Popular Electronics®

WORLD'S LARGEST SELLING ELECTRONICS MAGAZINE SEPTEMBER 1981/$1

For Home Safety: A Toxic Gas Alarm

For Realistic Music: An Audio Peak Extender

For Better Circuits: VMOS Power Devices

...able

...al Computer

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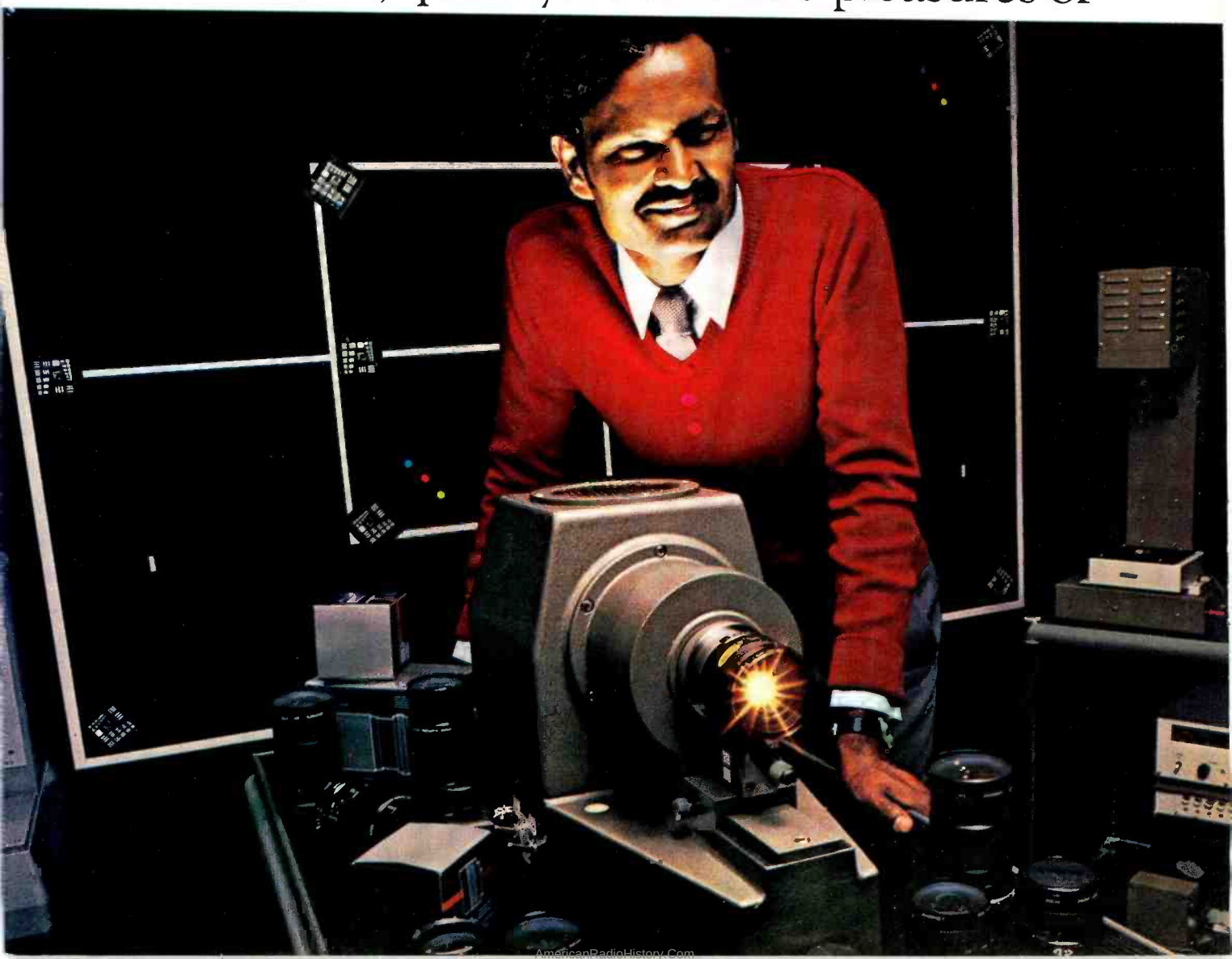
Reddy Chirra improves his vision with an Apple.

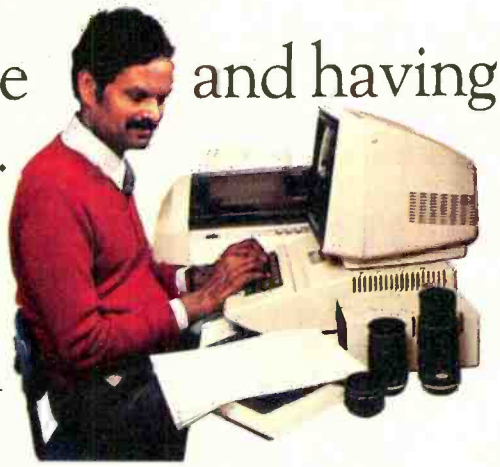
Reddy is an optical engineer who's used to working for big companies and using big mainframes.

