 p.m.	2200-2215	R. Japan	C	17755
5:00-5:30 p.m.	2200-2230	R. Nacional, Venezuela	B	15400 (irregular)
5:00-5:30 p.m.	2200-2230	R. Norway	C	17795, 15345 (Sun only)
5:00-5:45 p.m.	2200-2245	BBC	A	21710, 15420, 15260, 15070, 6175, 6120
5:00-6:00 p.m.	2200-2300	VOA	A	26040, 21485, 17870, 17710, 15445, 15410, 15250
5:00-7:00 p.m.	2200-2400	CBC Southern Service	B	9755, 5960 (Mon-Fri) (2300-0100 from Oct. 29)
5:00-7:00 p.m.	2200-2400	AFRTS—Washington	A	21570, 17765, 15430, 15330, 11790
9:30-6:00 p.m.	2230-2300	Kol Israel	A	17815, 15300, 12085, 11655, 9815
5:45-6:00 p.m.	2245-2300	BBC	A	15420, 15260, 15070, 9410 6175, 6120
5:45-6:00 p.m.	2245-2300	SODRE, Uruguay	C	11885, 9515 (time varies)
5:45-6:00 p.m.	2245-2300	UN Radio	A	15225, 11920 (Mon-Fri)
6:00-6:30 p.m.	2300-2330	R. Japan	C	17755
6:00-6:30 p.m.	2300-2330	R. Korea	C	15570, 15385, 15345 (frequent changes)
6:00-6:30 p.m.	2300-2330	R. Sweden	C	15275, 11705
6:00-6:30 p.m.	2300-2330	R. Vilnius	B	17870, 15525, 15405, 15180, 11790, 11735

p.m.	2300-2350	Rdif. Argentina	C	11710 (Mon-Fri)
p.m.	2300-2400	VOA	A	26095, 21610, 21460, 17895, 17820
p.m.	2300-2400	FEBC, Philippines	C	15450
p.m.	2300-2400	4VEH, Haiti	B	11835, 9770
p.m.	2300-2400	R. Moscow	A	21560, 17760, 17700, 15425, 12050, 12030, 11960, 11780, 11770, 11750, 9600
p.m.	2300-2430	BBC	A	15420, 15260, 15070, 11910, 9590, 9580, 9410, 7325, 6175, 6120
p.m.	2300-2450	R. Pyongyang	C	9977
p.m.	2300-0200	RTVD, Dom. Rep.	B	9505 (not all Eng.)
-1:06 a.m.	2300-0506	CBC Northern Service	B	9625, 6195 (not all English)
p.m.	2305-2320	Austrian R.	C	12015, 9770, 5945 (Sun only)
p.m.	2330-2400	R. Finland	B	15270, 11755 (frequent changes)
5 p.m.	2345-2445	R. Japan	B	17825, 15270
5 p.m.	0000-0015	R. Japan	C	17755
5 p.m.	0000-0025	R. Tirana	B	9750, 7065
0 p.m.	0000-0030	R. Norway	C	11860, 9605 (Mon only)
0 p.m.	0000-0030	R. Canada International	A	9755, 5960 (thru Oct. 28 only)
5 p.m.	0000-0055	R. Peking	B	17680, 15520, 15115
0 p.m.	0000-0100	VOA	A	21460, 17895, 17820, 15205, 11740, 9650, 6130
0 p.m.	0000-0100	R. Sofia	B	9705 or 15330
0 p.m.	0000-0200	R. Luxembourg	C	6090
0 p.m.	0000-0200	R. Moscow	A	21560, 17760, 17700, 15425, 12050, 11960, 11780, 11770, 11750, 9600, 9530
:00 p.m.	0000-0500	FEBC Philippines	C	17810
55 p.m.	0005-0155	Spanish Foreign R.	B	11880, 9630
30 p.m.	0015-0030	V. of Greece	B	11730, 9655, 9515
00 p.m.	0015-0100	BRT, Belgium	B	15175, 11715
50 p.m.	0030-0050	SODRE, Uruguay	C	11885, 9515 (time varies)
00 p.m.	0030-0100	R. Sweden	C	15290
00 p.m.	0030-0100	R. Prague	C	9630, 6055
00 p.m.	0030-0100	R. Kiev	B	17870, 15405, 15180, 15525, 11735, 9800
00 p.m.	0030-0100	La Cruz del Sur, Bolivia	D	4875 (Mon only)
00 p.m.	0030-0200	HCJB, Ecuador	A	15265
:30 p.m.	0030-0230	BBC	A	15260, 15070, 11910, 11750, 9580, 9410, 7325, 6175, 6120, 5975
2:00 p.m.	0030-0500	HCJB, Ecuador	B	11915, 9745
:35 p.m.	0050-0135	TWR-Bonaire	B	11925
:15 p.m	0100-0115	R. Japan	C	17755
:15 p.m.	0100-0115	Vatican R.	B	11845, 9605, 6015
:20 p.m.	0100-0120	RAI, Italy	B	11800 and 15315 or 9575
:30 p.m.	0100-0130	R. Canada International	A	17820, 9615, 5960
:45 p.m.	0100-0145	R. Berlin International	C	11970, 9730
:55 p.m.	0100-0155	R. Prague	B	11990, 9740, 9540, 7345, 5930
:55 p.m.	0100-0155	R. Peking	B	17680, 15520, 15115
:00 p.m.	0100-0200	VOA	A	15205, 11740, 9650, 6130
:00 p.m.	0100-0200	V. of Free China	C	17890, 15345, 15270
0:30 p.m.	0100-0330	R. Australia	B	21740, 17795
11:30 p.m.	0100-0430	AFRTS-Washington	A	21570, 17765, 15430, 9685, 6030
11:50 p.m.	0100-0450	R. Habana Cuba	A	11930, 11725
12:00 p.m.	0100-0500	WYFR, Family Radio	A	9715
9:30 p.m.	0115-0230	R. Free Grenada	B	15104 (irregular, time varies)
8:50 p.m.	0130-0150	V. of Germany	A	11865, 9605, 9565, 9545; 6145 6100, 6085, 6040
8:55 p.m.	0130-0155	Austrian Radio	B	9770, 5945
8:55 p.m.	0130-0155	R. Tirana	B	9750, 7120
9:00 p.m.	0130-0200	R. Budapest	B	17710, 15225, 11910; 9835, 9585, 6105 (Wed, Fri only)
9:25 p.m.	0130-0225	R. Bucharest	C	15380, 11940, 11840, 11735, 9690, 9570, 5990
-9:30 p.m.	0130-0230	R. Japan	C	21640, 17825, 17725, 15270
-9:15 p.m.	0145-0215	Swiss R. International	B	15305, 11715, 9725, 6135
-9:15 p.m.	0200-0215	R. Japan	C	17755
-9:25 p.m.	0200-0225	R. Warsaw	C	15120, 11815, 9525, 7270, 7145, 6135, 6095
-9:30 p.m.	0200-0230	R. Canada International	A	11940, 9615, 5960
-9:30 p.m.	0200-0230	R. Norway	B	11870, 11860, 9610 (Mon only)
-9:30 p.m.	0200-0230	R. Budapest	B	17710, 15225, 11910, 9835, 9585, 6105 (not Mon)
-9:50 p.m.	0200-0250	R. RSA	B	15220, 11900, 9610, 9585
0-9:55 p.m.	0200-0255	R. Peking	B	17855, 17680, 15115
0-10:00 p.m.	0200-0300	R. Moscow	A	21560, 17760, 17700, 15225, 12050, 11960, 11780, 11770, 11750, 9700, 9685, 9600, 9530
0-10:30 p.m.	0200-0330	R. Cairo	B	12050, 9475
5-9:30 p.m.	0215-0230	V. of Greece	B	11730, 9655, 9515
0-9:45 p.m.	0230-0245	R. Pakistan	C	21590, 17830
0-9:55 p.m.	0230-0255	R. Tirana	B	9750, 7120
0-10:00 p.m.	0230-0300	R. Lebanon	C	15285 (frequent changes)
0-10:00 p.m.	0230-0300	R. Sweden	C	11705, 9695
0-10:15 p.m.	0230-0315	R. Berlin International	C	11970, 9730
0-10:25 p.m.	0230-0325	R. Nederland	A	9590, 6165
0-10:30 p.m.	0230-0330	BBC	A	15070, 11910, 11750, 9580, 9410, 7325, 6175, 6120, 5975
0-11:00 p.m.	0250-0400	TIFC, Costa Rica	B	5055
00-10:15 p.m.	0300-0315	R. Japan	C	17755
00-10:15 p.m.	0300-0315	Austrian Radio	C	9770, 5945 (Sun only)
00-10:25 p.m.	0300-0325	R. Warsaw	C	15120, 11815, 9525, 7270, 7145, 6135, 6095
00-10:30 p.m.	0300-0330	R. Canada International	A	11940, 11845, 9560, 9535, 5960
00-10:30 p.m.	0300-0330	R. Portugal	B	11935, 6025 (Mon -0320)