But when he started his own consulting business, he soon learned how costly mainframe time can be. So he bought himself a 48K Apple II Personal Computer.

And, like thousands of other engineers and scientists, quickly learned the pleasures of



cutting down on shared time and having his own tamper-proof data base.



His Apple can handle formulas with up to 80 variables and test parameters on 250 different optical glasses.

He can even use BASIC, FORTRAN, Pascal and Assembly languages.

And Apple's HI-RES graphics come in handy for design.

Reddy looked at other microcomputers, but chose Apple for its in-depth documentation, reliability and expandability.

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CIRCLE NO. 6 ON FREE INFORMATION CARD

SEPTEMBER 1981 VOLUME 19, NUMBER 9

Popular Electronics

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE

Feature Articles

Construction Articles

Equipment Reviews

Columns

Departments

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Popular Electronics (ISSN 0032-4485) September 1981, Volume 19, Number 9. Published monthly by Ziff-Davis Publishing Co., at One Park Ave., New York, NY 10016. Richard P. Friese, President; Selwyn Taubman, Treasurer; Bertram A. Abrams, Secretary. One year subscription rate for U.S. and Possessions, $15.00; Canada, $20.00; all other countries, $23.00 (cash orders only, payable in U.S. currency). Second Class Postage Paid at New York, N.Y. 10016 and at additional mailing offices. Authorized as second class mail by the Post Office Dept., Ottawa, Canada, and for payment of postage in cash. POPULAR ELECTRONICS including ELECTRONICS WORLD, Trade Mark Registered. Indexed in the Reader's Guide to Periodical Literature. Ziff-Davis also publishes Boating, Car and Driver, Cycle, Flying, Popular Photography, Skiing, Stereo Review, Electronic Experimenter's Handbook, and Tape Recording & Buying Guide. Forms 3579 and all Subscription Correspondence: POPULAR ELECTRONICS. Circulation Dept. P.O. Box 2774, Boulder, CO 80302. Please allow at least eight weeks for change of address, enclosing, if possible, an address label from a recent issue. Permissions. Material in this publication may not be reproduced in any form without permission. Requests for permission should be directed to John Babcock, Rights and Permissions, Ziff-Davis Publishing Co., One Park Ave., New York, NY 10016.

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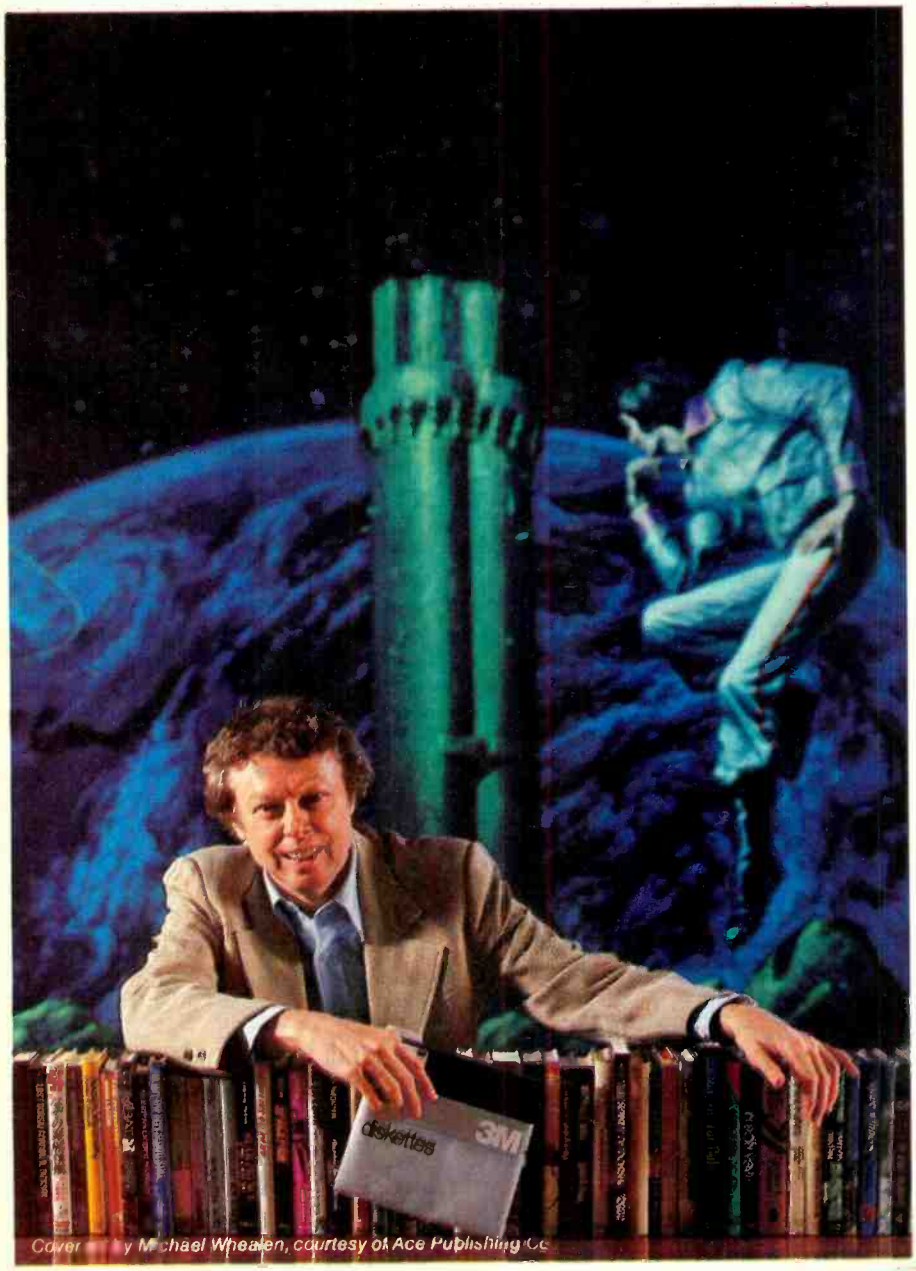