10:00-10:30 p.m.	0300-0330	R. Budapest	B	17710, 15225, 11910, 9835, 9585, 6105
10:00-10:30 p.m.	0300-0330	R. Kiev	B	17870, 15405, 15180, 11920, 11735, 9800, 9655
10:00-10:30 p.m.	0300-0330	R. Australia	C	15260 (Fri. only)
10:00-10:50 p.m.	0300-0350	V. of Free China	C	17890, 15345
10:00-10:55 p.m.	0300-0355	R. Prague	B	11990, 9740, 9540, 7345, 5930
10:00-10:55 p.m.	0300-0355	R. Peking	B	17680, 15300, 12055, 11685
10:00-11:00 p.m.	0300-0400	RAE, Argentina	C	9690 (Tue-Sat)
10:00-11:00 p.m.	0300-0400	Radiobras, Brazil	A	15290
10:00-11:00 p.m.	0300-0400	R. Baghdad	C	11935
10:00-11:00 p.m.	0300-0400	R. Moscow	B	17760, 17700, 12050, 11960, 11770, 11750, 11720, 9710 (from 0330), 9700, 9685, 9600, 9530
10:00-11:15 p.m.	0300-0415	R. Uganda	B	15325
10:00-11:26 p.m.	0300-0426	R. RSA	B	15220, 11900, 9585, 7270, 5980
10:00-11:30 p.m.	0300-0430	R. Cultural, Guatemala	B	3300
10:00 p.m.-2:30 a.m.	0300-0730	VOA	A	17865, 15245, 9670, 5995
10:30-10:55 p.m.	0330-0355	R. Tirana	B	7300, 6200
10:30-10:55 p.m.	0330-0355	Austrian Radio	C	9770, 5945
10:30-11:00 p.m.	0330-0400	R. Australia	B	17795
10:30-11:15 p.m.	0330-0415	R. Berlin International	B	11970, 11890, 11840
10:30-11:45 p.m.	0330-0445	BBC	A	11910 (to 0430), 9410, 6175, 5975
10:30-12:00 p.m.	0330-0500	R. Tanzania	D	15435
10:30 p.m.-1:00 a.m.	0330-0600	R. Habana Cuba	A	11760
10:51-10:58 p.m.	0351-0358	V. of Yerevan	C	17870, 15535, 15405, 15180 (Sun, Wed, Thu, Sat)
11:00-11:15 p.m.	0400-0415	R. Japan	C	17755
11:00-11:15 p.m.	0400-0415	R. Budapest	B	17710, 15225, 11910, 9835, 9585, 6105 (Wed & Sat) (Mon-0430)
11:00-11:30 p.m.	0400-0430	R. Bucharest	C	15380, 11940, 11840, 11735, 9690, 9570, 5990
11:00-11:30 p.m.	0400-0430	R. Canada International	A	11845, 9560, 9535, 5960
11:00-11:30 p.m.	0400-0430	R. Norway	B	11860, 9645 (Mon only)
11:00-11:45 p.m.	0400-0445	R. Korea	C	15570, 11820
11:00-11:55 p.m.	0400-0455	R. Peking	B	17680, 15300, 12055, 11685
11:00-12:00 p.m.	0400-0500	R. Moscow	B	17760, 15180, 12030, 12000, 11720, 9730, 9710
11:00-12:00 p.m.	0400-0500	R. Australia	B	17795, 15320
11:30-11:55 p.m.	0430-0455	Austrian R.	B	15260
11:30-12:00 p.m.	0430-0500	Swiss R. International	B	15305 (SSB), 11715, 9725
11:30-12:00 p.m.	0430-0500	R. Sofia	B	11750 (frequent changes)
11:30 p.m.-2:00 a.m.	0430-0700	AFRTS-Washington	A	17765, 15430, 9755, 6030
11:45 p.m.12:45 a.m.	0445-0545	BBC	A	9510, 6175, 5975
11:55 p.m.-1:30 a.m.	0455-0630	V. of Nigeria	C	15185, 15120, 7255
12:00-12:15 a.m.	0500-0515	Kol Israel	B	17815, 15485, 15105, 11655
12:00-12:15 a.m.	0500-0515	R. Japan	C	15270
12:00-12:30 a.m.	0500-0530	R. Portugal	B	11935, 6025 (Mon -0520)
12:00-1:00 a.m.	0500-0600	R. Australia	C	21680, 17890, 17870, 17725, 15240
12:00-2:00 a.m.	0500-0700	HCJB, Ecuador	B	11915, 9745, 6095
12:00-3:00 a.m.	0500-0800	R. Moscow	B	12050, 12030, 12000, 11750 (from 0600), 11720, 9730, 9710
12:15-1:15 a.m.	0515-0615	Spanish Foreign R.	B	11880, 9630
12:22-12:30 a.m.	0522-0530	UN Radio	A	9540, 6055 (Tue-Sat)
12:30-12:50 a.m.	0530-0550	V. of Germany	A	11905, 11785, 9650, 9545, 6185, 5960
12:30-1:25 a.m.	0530-0625	R. Nederland	A	9715, 6165
12:45-1:00 a.m.	0545-0600	UN Radio	A	9540, 6135 (Tue-Sat)
12:45-2:30 a.m.	0545-0730	BBC	B	15070, 11955, 11860, 9640, 9510, 6175
1:00-1:15 a.m.	0600-0615	R. Japan	C	15270
1:00-1:30 a.m.	0600-0630	R. Norway	B	11860 (Mon only)
1:00-1:30 a.m.	0600-0630	R. Australia	C	21680, 21525, 17725, 17555, 15240
1:00-2:00 a.m.	0600-0700	RAE, Argentina	C	9690 (Tue-Sat only)
1:00-2:00 a.m.	0600-0700	R. RSA	C	21535, 17780
1:15-1:30 a.m.	0615-0630	R. Canada International	B	11960, 11825, 9655, 9590, 6140 (Mon-Fri)
1:25-3:55 a.m.	0625-0855	V. of Malaysia	C	15295, 12350, 9750
1:30-2:00 a.m.	0630-0700	R. Australia	B	21680, 17725, 15240, 9670
1:30-3:00 a.m.	0630-0800	R. Habana Cuba	A	9525
1:40-7:15 a.m.	0640-1215	R. New Zealand	C	6105
1:45-2:00 a.m.	0645-0700	R. Canada International	B	11960, 11825, 9655, 9590, 6140 (Mon-Fri)
2:00-2:15 a.m.	0700-0715	R. Japan	C	15270
2:00-3:00 a.m.	0700-0800	Xandir Malta	D	9670 (Sat only) (frequent changes)
2:00-4:00 a.m.	0700-0900	R. Australia	B	21680, 17725, 11740, 9670, 9570
2:07-2:15 a.m.	0707-0715	UN Radio	A	9540, 6135 (Tue-Sat)
2:30-2:45 a.m.	0730-0745	UN Radio	A	9540, 6135 (Tue-Sat)
2:30-3:25 a.m.	0730-0825	R. Nederland	B	9770, 9715
2:30-4:00 a.m.	0730-0900	BBC	B	15070, 11955, 9640, 9510
2:55 a.m.-fade	0755-	Action Radio, Guyana	C	5950
3:00-3:15 a.m.	0800-0815	R. Japan	B	9505
3:00-5:00 a.m.	0800-1000	FEBC, Philippines	C	11765
3:30-4:25 a.m.	0830-0925	R. Nederland	B	9715

Explanatory Notes.

1. Times in first column are CDT. For EDT, add 1 hour. MDT, subtract 1 hour. PDT, subtract 2 hours. Days of week are in GMT.
2. Quality. A—strong signal and very reliable reception. B—regular reception. C—occasional reception under favorable conditions. D—rarely audible. These ratings are for locations in the central USA. European and African stations are in general, more reliably received in eastern North America. Asian and Pacific stations are more reliably received in western North America. North American stations are received well except in areas too close to the transmitter site.
3. The information in this listing is correct to press time. However, frequencies and schedules are constantly changing. Listen to "DX Digest" on R. Canada International for late changes, Sunday at 1807; 1915 (to Europe); GMT Mondays at 0017, 0117 and 0317; and Wednesdays at 2145.
4. R.—Radio; V.—Voice

ROJECT
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ONTH

ORREST M. MIMS

UNIVERSAL TRI-STATE NE GENERATOR

3 the most popular applications e generators are those of annun- d alarms. The tri-state tone gen- wn in Fig. 1 is more versatile in han most because it has three perating modes: steady, pulsat- wo-tone. It can be easily modified e a warbling sound and can gen- de range of audible frequencies.

alf of a 556 dual timer functions able multivibrator. The first asta- e timing components are *R1*, *R2*, scillates at a frequency of slightly a two hertz. The second astable, ives a small 8-ohm dynamic is programmed by *R4*, *R5*, and cillate at a frequency of 2.5 kHz. *R6* governs the volume of the m the speaker.

ee principle operating modes are by *S1*, an spdt toggle switch with (off) center position. Position 1 the output of the first astable to nd astable through *R3*. The result ttention-getting, two-tone signal equency fluctuates between 2200 0 Hz at a rate determined by the scillation of the first astable.

n 2 disconnects the first astable second astable, allowing the sec- operate independently. Conse- the speaker emits a steady tone. Position 3 connects the out- e first astable directly to the reset the second astable. This causes 0-Hz tone applied to the speaker to rupted at a rate determined by the able. The result is a series of tone

an experiment with the timing com- of both astable multivibrators to a wider range of tone modes and cies than those described above. ing the capacitance of *C1* to 10 mi- ds or more, for example, will reduce uency of oscillation of the first asta- pproximately 0.7 hertz. On the oth- d, reducing *C1* to 0.45 microfarads rease the first astable's oscillation ncy to about 15 Hz, causing a dis- arble to be heard when *S1* is in posi- or a rapid series of tone bursts when n position 3.

frequency of the second astable can de adjustable by replacing *R4* and h a 15,000-ohm potentiometer. To connect the wiper of the potentiom- pin 13 of the 556 and the stationary als to pins 8 and 14. You can make one or both astable responsive to changes in the level of ambient light by substituting a cadmium-sulfide photocell for one or more of the timing resistors.

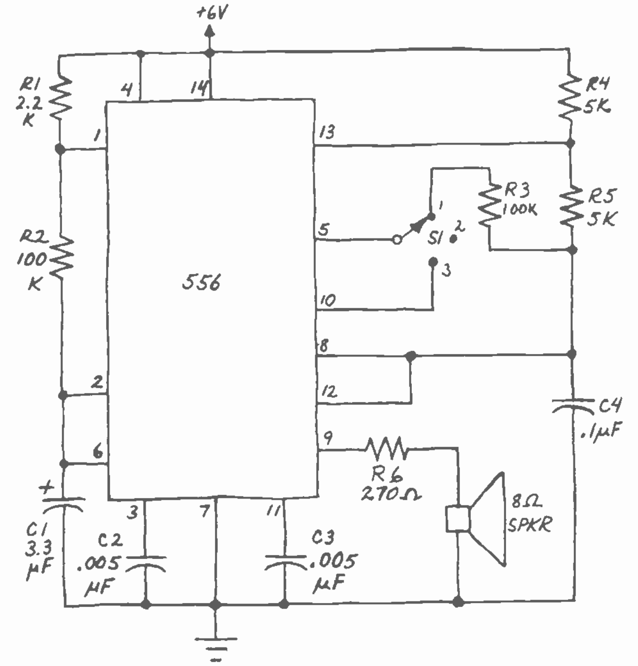


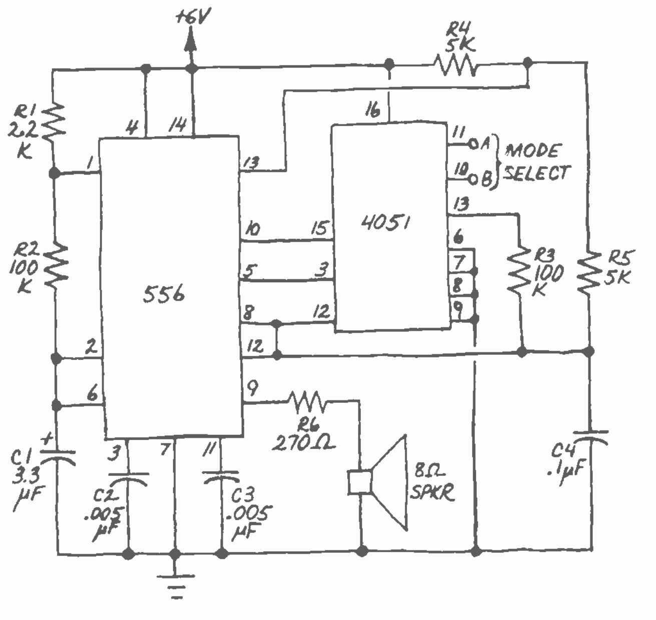
Fig. 1. Universal tri-state tone generator.

Digital Tone Mode Selection. It's possible to select the tone mode electronically with the help of a 4051 CMOS analog multiplexer/demultiplexer. Figure 2 shows how the 4051 is introduced into the circuit in place of *S1*.

A two-bit word selects the desired tone mode according to the truth table included in Fig. 2. Note the addition of a fourth tone mode, a ticking sound similar to that of a metronome. This sound represents the output of the first astable and its frequency can be altered by changing *R1*, *R2*, *C1*, or any combination of these components. When the metronome mode is selected, the second astable is disabled by the 4051.

You can modify the truth table in Fig. 2 by connecting any three of the eight analog switches in the 4051 to the rest of the circuit. Refer to the 4051 data sheet for details of the operation of this versatile chip.

Going Further. With a little ingenuity, you can select the desired tone mode—or turn the circuit on or off—with components other than the 4051. Try optoisolators, SCRs, transistors, or relays. You might even be able to add a tri-state LED to the circuit to provide simultaneous audible and visual outputs. ◇



MODE SELECT*		
B	A	TONE
0	0	TWO TONE
0	1	STEADY
1	0	TONE BURST
1	1	METRONOME

Fig. 2. Programmable four-state tone generator

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I.C. SOCKETS

- BOTH SOLDERTAB AND WIRE WRAP ARE TIN
- SOLDERTAB SOCKETS ARE LOW PROFILE
- WIRE WRAP SOCKETS ARE STANDARD PROFILE/LEVEL 3

Part No.	Description	1	10	100
8-ST	8 Pin Solder Tab	.08	.80	8.00
14-ST	14 Pin Solder Tab	.14	1.40	14.00
16-ST	16 Pin Solder Tab	.16	1.60	16.00
18-ST	18 Pin Solder Tab	.18	1.80	18.00
20-ST	20 Pin Solder Tab	.20	2.00	20.00
22-ST	22 Pin Solder Tab	.22	2.20	22.00
24-ST	24 Pin Solder Tab	.24	2.40	24.00
28-ST	28 Pin Solder Tab	.28	2.80	28.00
40-ST	40 Pin Solder Tab	.40	4.00	40.00
8-WW	8 Pin Wire Wrap	.24	2.30	20.50
14-WW	14 Pin Wire Wrap	.26	2.50	22.00
16-WW	16 Pin Wire Wrap	.30	2.85	25.50
18-WW	18 Pin Wire Wrap	.60	5.70	51.00
20-WW	20 Pin Wire Wrap	.70	6.65	59.50
22-WW	22 Pin Wire Wrap	.84	8.00	71.50
24-WW	24 Pin Wire Wrap	.96	9.10	81.50
28-WW	28 Pin Wire Wrap	1.12	10.00	95.20
40-WW	40 Pin Wire Wrap	1.36	12.50	115.00

MOLEX I.C. SOCKET PINS

.85/C 8.20/M 36.20/5M [illegible]

INTEGRATED CIRCUITS

7400 TTL

7400N	[illegible]
[illegible]	.19
7402N	.19
7405N	.23
7406N	.29
7407N	.29
7408N	.23
7410N	.23
7411N	.24
7413N	.40
7414N	.85
7420N	.23
7425N	.28
7426N	.28
7427N	.26
7430N	.23
7432N	.26
7439N	.50
7440N	.23
7442N	.54
7446N	.76
7447N	.70
7448N	.70
7450N	.23
7451N	.23
7453N	.23
7454N	.23
7460N	.23
7470N	.32
7473N	.37
7474N	.32
7476N	.33
7485N	.90
7486N	.32
7490N	.48
7492N	.48
7493N	.48
7495N	.65
7496N	.70
74107N	.30
74121N	.35
74123N	.61
74125N	.44
74126N	.44
74132N	.70
74141N	.90
74145N	.75
74147N	1.70
74148N	1.30
74150N	1.05
74151N	.70
74153N	.70
74154N	1.03
74155N	.70
74156N	.70
74162N	.90
74170N	1.60
74176N	.80
74180N	.80
74181N	1.95
74182N	.79
74184N	1.95
74S189N	2.75
74190N	1.00
74193N	.94
74195N	.88
74196N	.88
74197N	.88
74198N	1.49
74199N	1.49
74251N	1.09
74284N	3.50
74298N	.94
74365N	.67
74367N	.67
74368N	.67

74LS00 LS TTL

74LS01N	.28
74LS03N	.28
74LS08N	.29
74LS09N	.29
74LS11N	.28
74LS12N	.28
74LS13N	.59
74LS15N	.28
74LS20N	.28
74LS22N	.28
74LS26N	.35
74LS27N	.35
74LS28N	.35
74LS30N	.28
74LS32N	.35
74LS37N	.35
74LS40N	.28
74LS42N	.79
74LS74N	.45
74LS75N	.59
74LS78N	.42
74LS83N	.89
74LS85N	1.15
74LS86N	.45
74LS90N	.56
74LS93N	.56
74LS107N	.45
74LS109N	.45
74LS112N	.45
74LS113N	.45
74LS114N	.45
74LS122N	.75
74LS123N	1.00
74LS126N	.55
74LS138N	.89
74LS139N	.89
74LS153N	.84
74LS155N	.89
74LS156N	.89
74LS157N	.75
74LS158N	.75
74LS161N	1.02
74LS162N	1.02
74LS168N	1.14
74LS169N	1.14
74LS170N	1.73
74LS173N	1.34
74LS174N	1.06
74LS175N	.90
74LS190N	1.18
74LS191N	1.18
74LS192N	.99
74LS193N	.99
74LS196N	.89
74LS221N	1.40
74LS247N	1.15
74LS248N	1.15
74LS253N	.99
74LS260N	.50
74LS266N	.42
74LS279N	.75
74LS283N	.99
74LS290N	.65
74LS365N	.70
74LS366N	.70
74LS367N	.70
74LS368N	.70
74LS386N	.59
81LS95N	1.05
81LS96N	1.05
81LS97N	1.05
81LS98N	1.05

4000 CMOS

4000	.23
4001	.23
4002	.23
4007	.23
4008	.96
4009	.46
4010	.46
4011	.23
4012	.23
4013	.42
4014	.96
4015	.96
4016	.42
4017	1.05
4018	1.05
4019	.42
4020	1.14
4021	1.14
4022	.99
4023	.23
4024	.84
4025	.23
4027	.42
4028	.89
4029	1.14
4030	.42
4034	2.75
4035	1.32
4040	1.14
4041	1.06
4042	.89
4043	.82
4044	.82
4046	1.79
4047	1.45
4048	.80
4051	1.19
4052	1.19
4060	1.58
4071	.23
4072	.23
4073	.23
4075	.23
4089	2.75
4093	.76
4099	2.10
4503	.90
4510	1.14
4511	1.05
4512	1.00
4514	2.80
4515	2.80
4516	1.23
4518	1.14
4520	1.14
4522	1.75
4526	1.75
4527	1.68
4723	1.10
4724	1.20
74C00N	.25
74C02N	.25
74C04N	.27
74C08N	.25
74C10N	.25
74C14N	.90
74C20N	.25
74C30N	.25
74C32N	.25
74C42N	.98
74C48N	1.28
74C73N	.72
74C74N	.48
74C76N	.72
74C83N	1.38
74C85N	1.38
74C86N	.40
74C90N	.98
74C93N	.98
74C95N	1.10
74C150N	2.90
74C151N	1.90
74C154N	2.90
74C157N	1.90
74C160N	1.18
74C161N	1.18
74C164N	1.10
74C165N	1.10
74C173N	1.30
74C175N	1.16
74C192N	1.38
74C193N	1.38
74C195N	1.10
74C221N	1.90
74C901N	.48
74C908N	1.19
74C909N	1.78
74C914N	1.50
74C922N	5.70
74C923N	5.90
74C925N	7.80
74C926N	7.80
74C927N	7.80
74C928N	7.80
80C95N	.69
80C96N	.69
80C98N	[illegible]

LINEAR I.C.'S

CA3046	.75
CA3086	.60
LF351N	.76
LF353N	1.06
LF356N	1.20
LF357N	1.20
LF13741N	.76
LM301AN	.44
LM307N	.64
LM308N	1.00
LM311N	.90
LM317K	4.50
LM317T	3.00
LM317MP	1.90
LM318N	2.00
LM320MP-5	1.30
LM320MP-8	1.30
LM320MP-9	1.30
LM320MP-12	1.30
LM320MP-15	1.30
LM320MP-18	1.30
LM320MP-24	1.30
LM323K	7.00
LM324N	.77
LM325N	2.70
LM326N	2.70
LM327N	2.70
LM334Z	1.30
LM336Z	1.85
LM337K	5.45
LM337T	2.05
LM339N	1.11
LM340KC-5	1.80
LM340T-5	1.25
LM340T-6	1.25
LM340T-10	1.25
LM340T-12	1.25
LM340T-15	1.25
LM340T-18	1.25
LM340T-24	1.25
LM341P-5	.98
LM341P-6	.98
LM341P-8	.98
LM341P-10	.98
LM341P-12	.98
LM341P-15	.98
LM341P-18	.98
LM341P-24	.98
LM348N	1.60
LM349N	1.60
LM350K	6.10
LM358N	.72
LM378N	3.15
LM379S	5.60
LM380N-8	1.30
LM381N	2.25
LM382N	1.75
LM383AT	2.70
LM386N	1.10
LM387N	1.45
LM1310N	1.90
LM1800N	2.50
LM1812N	5.50
LM1830N	1.75
LM1889N	2.30
LM2111N	1.40
LM2907N	1.75
LM3089N	2.00
LM3900N	.80
LM3905N	1.40
LM3909N	.79
LM3914N	3.75
MC1456V	1.00
MC1458V	.60
MC1496N	.90
MC3302P	.70
NE555V	.48
NE556A	.88
NE560B	2.50
NE565A	1.20
NE566V	1.45
NE567V	1.15
UA709CN	[illegible]
UA723CN	.60
US733CN	.80
UA741CN	.44
UA747CN	.79
UA748CN	.45
UA7805CK	1.80
UA7805CU	1.25
UA7806CU	1.25
UA7810CU	1.25
UA7812CU	1.25
UA7815CU	1.25
UA7818CU	1.25
UA7824CU	1.25
UA78L05ACZ	.40
UA78L06ACZ	.40
UA78L08ACZ	.40
UA78L10ACZ	.40
UA78L15ACZ	.40
UA78L24ACZ	.40
UA7905CU	1.70
UA7906CU	1.70
UA7908CU	1.70
UA7909CU	1.70
UA7912CU	1.70
UA7915CU	1.70
UA7918CU	1.70
UA7924CU	1.70

A/D CONVERTERS & MISC

ADC0800PCN	11.00
ADC0816CCN	30.00
ADC[illegible]CCN	12.00
ADC351[illegible]CCN	12.00
ADC3701CCN	13.50
ADC3711CCN	13.50
[illegible]CN	3.00
DAC0808LCN	3.00
MM5314N	3.75
MM5837N	3.30

MEMORY

21L02-1	1.69
2114N	7.20
93410N	3.00
1702A	5.95
2708	13.99
74S188N	2.10
74S288N	2.10
74S570N	5.75
82S131N	5.75

MICROPROCESSOR

8080N	14.95
8080A	9.95
8212N	3.25
8216N	3.25
8224N	3.25
8228N	6.00
8238N	6.00
8251N	7.95
8255N	9.95
8304N	6.75

INTERFACE I.C.'S

8093N	.44
8094N	.44
8095N	.67
8097N	.67
8098N	.67
75450N	.88
75453N	.61
75454N	.61
75491N	.81
75492N	.89
75493N	1.09
75494N	1.19
MC1488N	1.39
MC1489N	1.39

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TEXAS INSTRUMENTS GOLD EDGEBOARD CONNECTORS

Solder Tab — Solder Eye — Wire Wrap

RELIABLE, COST-EFFICIENT CONTACT DESIGN
- 50 (Wire Wrap) to 75 (solder Tail) micro-inches gold inlay over a nickel diffusion barrier.
- Copper-nickel-tin CA 725 alloy.
- Bifurcated contact points.
- Preloaded, cantilever spring design.
- Contacts are user removable.

NOTE — Dimensions below are the pin center to center measurement followed by the distance separating the two pin rows.

H4 SERIES .100" x .200" EDGEBOARD CONNECTORS

Positions Contacts	Part No. Solder Tab	1	10	100	Part No. Solder Eye	1	10	100
18/36	C6-18	2.01	18.40	151.00	C5-18	1.98	18.20	149.00
22/44	C6-22	2.40	22.00	180.00	C5-22	2.28	20.90	171.00
25/50	C6-25	2.73	25.00	205.00	C5-25	2.49	22.80	187.00
30/60	C6-30	3.24	29.70	243.00	C5-30	2.85	26.10	214.00
31/62	C6-31	3.36	30.80	252.00	C5-31	2.94	27.00	221.00
36/72	C6-36	3.87	35.50	290.00	C5-36	3.30	30.30	248.00
40/80	C6-40	4.29	39.30	322.00	C5-40	3.60	33.00	270.00
43/86	C6-43	4.62	42.30	347.00	C5-43	3.81	34.90	286.00
50/100	C6-50	5.36	49.00	401.00	C5-50	4.32	39.60	324.00

For polarizing keys order P/N CR1164-2 10/ea 7.50/C

H4 SERIES .125" x .250" EDGEBOARD CONNECTORS

Positions Contacts	Part No. Solder Tab	1	10	100	Part No. Solder Eye	1	10	100
22/44	C4-22	2.58	23.70	194.00	C3-22	2.28	20.90	171.00
28/56	C4-28	3.21	29.40	241.00	C3-28	2.79	25.60	209.00
31/62	C4-31	3.51	32.20	263.00	C3-31	3.06	28.10	230.00
36/72	C4-36	4.02	36.90	302.00	C3-36	3.45	31.60	259.00
40/80	C4-40	4.44	40.70	333.00	C3-40	3.81	34.90	286.00
44/88	C4-44	4.83	44.30	362.00	C3-44	4.17	38.20	313.00
50/100	C4-50	5.46	50.10	410.00	C3-50	4.65	42.90	351.00

For polarizing keys order P/N CR1164-2 10/ea 7.50/C

H4 SERIES .156" x .200" EDGEBOARD CONNECTORS

Positions Contacts	Part No. Solder Tab	1	10	100	Part No. Solder Eye	1	10	100
10/20	C1-10	1.29	11.80	97.00	C2-10	1.29	11.80	97.00
15/30	C1-15	1.74	16.00	131.00	C2-15	1.74	16.00	131.00
18/36	C1-18	2.01	18.40	151.00	C2-18	2.01	18.40	151.00
22/44	C1-22	2.37	21.70	178.00	C2-22	2.37	21.70	178.00
25/50	C1-25	2.64	24.20	198.00	C2-25	2.64	24.20	198.00

For polarizing keys order P/N CR1164-1 10/ea 7.50/C

SILICON TRANSISTORS

Part	1	10	100	1000
2N3055	1.23	11.28	102.50	922.50
2N3904	.20	1.79	16.25	146.25
2N3906	.20	1.79	16.25	146.25
2N4124	.21	1.93	17.50	157.50
2N4126	.22	2.01	18.25	164.25
2N4401	.21	1.93	17.50	157.50
2N4403	.21	1.93	17.50	157.50
2N4410	.24	2.20	20.00	180.00
2N5087	.24	2.20	20.00	180.00
2N5089	.24	2.20	20.00	180.00
2N5210	.27	2.48	22.50	202.50
2N5457	.51	4.68	42.50	382.50
92PU01A	.39	3.30	27.50	247.50
92PU10	.35	3.00	25.00	225.00
92PU45A	.35	3.00	25.00	225.00
92PU51A	.39	3.30	27.50	247.50
MJ2955	1.47	13.48	122.50	1102.25
MJE172	.56	4.80	40.00	360.00
MJE182	.53	4.50	37.50	337.50
MJE3439	.56	4.80	40.00	360.00
MJE344	.56	4.80	40.00	360.00
MJE370	.70	6.00	50.00	450.00
MJE371	.88	7.50	62.50	562.50
MJE520	.67	5.70	47.50	427.50
MJE521	.67	5.70	47.50	427.50
MJE703	.70	6.00	50.00	450.00
MJE712	.56	4.80	40.00	360.00
MJE722	.53	4.50	37.50	337.50
MJE803	.88	7.50	62.50	562.50
MPF102	.54	4.95	45.00	405.00
MPS2222A	.21	1.93	17.50	157.50
MPS2369A	.24	2.20	20.00	180.00
MPS2907A	.24	2.20	20.00	180.00
MPS3392	.23	2.07	18.75	169.00
MPS3393	.21	1.93	17.50	157.50
MPS3394	.24	2.20	20.00	180.00
MPS3395	.24	2.20	20.00	180.00
MPS3563	.21	1.93	17.50	157.50
MPS3565	.21	1.93	17.50	157.50
MPS3638A	.21	1.93	17.50	157.50
MPS3641	.21	1.93	17.50	157.50
MPS3643	.21	1.93	17.50	157.50
MPS918	.21	1.93	17.50	157.50
MPS930	.21	1.93	17.50	157.50
MPSA13	.27	2.48	22.50	202.50
TIP112	.98	8.40	70.00	630.00
TIP117	1.02	8.70	72.50	652.50
TIP120	1.17	10.73	97.50	877.50
TIP122	1.54	13.20	110.00	990.00
TIP127	1.54	13.20	110.00	990.00
TIP132	1.54	13.20	110.00	990.00
TIP135	1.54	13.20	110.00	990.00
TIP29C	.81	6.90	57.50	517.50
TIP30C	.81	6.90	57.50	517.50
TIP31C	.98	8.40	70.00	630.00
TIP32C	1.02	8.70	72.50	652.50
TIP61C	.81	6.90	57.50	517.50
TIP62C	.81	6.90	57.50	517.50

1/2 WATT ZENER DIODES

24 ea .80 10 15.00 C

1N5226B	3.3V	1N5242B	12V
1N5227B	3.6V	1N5243B	13V
1N5228B	3.9V	1N5244B	14V
1N5229B	4.3V	1N5245B	15V
1N5230B	4.7V	1N5246B	16V
1N5231B	5.1V	1N5247B	17V
1N5232B	5.6V	1N5248B	18V
1N5233B	6.0V	1N5249B	19V
1N5234B	6.2V	1N5250B	20V
1N5235B	6.8V	1N5251B	22V
1N5236B	7.5V	1N5252B	24V
1N5237B	8.2V	1N5253B	25V
1N5238B	8.7V	1N5254B	27V
1N5239B	9.1V	1N5255B	28V
1N5240B	10V	1N5256B	30V
1N5241B	11V	1N5257B	33V

SILICON DIODES

Part	10	100
1N4001	.80	7.00
1N4002	.80	7.00
1N4003	.80	7.50
1N4004	.80	7.90
1N4005	1.00	9.00
1N4006	1.00	9.00
1N4007	1.00	9.00
1N4148	.60	5.00

SLIDE SWITCHES

SPST	.15	1.25/10	10.00/C
SPDT	.19	1.70/10	13.00/C
DPDT	.23	2.00/10	19.00/C

FREE CATALOG

8080A CHIP SET

ONE EACH 8080A, 8212, 8224 and 8228 PLUS SIXTEEN 2102AN-4L ALL FOR — **$44.95**

STRANDED HOOK UP WIRE

20 ga PVC	2.50/100'	10.00/500'
22 ga PVC	2.50/100'	10.00/500'
24 ga PVC	2.80/100'	11.25/500'

DIGI-KEY Means Toll Free Wats

TIME-TEMPERATURE PROGRAMMABLE MODULE

USER PROGRAMMABLE FOR:
- 12 or 24 Hour Display
- °F and/or °C, as well as virtually any number of temperature sensors
- Fixed or flashing colon format
- 50/60 Hz line frequency operation

MA 1026 by National Semiconductor

FEATURES
- Giant 0.7 inch 4 digit LED display with red lens
- PM, colon, degree and alarm "ON" LED indicators
- 6 display modes — temperature, time, seconds, alarm, sleep and lamp test
- Exclusive Digi-Key switching panel available to simplify hook up
- Leading zero blanking
- Time & normal display mode, with temperature display at push of switch

The MA1026 Clock Module offers capabilities beyond simple time keeping functions available in most conventional clock modules. [illegible]

HOW TO ORDER —

Catalog No.	Description	COST
MA1026M	MA1026 Clock Module (Assembled and Tested with data sheet)	$19.95
MA1026P	Digi-Key Switching Panel Kit for MA1026M (includes P.C. Board, 12 low profile switches, wraposts, standoffs, hardware, components, two LM334 temperature sensors, two KOA32 trimpots, and instructions)	11.95
MA1026T	Special transformer for MA1026M suitable for most applications	2.95
MA1026B	Alarm buzzer for MA1026M	2.75
MA1026K	Includes MA1026M, P, T and B	34.95
MA1026C	Conventional Switch Set for applications where MA1026P is not used. Includes one 501PB and ten 502PB switches and special wiring instructions	2.95
MA1026R	Includes MA1026M clock module, MA1026C conventional switch set, MA1026T special transformer, two LM334 temperature sensors, and two KOA32 trimpots	29.95

For each additional sensor unit, the following are suggested:

LM334	Temperature transducer for MA1026M module	$1.30
KOA32	300 ohm trimpot for LM334 transducer	.43
502PB	Normally open switch	.45

NEW! THE MA1023 by NATIONAL SEMICONDUCTOR

THE "PROGRAMMABLE" CLOCK MODULE MA1023

0.7" HIGH DIGITS — RED LED DISPLAY (Not shown actual size)

The MA1023 Clock Module offers a degree of flexibility not available in conventional clock modules. [illegible]

DIGI-KEY SWITCHING PANEL KIT MA1023P

(Shown assembled and "sandwich mounted" to MA1023 Clock Module)

Catalog No.	Description	COST
MA1023M	MA1023 Clock Module Only (Assembled and tested)	19.95
MA1023P	Digi-Key Switching Panel Kit for MA1023 (includes P.C. Board, Switches, Wraposts, Standoffs, Hardware, Components)	6.95
MA1023T	Special Transformer For MA1023	7.95
MA1023B	Alarm Buzzer For MA1023	2.25
MA1023K	Includes MA1023M, P, T & B	[illegible]
MA1023C	Conventional switch set for applications where MA1023P is not used. Includes one 501PB and six 502PB switches	[illegible]
MA1023R	Clock Module, Conventional Switches, Transformer [illegible]	[illegible]

JMJ DIGITAL DISPLAY BEZEL

FOR MA1002, MA1010 AND MA1023 CLOCK MODULES — **$4.95**

PATENTED CHROMAFILTER SCREEN, DIE CAST METAL FRAME MOUNTS IN PANELS UP TO 3/16" THICK, NO EXPOSED HARDWARE, SCRATCH RESISTANT AND EASILY CLEANED, ELIMINATES GLARE.

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400	BEZEL WITH RED FILTER	4.95
420	MOUNTING ADAPTER FOR MA1001 & MA1002	.69
421	MOUNTING ADAPTER FOR MA1010	.69
422	UNIVERSAL PC BOARD MOUNTING ADAPTER	.69
423	MOUNTING ADAPTER FOR MA1023	.69
424	BEZEL AND ENCLOSURE FOR MA1003	5.95

NEW: DIGI-CLOCK ONLY $19.95

- Trouble-free Module!
- 270° Swivel Mount!
- Inlaid Walnut Chrome Trim Bezel!
- 12 VDC — Ideal for Car, Van or Boat!
- 3-5/8" x 2-3/16" Tall x 2-1/8" Deep!
- Quick and Easy To Install!

Part No. 5001K

ok $6.95 $7.95 — STRIPS — WRAPS — UNWRAPS

5% CARBON FILM RESISTORS

1/4 WATT RESISTOR ASSORTMENTS

Catalog number	Description	PRICE
RS125	Set of 5 each of the 73 standard 5% 1/4 watt carbon film resistors in the series 1.0, 1.2, 1.5, 1.8, 2.2, etc., through 1.0 megohm (365 total pcs.)	$9.90
RS225	Set of 5 each of the 73 standard 5% 1/4 watt carbon film resistors in the series 1.1, 1.3, 1.6, 2.0, 2.4, etc., through 910 kilohm (360 total pcs.)	$9.90

1/2 WATT RESISTORS ASSORTMENTS

Catalog Number	Description	PRICE
RS150	Set of 5 each of the 73 standard 5% 1/2 watt carbon film resistors in the series 1.0, 1.2, 1.5, 1.8, 2.2, etc., through 1.0 megohm (365 total pcs.)	$9.90
RS250	Set of 5 each of the 73 standard 5% 1/2 watt carbon film resistors in the series 1.1, 1.3, 1.6, 2.0, 2.4, etc., through 910 kilohm (360 total pcs.)	$9.90

PANASONIC TRIMMER POTENTIOMETERS

1/4" (8 mm) DIA. [illegible] VARIABLE RESISTORS

Lay Down	Stand Up	Resist.	1	10	100	1000
K4A13	KOA13	1.0K	.32	2.40	21.00	160.00
K4A23	KOA23	2.0K	.32	2.40	21.00	160.00
K4A53	KOA53	5.0K	.32	2.40	21.00	160.00
K4A14	KOA14	10K	.32	2.40	21.00	160.00
K4A24	KOA24	20K	.32	2.40	21.00	160.00
K4A54	KOA54	50K	.32	2.40	21.00	160.00
K4A15	KOA15	100K	.32	2.40	21.00	160.00
K4A25	KOA25	200K	.32	2.40	21.00	160.00
K4A55	KOA55	500K	.32	2.40	21.00	160.00

PLESSEY MINIBOX METALLIZED POLYESTER CAPACITORS

[illegible]

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ACE 200-K

Part No. 923332 $18

- Two 5-way binding posts
- Kit form

728 SOLDERLESS PLUG IN TIE POINTS — CAPACITY UP TO 8 14 PIN DIP ICs

Digi-Key Stocks the Entire AP Line

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2-56 1/4 SCREW	1.39/C
2-56 1/2 SCREW	1.39/C
4-40 1/4 SCREW	.99/C
4-40 1/2 SCREW	.99/C
6-32 1/4 SCREW	.99/C
6-32 1/2 SCREW	.99/C
8-32 3/8 SCREW	.99/C
8-32 1/2 SCREW	.99/C
2-56 HEX NUT	.75/C
4-40 HEX NUT	.75/C
6-32 HEX NUT	.75/C
8-32 HEX NUT	.75/C
NO. 2 LOCKWASHER	.55/C
NO. 4 LOCKWASHER	.55/C
NO. 6 LOCKWASHER	.55/C
NO. 8 LOCKWASHER	.55/C

PANASONIC ELECTROLYTIC CAPACITORS

VALUE	Radial Leads 1	10	100	Axial Leads 1	10	100
.47/50V	.12	1.03	8.53	.17	1.40	11.67
1/50V	.12	1.03	8.53	.17	1.40	11.67
2.2/50V	.12	1.03	8.53	.17	1.40	11.67
3.3/50V	.12	1.03	8.53	.17	1.40	11.67
4.7/35V	.12	1.03	8.53	.17	1.40	11.67
4.7/50V	.13	1.09	9.08	.20	1.69	14.07
10/16V	.12	1.03	8.53	.17	1.40	11.67
10/25V	.12	1.03	8.53	.17	1.40	11.67
10/35V	.13	1.09	9.08	.20	1.69	14.07
10/50V	.15	1.25	10.42	.23	1.91	15.87
22/16V	.13	1.09	9.08	.20	1.69	14.07
22/25V	.13	1.09	9.08	.21	1.74	14.49
22/35V	.16	1.48	12.33	.23	1.91	15.87
22/50V	.19	1.64	13.65	.26	2.24	18.60
33/16V	.14	1.16	9.60	.20	1.69	14.07
33/25V	.13	1.14	9.48	.23	1.91	15.87
33/35V	.19	1.61	13.40	.27	2.24	18.60
33/50V	.21	1.72	14.34	.30	2.57	21.35
47/10V	.13	1.11	9.22	.20	1.69	14.07
47/16V	.15	1.25	10.42	.23	1.91	15.87
47/25V	.15	1.25	10.42	.26	2.24	18.60
47/35V	.21	1.73	14.34	.31	2.65	22.05
47/50V	.22	1.84	15.28	.34	2.90	24.12
100/10V	.15	1.25	10.42	.23	1.91	15.87
100/16V	.19	1.61	13.40	.26	2.24	18.60
100/25V	.19	1.61	13.40	.31	2.65	22.05
100/35V	.22	1.84	15.28	.41	3.48	28.95
100/50V	.33	2.81	23.40	.43	3.61	30.04
220/10V	.21	1.74	14.48	.28	2.34	19.50
220/16V	.22	1.84	15.28	.31	2.65	22.05
220/25V	.21	1.74	14.48	.42	3.57	29.75
220/35V	.36	3.09	25.70	.49	4.14	34.44
220/50V	.46	3.92	32.59	.58	4.94	41.10
330/6V	.21	1.74	14.48	.28	2.34	19.50
330/10V	.22	1.84	15.28	.31	2.65	22.05
330/16V	.32	2.75	22.85	.42	3.57	29.49
330/25V	.31	2.60	21.64	.48	4.06	33.78
330/35V	.46	3.92	32.59	.54	4.62	38.48
330/50V	.75	6.41	53.39	.73	6.19	51.57
470/6V	.21	1.78	14.77	.31	2.65	22.05
470/10V	.32	2.68	22.32	.42	3.57	29.48
470/16V	.34	2.92	24.33	.47	4.02	33.47
470/25V	.36	3.09	25.70	.55	4.72	39.28
470/35V	.57	4.89	40.73	.62	5.25	43.70
470/50V	.83	7.09	59.03	.88	7.50	62.43
1000/6V	.34	2.84	23.66	.47	4.02	33.34
1000/10V	.37	3.10	25.80	.52	4.42	36.78
1000/16V	.44	3.75	31.23	.57	4.86	40.43
1000/25V	.75	6.41	53.39	.80	6.84	56.99
1000/35V	.80	6.85	57.02	.94	7.98	66.48
2200/6V	.48	4.08	33.94	.57	4.86	40.72
2200/10V	.62	5.30	44.13	.74	6.32	52.64
2200/16V	.80	6.85	57.02	.88	7.50	62.28
2200/25V	1.04	8.94	74.48	1.11	9.45	78.68
3300/6V	.67	5.70	47.49	.78	6.61	55.08
3300/10V	.80	6.83	56.92	.94	7.98	67.03
3300/16V	1.05	8.94	74.48	1.11	9.45	78.68
3300/25V	1.48	12.64	105.39	1.54	13.12	109.30
4700/6V	.83	7.09	59.03	.99	8.47	70.54
4700/10V	.99	8.43	70.25	1.22	10.43	86.84
4700/16V	1.46	12.45	103.75	1.49	12.76	106.37
6800/6V	.99	8.43	70.25	1.21	10.36	86.27
6800/10V	1.38	11.81	98.37	1.48	12.63	105.25
6800/16V				1.89	16.19	134.88
10,000/6V	1.38	11.81	98.37	1.47	12.55	104.54
10,000/10V				1.89	16.19	134.88

PANASONIC POLYESTER CAPACITORS

100 VDC plus minus 10% TOLERANCE

PART NO.	CAP (UFD)	1	10	100	1000
M1102	.001	.14	1.17	8.34	75.04
M1122	.0012	.14	1.17	8.34	75.04
M1152	.0015	.14	1.17	8.34	75.04
M1182	.0018	.14	1.17	8.34	75.04
M1222	.0022	.14	1.17	8.34	75.04
M1272	.0027	.14	1.17	8.34	75.04
M1332	.0033	[illegible]	[illegible]	[illegible]	[illegible]
M1392	.0039	[illegible]	[illegible]	[illegible]	[illegible]
M1472	.0047	[illegible]	[illegible]	[illegible]	[illegible]
M1562	.0056	[illegible]	[illegible]	[illegible]	[illegible]
M1682	.0068	[illegible]	[illegible]	[illegible]	[illegible]
M1822	.0082	[illegible]	[illegible]	[illegible]	[illegible]
M1103	.01	[illegible]	[illegible]	[illegible]	[illegible]
M1123	.012	[illegible]	[illegible]	[illegible]	[illegible]
M1153	.015	[illegible]	[illegible]	[illegible]	[illegible]
M1183	.018	[illegible]	[illegible]	[illegible]	[illegible]
M1223	.022	[illegible]	[illegible]	[illegible]	[illegible]
M1273	.027	[illegible]	[illegible]	[illegible]	[illegible]
M1333	.033	[illegible]	[illegible]	[illegible]	[illegible]
M1393	.039	[illegible]	[illegible]	[illegible]	[illegible]
M1473	.047	[illegible]	[illegible]	[illegible]	[illegible]
M1563	.056	[illegible]	[illegible]	[illegible]	[illegible]
M1683	.068	[illegible]	[illegible]	[illegible]	[illegible]
M1823	.082	[illegible]	[illegible]	[illegible]	[illegible]
M1104	.1	[illegible]	[illegible]	[illegible]	[illegible]
M1124	.12	[illegible]	[illegible]	[illegible]	[illegible]
M1154	.15	[illegible]	[illegible]	[illegible]	[illegible]
M1184	.18	[illegible]	[illegible]	[illegible]	[illegible]
M1224	.22	[illegible]	[illegible]	[illegible]	[illegible]
M1274	.27	[illegible]	[illegible]	[illegible]	[illegible]
M1334	.33	[illegible]	[illegible]	[illegible]	[illegible]
M1394	.39	[illegible]	[illegible]	[illegible]	[illegible]
M1474	.47	[illegible]	[illegible]	[illegible]	[illegible]

PANASONIC METALLIZED POLYESTER CAPACITORS

50 VDC plus minus 10% TOLERANCE

[illegible]

PANASONIC RESIN DIPPED TANTALUM CAPACITORS

[illegible]

PANASONIC DISC CAPACITORS

[illegible]

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RCA Cosmac Super Elf Computer $106.95

Compare features before you decide to buy any other computer. There is no other computer on the market today that has all the desirable benefits of the **Super Elf** for so little money. The Super Elf is a small single board computer that does many **big** things. It is an excellent computer for training and for learning programming with its machine language and yet it is easily **expanded with additional memory, Full Basic, ASCII Keyboards, video character generation, etc.**

Before you buy another small computer, see if it includes the following features: ROM monitor; State and Mode displays; Single step; Optional address displays; Power Supply; Audio Amplifier and Speaker; Fully socketed for all IC's; Real cost of in warranty repairs; Full documentation.

The **Super Elf** includes a **ROM** monitor for program loading, editing and execution with **SINGLE STEP for program debugging** which is not included in others at the same price. With **SINGLE STEP** you can see the microprocessor chip operating with the **unique Quest** address and data bus displays **before, during and after executing** instructions. Also, CPU mode and instruction cycle are decoded and displayed on 8 LED indicators.

An RCA 1861 **video graphics** chip allows you to connect to your own TV with an inexpensive video modulator to do graphics and games. There is a **speaker system** included for writing your own music or using many music programs already written. The speaker amplifier may also be used to drive relays for control purposes.

A 24 key **HEX keyboard** includes 16 HEX keys plus **load, reset, run, wait, input, memory protect, monitor select** and **single step**. Large, on board displays provide output and optional **high and low address**. There is a 44 pin standard connector slot for PC cards and a 50 pin connector slot for the Quest Super Expansion Board. Power supply and sockets for **all** IC's are included in the price plus a detailed 127 pg. instruction manual which now includes over 40 pgs. of software info. Including a series of lessons to help get you started and a music program and graphics target game.

Many schools and universities are using the Super Elf as a course of study. OEM's use it for training and research and development.

Remember, other computers only offer Super Elf features at additional cost or not at all. **Compare before you buy. Super Elf Kit $106.95, High address option $8.95, Low address option $9.95. Custom Cabinet** with drilled and labelled plexiglass front panel **$24.95.** Expansion Cabinet with room for 4 S-100 boards **$41.00. NiCad Battery Memory Saver Kit $6.95.** All kits and options also come completely assembled and tested.

Questdata, a 12 page monthly software publication for 1802 computer users is available by subscription for $12.00 per year.

Tiny Basic Cassette **$10.00**, on ROM **$38.00**, original Elf kit board **$14.95.**

Super Expansion Board with Cassette Interface $89.95

This is truly an astounding value! This board has been designed to allow **you** to decide how you want it optioned. **The Super Expansion Board comes with 4K of low power RAM** fully addressable anywhere in 64K with built-in memory protect and **a cassette interface**. Provisions have been made for all other options on the same board and it fits neatly into the hardwood cabinet alongside the **Super Elf**. The board includes slots for up to 6K of **EPROM** (2708, 2758, 2716 or TI 2716) and is **fully socketed**. EPROM can be used for the monitor and Tiny Basic or other purposes.

A 1K Super ROM Monitor $19.95 is available as an on board option in 2708 EPROM which has been preprogrammed with a program loader/editor and error checking multi file cassette read/write software, (relocatible cassette file) another exclusive from Quest. It includes register save and readout, block move capability and video graphics driver with blinking cursor. Break points can be used with the register save feature to isolate program bugs quickly, then follow with single step. The Super Monitor is written with subroutines allowing users to take advantage of monitor functions simply by calling them up. Improvements and revisions are easily done with the monitor. If you have the **Super Expansion Board** and **Super Monitor** the monitor is up and running at the push of a button.

Other on board options include **Parallel Input and Output Ports with full handshake**. They allow easy connection of an ASCII keyboard to the input port. **RS 232 and 20 ma Current Loop** for teletype or other device are on board and if you need more memory there are two **S-100** slots for static RAM or video boards. A Godbout 8K RAM board is available for $135.00. Also a 1K Super Monitor version 2 with video driver for full capability display with Tiny Basic and a video interface board. **Parallel I/O Ports $9.85, RS 232 $4.50, TTY 20 ma I/F $1.95, S-100 $4.50. A 50 pin connector set** with ribbon cable is available at $12.50 for easy connection between the **Super Elf** and the **Super Expansion Board.**

The Power Supply Kit for the Super Expansion Board is a 5 amp supply with multiple positive and negative voltages $29.95. Add $4.00 for shipping. Prepunched frame $7.50. Case $10.00. Add $1.50 for shipping.

Multi-volt Computer Power Supply

8v 5 amp, ±18v .5 amp, 5v 1.5 amp, −5v .5 amp, 12v .5 amp, −12 option, ±5v, ±12v are regulated. Kit $29.95. Kit with punched frame $37.45. Woodgrain case $10.00.

60 Hz Crystal Time Base Kit $4.40

Converts digital clocks from AC line frequency to crystal time base. Outstanding accuracy. Kit includes: PC board, IC, crystal, resistors, capacitors and trimmer.

TERMS: $5.00 min. order U.S. Funds. Calif residents add 6% tax.
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Same day shipment. First line parts only. Factory tested. Guaranteed money back. Quality IC's and other components at factory prices.

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For will call only: (408) 988-1640
2322 Walsh Ave.

INTEGRATED CIRCUITS

7400TTL

7400N	17
7402N	17
7404N	19
7409N	.23
7410N	.17
7414N	63
7420N	.17
7422N	1.39
7430N	.20
7442N	50
7445N	69
7447N	60
7448N	69
7450N	.17
7474N	.29
7475N	49
7485N	.88
7489N	2.00
7490N	.43
7492N	43
7493N	43
7495N	69
74100N	90
74107N	.29
74121N	34
74123N	.59
74125N	39
74145N	.69
74150N	.95
74151N	.69
74154N	1.00
74157N	69
74161N	.87
74162N	87
74163N	87
74174N	96
74175N	90
74190N	1.15
74192N	87
74193N	85
74221N	1.55
74298N	1.65
74365N	.66
74366N	.66
74367N	.66

74LS00 TTL

74LS00N	.25
74LS02N	25
74LS04N	25
74LS05N	25
74LS08N	25
74LS10N	25
74LS13N	40
74LS14N	90
74LS20N	.25
74LS22N	.25
74LS28N	41
74LS30N	25
74LS33N	39
74LS38N	30
74LS74N	70
74LS75N	.47
74LS90N	51
74LS93N	.51
74LS95N	1.89
74LS107N	.35
74LS112N	35
74LS113N	35
74LS132N	72
74LS136N	35
74LS151N	67
74LS155N	67
74LS157N	67
74LS162N	.91
74LS163N	.91
74LS174N	95
74LS190N	1.06
74LS221N	1.95
74LS258N	67
74LS367N	1.35

LINEAR

CA3045	90
CA3046	67
CA3081	1.80
CA3082	1.90
CA3089	2.95
LM301 AN/AH	35
LM305H	.87
LM307N	35
LM308N	.89
LM309H	1.15
LM309K	1.50
LM311H/N	90
LM317T/K	2.92
LM318	1.35
LM320K-5	1.20
LM323K-5	6.95
LM320K-12	1.35
LM320K-15	1.35
LM320T-5	1.60
LM320T-8	1.60
LM320T-12	1.50
LM320T-15	1.60
LM324N	1.15
LM339N	1.55
LM340K-5	1.35
LM340K-8	1.35
LM340K-12	1.35
LM340K-15	1.35
LM340K-24	1.35
LM340T-5	1.25
LM340T-8	1.25
LM340T-12	1.25
LM340T-15	1.25
LM340T-18	1.25
LM340T-24	1.25
LM343H	4.50
LM350	7.50
LM370	1.15
LM377	3.00
LM379	5.00
LM380N	1.00
LM381	1.60
LM382	1.60
LM703H	.40
LM709H	28
LM723H/N	50
LM733N	.67
LM741CH	35
LM741N	25
LM747H/N	62
LM748N	35
LM1303N	.82
LM1304	1.10
LM1305	1.27
LM1307	2.00
LM1310	2.75
LM1458	.47
LM1800	1.75
LM1812	7.50
LM1889	3.00
LM2111	1.75
LM2902	1.50
LM3900N	60
LM3905	1.75
LM3909N	61
MC1458V	50
NE540L	2.89
NE550N	65
NE555V	.43
NE556A	.79
NE565A	1.00
NE566V	1.50
NE567V	1.20
NE570B	5.00
NE571B	5.00
78L05	60
78L08	60
78M05	85
75108	1.75
75491CN	50
75492CN	.55
75494CN	.89

A to D CONVERTER

8038B	4.50
8700CJ	13.95
8701CN	22.00
8750CJ	13.95
LD130	9.95
9400CJV/F	7.40
ICL7103	9.50
ICL7107	14.25

CMOS

CD34001 Fair.	50
CD4000	16
CD4001	28
CD4002	.28
CD4006	1.10
CD4007	28
CD4008	28
CD4009	39
CD4010	.39
CD4011	28
CD4012	.28
CD4013	.36
CD4014	86
CD4015	.86
CD4016	.36
CD4017	.94
CD4018	.94
CD4019	28
CD4020	1.02
CD4021	1.02
CD4022	.86
CD4023	28
CD4024	75
CD4025	28
CD4026	1.51
CD4027	.36
CD4028	79
CD4029	1.02
CD4030	28
CD4035	1.02
CD4040	1.02
CD4042	71
CD4043	.63
CD4044	63
CD4046	1.87
CD4049	.36
CD4050	.36
CD4051	1.13
CD4060	1.42
CD4066	.71
CD4068	.40
CD4069	40
CD4070	.40
CD4071	.28
CD4072	28
CD4073	.28
CD4075	28
CD4076	1.75
CD4078	40
CD4081	28
CD4082	.28
CD4116	47
CD4490	5.50
CD4507	1.00
CD4508	4.25
CD4510	1.02
CD4511	94
CD4515	2.52
CD4516	1.10
CD4518	1.02
CD4520	1.02
CD4527	1.51
CD4528	.79
CD4553	3.50
CD4566	2.25
CD4583	4.50
CD4585	1.10
CD40192	3.00
74C00	28
74C04	33
74C10	28
74C14	2.10
74C20	28
74C30	28
74C48	1.95
74C74	.75
74C76	1.40
74C90	1.15
74C93	1.40
74C154	3.00
74C160	1.44
74C175	1.35
74C192	1.65
74C221	2.00
74C905	3.00
74C906	75
74C914	1.95
74C922	5.50
74C923	5.50
74C925	6.95
74C926	6.95
74C927	6.95

INTERFACE

8095	.65
8096	.65
8097	.65
8098	.65
8T09	1.25
8T10	4.50
8T13	3.00
8T20	5.50
8T23	3.10
8T24	3.50
8T25	3.20
8T26	1.69
8T28	2.75
8T97	1.69
8T98	1.69

MOS/MEMORY RAM

2101-1	3.95
2102-1	95
2102AL-4	1.60
21L02-1	1.18
21F02	1.25
2104A-4	4.95
2107B-4	3.75
2111-1	3.75
2112-2	3.95
2114L-3	7.90
4116	10.95
2513B	6.30
MM5262	40
MM5280	3.00
MM5320	9.95
MM5330	5.94
PD411D-3	4.00
PD411D-4	5.00
P5101L	13.95
4200A	9.95
82S25	2.90
91L02A	1.50
HD0165-5	6.95
MM57100	4.50
GIAY38500-1	9.95
MCM6571A	9.95
9368	3.50
4100	10.00
416	16.00

CLOCKS

MM5314	3.90
MM5315	4.00
MM5369	2.10
MM5841	14.45
MM5865	7.95
CT7001	5.80
CT7010	8.95
CT7015	7.25
MM5375AA/N	3.90
MM5375AG/N	4.90
7205	16.50
7207	7.50
7208	15.95
7209	4.95
DS0026CN	3.75
DS0056CN	3.75
MM53104	2.50

MICROPROCESSOR

6800	17.50
6802	18.75
8080A with data	8.95
8085	27.00
Z80A	19.75
8212	2.90
8214	8.00
8216	2.90
8224	2.90
8228	5.35
8251	8.50
8253	10.00
8255	9.25
8257	19.50
8259	19.50
1802CP plas.	13.95
1802DP plas.	17.95
1861P	11.50
CDP1802CD	19.95
CDP1802D	25.00
CDP1861	12.95
6820	9.95
6850	12.95
6502	12.50
6504	16.50
6522	13.60

UART/FIFO

AY5-1013	5.50
AY5-1014	7.50
3341	6.95

PROM

1702A	3.95
N82S23	2.95
N82S123	3.50
N82S126	3.75
N82S129	3.75
N82S131	3.75
N82S136	8.75
N82S137	8.75
2708	10.50
DM8577	2.90
8223	2.90
2716TI	29.50
2716 Intel	48.00

CONNECTORS

44 pin edge	2.75
100 pin edge	4.50
100 pin edge WW	5.25

IC SOCKETS
Solder Tin Low Profile

PIN	1 UP	PIN	1UP
8	15	22	30
14	14	24	35
16	16	28	42
18	.27	36	58
20	29	40	.57

3 level wire wrap gold 14 pin 25
2 level 14 pin ww 20

WIRE WRAP LEVEL 3

PIN		PIN	
14	25	24	86
16	33	28	1.00
18	57	40	1.23

CRYSTALS

1 MHz	4.50
2 MHz	4.50
4 MHz	4.25
5 MHz	4.25
10 MHz	4.25
18 MHz	3.90
20 MHz	3.90
32 MHz	3.90
32768 MHz	4.00
1.8432 MHz	4.50
3.5795 MHz	1.20
2.0100 MHz	1.95
2.097152 MHz	4.50
2.4576 MHz	4.50
3.2768 MHz	4.50
5.0688 MHz	4.50
5.185 MHz	4.50
5.7143 MHz	4.50
6.5536 MHz	4.50
14.31818 MHz	4.25
18.432 MHz	4.50
22.1184 MHz	4.50

KEYBOARD ENCODERS

AY5-2376	$12.50
AY5-3600	17.95
74C922	5.50
74C923	5.50
HD0165-5	6.95

D Connectors RS232

DB25P	2.95
DB25S	3.95
Cover	1.50
RS232 Complete Set	6.50
DE9S	1.95
DA15P	2.10
DA15S	3.10

TRANSISTORS

2N1893	40
2N2222A	18
2N2369	.30
2N2904A	20
2N2907A	.25
2N3053	.40
2N3638	25
2N3643	25
2N3904	18
2N3906	18
2N3055	69
2N4400	25
2N4401	75
2N4402	20
TIP31	60
TIP33A	1.00

RESISTORS ¼ watt 5%
10 per type .03 — 1000 per type .012
25 per type .025 — 350 piece pack
100 per type .015 — 5 per type 6.75

KEYBOARDS

56 key ASCII keyboard kit	$67.50
Fully assembled	77.50
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Fully assembled 70.00 Enclosure	14.95

LEDS

Red T018	15
Green, Yellow T018	20
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Green, Orange, Yellow Jumbo	.25
Cliplite LED Mounting Clips	8/$1.25

(specify red, amber, green, yellow, clear)

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Model 150 Bus Grabber Kit	$369.00
Sinclair 3½ Digit Multimeter	$59.95
Clock Calendar Kit	$23.95
2.5 MHz Frequency Counter Kit	$37.50
30 MHz Frequency Counter Kit	$47.75

TRANSFORMERS

6V 300 ma	3.25
12 Volt 300 ma transformer	1.25
12.6V CT 600 ma	3.75
12V 250 ma wall plug	2.95
12V CT 250 ma wall plug	3.50
24V CT 400 ma	3.95
10V 1.2 amp wall plug	4.85
12V 6 amp	12.95

DISPLAY LEDS

MAN1	CA	270	2.90
MAN3	CC	125	.39
MAN72/74	CA/CA	300	1.00
DL704	CC	300	1.25
DL707/DL707R	CA	300	1.00
DL727/728	CA/CC	500	1.90
DL747/750	CA/CC	600	1.95
DL750	CC	600	1.95
FND359	CC	357	.70
FND500/507	CC/CA	500	1.35
FND503/510	CC/CA	500	90
FND800/807	CC/CA	800	2.20
3 digit Bubble			.60
4 digit Bubble			.80
DG8 Fluorescent			1.75
DG10 Fluorescent			1.75
5 digit 14 pin display			1.00
NSN69 9 digit display			60
7520 Clairex photocells			.39
TIL311 Hex			9.50

MA1002A	8.95
MA1012A	8.95
102P3 transformer	2.25

North Star Floppy Disk Kit	$665.00
Additional Drive Kit	415.00

Rockwell AIM 65 Computer

6502 based single board with full ASCII keyboard and 20 column thermal printer. 20 char. alphanumeric display, ROM monitor, fully expandable. $375.00. 4K version $450.00. 4K Assembler $85.00. 8K Basic Interpreter $100.00. Power supply assy. in case $60.00. AIM 65 in thin briefcase with power supply $485.00.

Not a Cheap Clock Kit $14.95

Includes everything except case. 2-PC boards. 6-.50" LED Displays. 5314 clock chip, transformer, all components and full instructions. Orange displays also avail. **Same kit w/.80" displays. Red only. $21.95 Case $11.75**

Video Modulator Kit $8.95

Convert your TV set into a high quality monitor without affecting normal usage. Complete kit with full instructions.

S-100 Computer Boards

8K Static RAM Kit Godbout	$135.00
16K Static RAM Kit	265.00
24K Static RAM Kit	423.00
32K Dynamic RAM Kit	310.00
64K Dynamic RAM Kit	470.00
8K/16K Eprom Kit (less PROMS)	**$89.00**
Video Interface Kit	**$139.00**
Motherboard $39. Extender Board	**$8.99**

79 IC Update Master Manual $35.00

Complete IC data selector, 2500 pg. master reference guide. Over 50,000 cross references. Free update service through 1979. Domestic postage $3.50. 1978 IC Master closeout $19.50. No foreign orders.

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DC clock with 4-.50" displays. Uses National MA-1012 module with alarm option. Includes light dimmer, crystal timebase PC boards. Fully regulated, comp. instructs. Add $3.95 for beautiful dark gray case. Best value anywhere.

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Full six digit battery operated. 2–5 volts. 3.2768 MHz crystal accuracy. Times to 59 min., 59 sec., 99 1/100 sec. Times std., split and Taylor. 7205 chip, all components minus case. Full instructions.

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Batt/AC oper. 0.1mv–1000v. 5 ranges, 0.5% accur. Resistance 6 low power ranges 0.1 ohm–20M ohm. DC curr. .01 to 100ma. Hand held, ½" LCD displays, auto zero, polarity, overrange. $69.95.

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Active Electronic Sales Corp.

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2708 1K x 8 450 NS		$9.95
2716/TMS2516 16K (2K x 8) 450NS (1 power supply - Intel version)		$49.95
TMS2716 16K (2K x 8) 450NS (3 power supplies)		$34.95

MOS Static RAM's

Part No.		Price
2101 1K 22 PIN	~~$2.39~~	$1.98
2102LFPC 1K 350NS (Low Power)		$1.19
2102-1PC 1K 450NS	~~$.99~~	0.94
2114 4K (1K · 4) 300NS	~~$6.75~~	$5.99

MOS Dynamic RAM's

Part No.	Price
4K 4027 4K (4K x 1) 300NS 16 PIN	$2.95
16K 416-3 16K (16K x 1) 200NS 16PIN	$12.95
16K 416-5 16K (16K x 1) 300NS 16PIN	$10.95

UART's

Part No.		Price
AY5-1013A	~~$4.50~~	$4.25
AY3-1015	~~$5.50~~	$5.25

1K CMOS RAM

Part No.		Price
5101 450NS (Low Power)	~~$4.50~~	$3.95

Power Transistors

054	.65	60V	NPN
055	.69	70V	NPN
442	1.50	160V	NPN
771	1.95	50V	NPN
772	1.95	100V	NPN
773	2.50	160V	NPN
29	.50	1A 60V	NPN
30	.50	1A 60V	PNP
31	.55	3A 60V	NPN
32	.55	3A 60V	PNP
41	.98	6A 60V	NPN
42	1.10	6A 60V	PNP
115	.85	2A 60V	PNP
125	.85	5A 60V	PNP
127	.95	5A 100V	PNP
2955	1.10	15A 60V	PNP
3055	.92	15A 60V	NPN

SCR

D .34 5.0 AMP 400V TO-220

MICROPROCESSOR CHIP SETS

Part No.	Price	Part No.	Price
8080A	6.95	6800	6.95
8085	12.95	6802	11.95
8212	3.45	6810	3.95
8214	3.95	6820	3.95
8216	3.25	6821	3.95
8224	2.95	6850	4.25
8226	2.25	6852	3.95
8228	3.98	SCP1802LE	9.95
8238	4.75	SCP1824LE	3.50
8251	5.75	SCP1852LE	1.50
8253	14.95	SCP1853LE	1.45
8255	5.75	SCP1854LE	6.95
8257	10.95	SCP1856LE	1.95
8259	14.95	SCP1858LE	1.95
		SCP1859LE	1.50

Zilog

Z80-CPU	$9.95
Z80A-CPU	$11.95
Z80-PIO	$7.95
Z80A-PIO	$8.95
Z80-CTC	$7.95
Z80A-CTC	$8.95
Z80-DMA	$24.95
Z80-SIO/0	$35.00
Z80A-SIO/0	$45.00
Z80-SIO/1	$35.00
Z80A-SIO/1	$45.00
Z80-SIO/2	~~$35.00~~ $35.00
Z80A—SIO/2	~~$50.00~~ $45.00

BOURNS®

POTENTIOMETERS

TRIMPOT® Potentiometers

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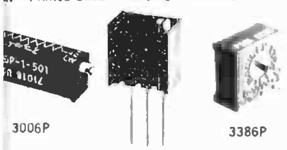

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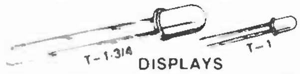

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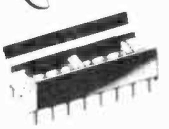

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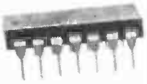

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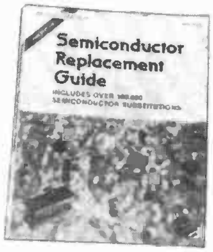

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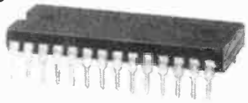

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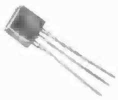

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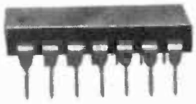

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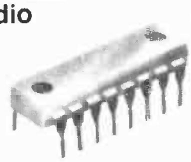

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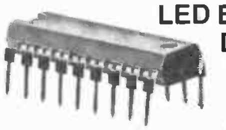

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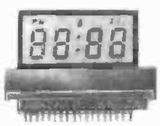

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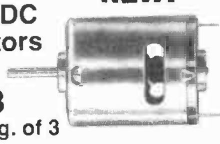

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CD4066	79	CD4511	1 29
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74C107	1 25	74C193	2 49
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NE561B	5 00	75453CN	39
NE562B	5 00	75454CN	39
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NE566CN	1 75	75492CN	89
NE567V/H	99	75493N	89
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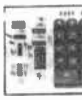

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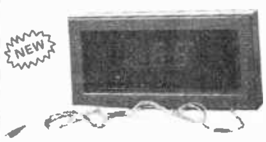

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3.95 each

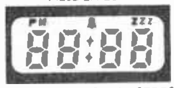
TV GAME CHIP AND CRYSTAL
AY-3-8500-1 and 2.01 MHZ Crystal (Chip & Crystal includes score display, 6 games and select angles, etc 7.95/set

DISCRETE LEDS

.200" dia.				.125" dia.		
XC556R	red	5/$1		XC209R	red	5/$1
XC556G	green	4/$1		XC209G	green	4/$1
XC556Y	yellow	4/$1		XC209Y	yellow	4/$1
XC556C	clear	4/$1				
.200" dia.				.185" dia.		
XC22R	red	5/$1		XC526R	red	5/$1
XC22G	green	4/$1		XC526G	green	4/$1
XC22Y	yellow	4/$1		XC526Y	yellow	4/$1
.170" dia.				XC526C	clear	4/$1
MV10B	red	4/$1		.190" dia.		
.085" dia.				XC111R	red	5/$1
MV50	red	6/$1		XC111G	green	4/$1
				XC111Y	yellow	4/$1
				XC111C	clear	4/$1

INFRA-RED LED
1/4"x1/4"x1/16" flat
5/$1

TIMEX T1001
LIQUID CRYSTAL DISPLAY
CLASS II
FIELD EFFECT



4 DIGIT 5 CHARACTERS
THREE ENUNCIATORS
2.00" x 1.20" PACKAGE
INCLUDES CONNECTOR

T1001-Transmissive	$7.95
T1001A-Reflective	8.25

DISPLAY LEDS

TYPE	POLARITY	HT	PRICE	TYPE	POLARITY	HT	PRICE
MAN 1	Common Anode red	270	2 95	MAN 6730	Common Anode-red ±1	560	99
MAN 2	5 x 7 Dot Matrix-red	300	4 95	MAN 6740	Common Cathode-red-D D	560	99
MAN 3	Common Cathode red	125	25	MAN 6750	Common Cathode-red ±1	560	99
MAN 4	Common Cathode-red	187	1 95	MAN 6760	Common Anode-red	560	99
MAN 7G	Common Anode-green	300	1 25	MAN 6780	Common Cathode-red	560	99
MAN 7Y	Common Anode-yellow	300	99	DL701	Common Anode-red ±1	300	99
MAN 72	Common Anode-red	300	99	DL704	Common Cathode-red	300	99
MAN 74	Common Cathode-red	300	1 25	DL707	Common Anode-red	300	99
MAN 82	Common Anode-yellow	300	99	DL728	Common Cathode red	500	1 49
MAN 84	Common Cathode-yellow	300	99	DL741	Common Anode red	600	1 25
MAN 3620	Common Anode-orange	300	99	DL746	Common Anode-red ±1	630	1 49
MAN 3630	Common Anode orange ±1	300	99	DL747	Common Anode-red	600	1 49
MAN 3640	Common Cathode-orange	300	99	DL749	Common Cathode red ±1	630	1 49
MAN 4610	Common Anode-orange	300	99	DL750	Common Cathode-red	600	1 49
MAN 4640	Common Cathode-orange	400	99	DL338	Common Cathode-red	110	35
MAN 4710	Common Anode-red	400	99	FND70	Common Cathode	250	69
MAN 4730	Common Anode-red ±1	400	99	FND358	Common Cathode ±1	357	99
MAN 4740	Common Cathode-red	400	99	FND359	Common Cathode	357	75
MAN 4810	Common Anode-yellow	400	99	FND503	Common Cathode(FND500)	500	99
MAN 4840	Common Cathode yellow	400	99	FND507	Common Anode (FND510)	500	99
MAN 6610	Common Anode-orange D D	560	99	5082-7730	Common Anode-red	300	1 30
MAN 6630	Common Anode-orange ±1	560	99	HDSP-3400	Common Anode red	800	2 10
MAN 6640	Common Cathode-orange-D D	560	99	HDSP-3403	Common Cathode red	800	2 10
MAN 6650	Common Cathode-orange ±1	560	99	5082-7300	4 x 7 sgl Digit-RHDP	600	19 95
MAN 6660	Common Anode-orange	560	99	5082-7302	4 x 7 Sgl Digit-LHDP	600	19 95
MAN 6680	Common Cathode-orange	560	99	5082-7304	Overrange character (±1)	600	15 00
MAN 6710	Common Anode red-D D	560	99	5082-7340	4 x 7 Sgl Digit-Hexadecimal	600	22 50

EXAR

XR205	$8.40	JE2206KA	14.95	XR2242CP	1.50
XR210	4.40	JE2206KB	19.95	XR2264	4.25
XR215	4.40	XR1800	3.20	XR2556	3.20
XR320	1.55	XR2206	4.40	XR2567	2.99
XR-L555	1.50	XR2207	3.85	XR3403	1.25
XR555	.39	XR2208	5.20	XR4136	1.25
XR556	.99	XR2209	1.75	XR4151	2.85
XR567CP	.99	XR2211	5.25	XR4194	4.95
XR567CT	1.25	XR2212	4.35	XR4202	3.60
XR1310P	1.30	XR2240	3.45	XR4212	2.05
XR1468CN	3.85			XR4558	.75
XR1488	1.39			XR4739	1.15
XR1489	1.39			XR4741	1.47

DIODES

TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
1N746	3.3	400m	4/1.00	1N4002	100 PIV	1 AMP	12/1.00
1N751	5.1	400m	4/1.00	1N4003	200 PIV	1 AMP	12/1.00
1N752	5.6	400m	4/1.00	1N4004	400 PIV	1 AMP	12/1.00
1N753	6.2	400m	4/1.00	1N4005	600 PIV	1 AMP	10/1.00
1N754	6.8	400m	4/1.00	1N4006	800 PIV	1 AMP	10/1.00
1N757	9.0	400m	4/1.00	1N4007	1000 PIV	1 AMP	10/1.00
1N759	12.0	400m	4/1.00	1N3600	50	200m	6/1.00
1N959	8.2	400m	4/1.00	1N4148	75	10m	15/1.00
1N965	15	400m	4/1.00	1N4154	35	10m	12/1.00
1N5232	5.6	500m	28	1N4305	75	25m	15/1.00
1N5234	6.2	500m	28	1N4734	5.6	1w	28
1N5235	6.8	500m	28	1N4736	6.8	1w	28
1N5236	7.5	500m	28	1N4738	8.2	1w	28
1N5242	12	500m	28	1N4742	12	1w	28
1N5245	15	500m	28	1N4744	15	1w	28
1N456	25	40m	6/1.00	1N1183	50 PIV	35 AMP	1.60
1N458	150	7m	6/1.00	1N1184	100 PIV	35 AMP	1.70
1N485A	180	10m	5/1.00	1N1185	150 PIV	35 AMP	1.70
1N4001	50 PIV	1 AMP	12/1.00	1N1186	200 PIV	35 AMP	1.80
				1N1188	400 PIV	35 AMP	3.00

SCR AND FW BRIDGE RECTIFIERS

C36D	15A @ 400V	SCR(2N1849)	$1.95
C38M	35A @ 600V	SCR	1.95
2N2328	1.6A @ 300V	SCR	.50
MDA 980-1	12A @ 50V	FW BRIDGE REC	1.95
MDA 980-3	12A @ 200V	FW BRIDGE REC	1.95

RCA LINEAR

CA3013T	2 15	CA3082N	2 00
CA2023T	2 56	CA3083N	1 60
CA3035T	2 48	CA3086N	85
CA3039T	1 35	CA3089N	3 75
CA3046N	1 30	CA3130T	1 39
CA3059N	3 25	CA3140T	1 25
CA3060N	3 25	CA3160T	1 25
CA3080T	85	CA3401N	49
CA3081N	2 00	CA3600N	3 50

CALCULATOR CHIPS/DRIVERS

MM5725	$2 95
MM5738	2 95
DM8864	2 00
DM8865	1 00
DM8887	75
DM8889	75
9374 7 seg C A LED driver	1 50

CLOCK CHIPS

MM5309	$4 95
MM5311	4 95
MM5312	4 95
MM5314	4 95
MM5316	6 95
MM5318	9 95
MM5369	2 95
MM5387 1998A	4 95
MM5841	9 95

MOTOROLA

MC1408L7	$4 95
MC1408L8	5 75
MC1439L	2 95
MC3022P	2 95
MC3061P	3 50
MC4016(74416)	7 50
MC4024P	3 95
MC4040P	6 95
MC4044P	4 50

IC SOLDERTAIL — LOW PROFILE (TIN) SOCKETS

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin LP	$.17	16	15	22 pin LP	$ 37	36	35
14 pin LP	20	19	18	24 pin LP	38	37	36
16 pin LP	22	21	20	28 pin LP	45	44	43
18 pin LP	29	28	27	36 pin LP	60	59	58
20 pin LP	34	32	30	40 pin LP	63	62	61

SOLDERTAIL STANDARD (TIN)

	1-24	25-49	50-100		1-24	25-49	50-100
14 pin ST	$ 27	25	24	24 pin ST	$ 99	90	81
16 pin ST	30	27	25	36 pin ST	1 39	1 26	1 15
18 pin ST	35	32	30	40 pin ST	1 59	1.45	1.30
24 pin ST	49	45	42				

SOLDERTAIL STANDARD (GOLD)

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin SG	$ 30	27	24	24 pin SG	$ 70	63	57
14 pin SG	35	32	29	28 pin SG	1 10	1 00	90
16 pin SG	38	35	32	36 pin SG	1 65	1.40	1 26
18 pin SG	52	47	43	40 pin SG	1 75	1 59	1 45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin WW	$ 39	38	31	22 pin WW	$ 95	85	75
10 pin WW	45	41	37	24 pin WW	1.05	95	85
14 pin WW	39	38	37	28 pin WW	1 40	1 25	1 10
16 pin WW	43	42	41	36 pin WW	1 59	1 45	1 30
18 pin WW	75	68	62	40 pin WW	1 75	1.55	1 40

TRANSISTORS

C106B1	.50	2N3055	.89	2N3904	4/1.00
MPSA05	.30	MJE3055	1.00	2N3905	4/1.00
MPSA06	5/1.00	2N3392	5/1.00	2N3906	4/1.00
TIS97	6/1.00	2N3398	5/1.00	2N4013	3/1.00
TIS98	6/1.00	PN3567	3/1.00	2N4123	6/1.00
40409	1.75	PN3568	4/1.00	PN4249	4/1.00
40410	1.75	PN3569	4/1.00	PN4250	4/1.00
40673	1.75	MPS3638A	5/1.00	2N4400	4/1.00
2N918	4/1.00	MPS3702	5/1.00	2N4401	4/1.00
2N2219A	2/1.00	2N3704	5/1.00	2N4402	4/1.00
2N2221A	4/1.00	MPS3704	5/1.00	2N4403	4/1.00
2N2222A	5/1.00	2N3705	5/1.00	2N4409	5/1.00
PN2222 Plastic	7/1.00	MPS3705	5/1.00	2N5086	4/1.00
2N2369	5/1.00	2N3706	5/1.00	2N5087	4/1.00
2N2369A	4/1.00	MPS3706	5/1.00	2N5088	4/1.00
MPS2369	5/1.00	2N3707	5/1.00	2N5089	4/1.00
2N2484	4/1.00	2N3711	5/1.00	2N5129	5/1.00
2N2906	4/1.00	2N3724A	.65	PN5134	5/1.00
2N2907	5/1.00	2N3725A	1.00	PN5138	5/1.00
PN2907 Plastic	7/1.00	2N3772	2.25	2N5139	5/1.00
2N2925	5/1.00	2N3823	1.00	2N5210	5/1.00
MJE2955	1.25	2N3903	5/1.00	2N5449	3/1.00
2N3053	2/1.00			2N5951	3/1.00

1/4 WATT RESISTOR ASSORTMENTS – 5%

ASST. 1	5 ea	50 PCS	$1.75
ASST. 2	5 ea	50 PCS	1.75
ASST. 3	5 ea	50 PCS	1.75
ASST. 4	5 ea	50 PCS	1.75
ASST. 5	5 ea	50 PCS	1.75
ASST. 6	5 ea	50 PCS	1.75
ASST. 7	5 ea	50 PCS	1.75

ASST. 8R Includes Resistor Assortments 1-7 (350 PCS.) $9.95 ea.

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

	1-9	10-99	100		1-9	10-99	100
10 pf	.05	.04	.03	.001µF	.05	.04	.035
22 pf	.05	.04	.03	.0047µF	.05	.04	.035
47 pf	.05	.04	.03	.01µF	.05	.04	.035
100 pf	.05	.04	.03	.022µF	.06	.05	.04
220 pf	.05	.04	.03	.047µF	.06	.05	.04
470 pf	.05	.04	.035	.1µF	.12	.09	.075

100 VOLT MYLAR FILM CAPACITORS

.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022	.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	.28	.23	.17	1.5/35V	.30	.26	.21
.15/35V	.28	.23	.17	2.2/25V	.31	.27	.22
.22/35V	.28	.23	.17	3.3/25V	.31	.27	.22
.33/35V	.28	.23	.17	4.7/25V	.32	.28	.23
.47/35V	.28	.23	.17	6.8/25V	.36	.31	.25
.68/35V	.28	.23	.17	15/25V	.63	.50	.40
1.0/35V	.28	.23	.17				

MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS

Axial Lead				Radial Lead			
.47/50V	.15	.13	.10	.47/25V	.15	.13	.10
1.0/50V	.16	.14	.11	.47/50V	.16	.14	.11
3.3/50V	.14	.12	.09	1.0/16V	.15	.13	.10
4.7/25V	.15	.13	.10	1.0/25V	.15	.13	.10
10/25V	.15	.13	.10	1.0/50V	.16	.14	.11
10/50V	.16	.14	.12	4.7/16V	.15	.13	.10
22/25V	.17	.15	.12	4.7/25V	.15	.13	.10
22/50V	.24	.20	.18	4.7/50V	.16	.14	.11
47/25V	.19	.17	.15	10/16V	.14	.12	.09
47/50V	.25	.21	.19	10/25V	.15	.13	.10
100/25V	.24	.20	.18	10/50V	.16	.14	.12
100/50V	.35	.30	.28	47/50V	.24	.21	.19
220/25V	.32	.28	.25	100/16V	.19	.15	.14
220/50V	.45	.41	.38	100/25V	.24	.20	.18
470/25V	.33	.29	.27	100/50V	.35	.30	.28
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by Harold S. Engelsohn

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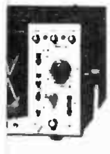
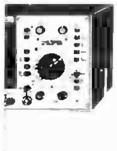


The 30 MHz Dual Trace Oscilloscope with Delay

- 5mV sensitivity.
- Built-in delay line.
- Single shot trigger (CH-1, CH-2).
- 5" P-D-A CRT assures brighter, sharper trace.
- 20 nS/cm sweep capability plus 11.7 nSec rise time.

LIST PRICE: $1120 OUR PRICE: $935



25 MHz Dual Trace, Oscilloscope Delayed Sweep

- Sweep delay, continuously variable from 1 uSec to 5 Sec.
- 5 mV/Div. Vertical Sensitivity with ±3% acc.
- Rectangular CRT with internal graticule.
- 14 nSec rise time.
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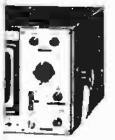
LIST PRICE: $1530 OUR PRICE: $1350



The 20 MHz Dual Trace Oscilloscope

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- Front panel X-Y operation.
- 17.5 nanosec rise time.
- Automatic trigger from either channel, including TV sync.
- 10 mV sensitivity.

LIST PRICE $835 •OUR PRICE: $708

The 20 MHz Single Trace Triggered Oscilloscope

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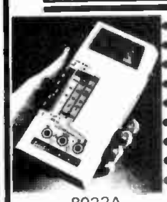

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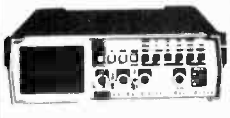
8022A OUR PRICE: $129
8020A $169



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- True RMS for ac accuracy
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- One year accuracy reduces calibration costs
- COMMON floatable to 500V
- Recessed jacks reduce shock hazard
- Current mode fuse protection to 600V
- Voltage mode transient protection to 6 kV
- Autozero and autopolarity
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- Resistance resolution to 0.001Ω with 8012A
- Built-in batteries and charger (Option -01)
- Rugged enough for field or bench

8010A OUR PRICE $239

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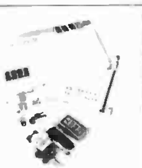

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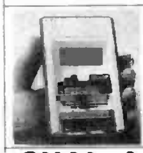

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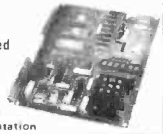

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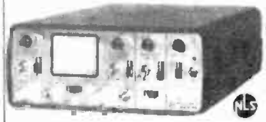

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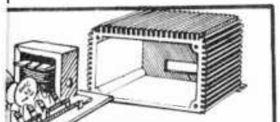

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ELECTRONICS WORLD®
Personal Electronics News

Sun power counts traffic in Glendale, AZ. It is an electronic vehicle counting system built around low-voltage, low-current microprocessor technology that draws electrical power from a panel of solar cells. The "StreeterAmet MR Traficounter" system counts vehicular traffic in six lanes via six inductive road loops. Lead/gel cells on constant trickle charge from the solar cells serve as backup for the batteries supplied with the Traficounter to give anywhere from 15 to 30 days of power if the sun fails to shine for that long a time.

Algebraic notation loses out to Reverse Polish Notation (RPN) calculator system, according to a study conducted at the State University of New York at Buffalo with 20 test subjects. Furthermore, most people have no idea how their calculators operate or how to use them efficiently, it was found. RPN users had strong preference for their system, claiming greater speed, accuracy, and efficiency. When algebraic-only users were trained in RPN, several subjects informally expressed a desire to buy RPN calculators. It was stated that manufacturers have ignored the thought processes that go on as the user operates the calculator and that, as a result, some calculators appear to be inefficient primarily because the user cannot grasp the internal logic of the calculator.

Private receiving equipment for TV satellite transmissions may be licensed or otherwise regulated by the FCC if the National Association of Broadcasters has its way.

The NAB has filed a petition with the Commission asking that it conduct inquiries and adopt policies before any "widespread proliferation of receive-only earth stations operated by members of the viewing audience" occurs. The NAB claims that such a development could hurt the market for TV programming, threaten the conventional system for relaying TV signals, and adversely affect local video services.

According to estimates, some 5,000 such earth stations, most of which have not been subjected to official FCC procedures, exist. However, there are an estimated 4.2 million households with marginal or nonexistent TV reception capability--because of location--that are considered to constitute a potential market for receive-only terminal equipment. Cost of a private earth station is said to range between $1,000 and $8,000, depending on the signal quality desired.

An ultrathin, "paper" battery has been announced by the Electronic Components Division of Panasonic Company. The new battery is well suited for electronic devices with low current drains (20 to 50 μA), such as calculators, watches, and cameras, and comes in a wide variety of shapes. It operates in essentially the same manner as a conventional zinc/acid dry cell, except that stainless steel plate replaces the carbon electrode and zinc perchlorate is used in the electrolyte instead of ammonium or zinc chloride, which would attack the stainless steel. Specifications for a battery measuring 70 x 20 x 0.8 mm are: nominal voltage 1.4 V, discharge capability 27 mAh, expected lifetime in a calculator with an LCD display 1000 hours.

Ease in shopping for computers is the goal of a new service implemented by the Southern California Computer Dealers Association. By calling the toll-free number (800) 432-7257 Ext. 815, anyone in the area from San Diego to Santa Barbara can reach the Consumer Computer Information Service. The voice that answers will ask the caller his location and will then supply the names, addresses, and phone numbers of the three nearest computer stores.

A national radio paging network for consumers is being developed by the British Post Office. Hopes are that it will serve about 1.6-million customers by the mid-1980s. The campaign encourages private, rather than business, use of the net. The government initiated its paging service in a 1973 trial in the Thames Valley, where about 2500 customers are currently served. In late 1976, the service was extended to London, where current usage is about 18,000. Thousands of new pagers, purchased from Motorola Ltd., are on order to service the Birmingham and Manchester areas this year.

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