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Gordon R. Dickson,
Science Fiction Author,
Minneapolis, Minnesota

Gordon Dickson: a small businessman whose product is his own imagination. He's written more than 40 novels and 150 short stories; his newest work is *The Final Encyclopedia*. He uses his personal computer and word processing software to maximize his production. All his words—his product—are stored on diskettes. He calls up sentences and paragraphs on demand, and gets more rewrite out of the time available. So he depends on Scotch diskettes to save himself production time.

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CIRCLE NO. 54 ON FREE INFORMATION CARD

EDITORIAL

COMPUTER LITERACY

". . . an essential outcome of contemporary education is computer literacy."—*Mathematics Teacher,* May '78.

More than three years after the above statement was published, the outcome is not as positive as one might wish, though some progress has been made toward the goal. Attitudinally, few people today seriously question the need for computer literacy in the upcoming generation of adults in the U.S. And more and more computers are being purchased by educational institutions for student-related activities as well as for nonteaching purposes. But only 15 percent of all U.S. public schools use computers for the foregoing activities, according to a recent survey by the National Institute of Education.

Before great strides can be made to develop computer literacy through school programs, there must be satisfactory answers to a series of questions. Where does the money come from? For equipment. For software and related computer material. For development of effective curricula. For teacher training.

We know that government funding for educational material is harder to come by than in the past. Certainly, a bad taste remains from the halcyon days of easy federal and state money for education. Much of the equipment bought then now gathers dust in storerooms. We cannot allow this to happen again, of course. Nonetheless, to prepare students today for the computerized society they will face in the future will doubtlessly require governmental assistance.

Along these lines, there have been bills in Congress to establish a national commission to study information technology, another to amend Title III of the Elementary and Secondary Education Act of 1965 to establish a National Center for Personal Computers in Education, and a bill to be reintroduced for federal funds to establish an information clearing house to encourage computer use in school systems.

Other countries are addressing the educational challenge to prepare students for a computerized society. France has a government-funded five-year plan started in 1978 to have a microcomputer in each of its 7,200 secondary schools to train teachers and students in the use of one. Japan, too, has embarked on a funded program for developing computer-assisted instruction, though programming in Kanji-Kana is much more complicated than with our alphabetic language.

Interestingly, Seymour Papert, a math professor at the Massachusetts Institute of Technology, proposes that a child entering school be issued a microcomputer for school and home use. Nice thought, but in an age where even pencils are at a premium, this is unlikely to happen. He also observes that computer teaching to date has been unimaginative and simply mimics traditionally deficient teaching methods. He points out a more innovative method used by the MIT Children's Learning Lab. Here a child is taught a computer language, LOGO, with which he interacts to solve a math problem or learn a new word.

So the problems of adding a fourth "R" to pre-college education are not without challenge. But if we don't embark on developing a computer-literate population in earnest, our economic position will deteriorate as time passes. Furthermore, academically disadvantaged students will fall behind in the new industrial revolution that we're in right now because more affluent students will surely own their own micro just as they own hi-fi stereo components.

Art Salsberg

Popular Electronics

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"No one else gives you as many functions in a handheld DMM.

Now you can move up to Fluke."

We've got great news for people who've been holding out for a high quality, high performance DMM at a moderate price: Fluke's new nine-function model D 804 is now available at select electronics supply stores.

With a suggested U.S. price of only $249 and features you won't find in any other handheld DMM, the D 804 is an exceptional value. Here's why.

Logic level and continuity testing: A real time-saver for troubleshooting passive circuits in pcb's, cables, relay panels and the like. The D 804 has a switch-selectable audible tone and visual symbols to indicate continuity or logic levels.

Direct temperature readings in °C: Used with any K-type thermocouple, the D 804 delivers fully-compensated readings in °C from -20°C to +1265°C, for checking heating and refrigeration systems.

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And more: 0.1% basic dc accuracy, conductance, 26 measurement ranges, battery, safety-designed test leads and a one year parts and labor warranty. A full line of accessories is also available to extend the measurement capabilities of your DMM.

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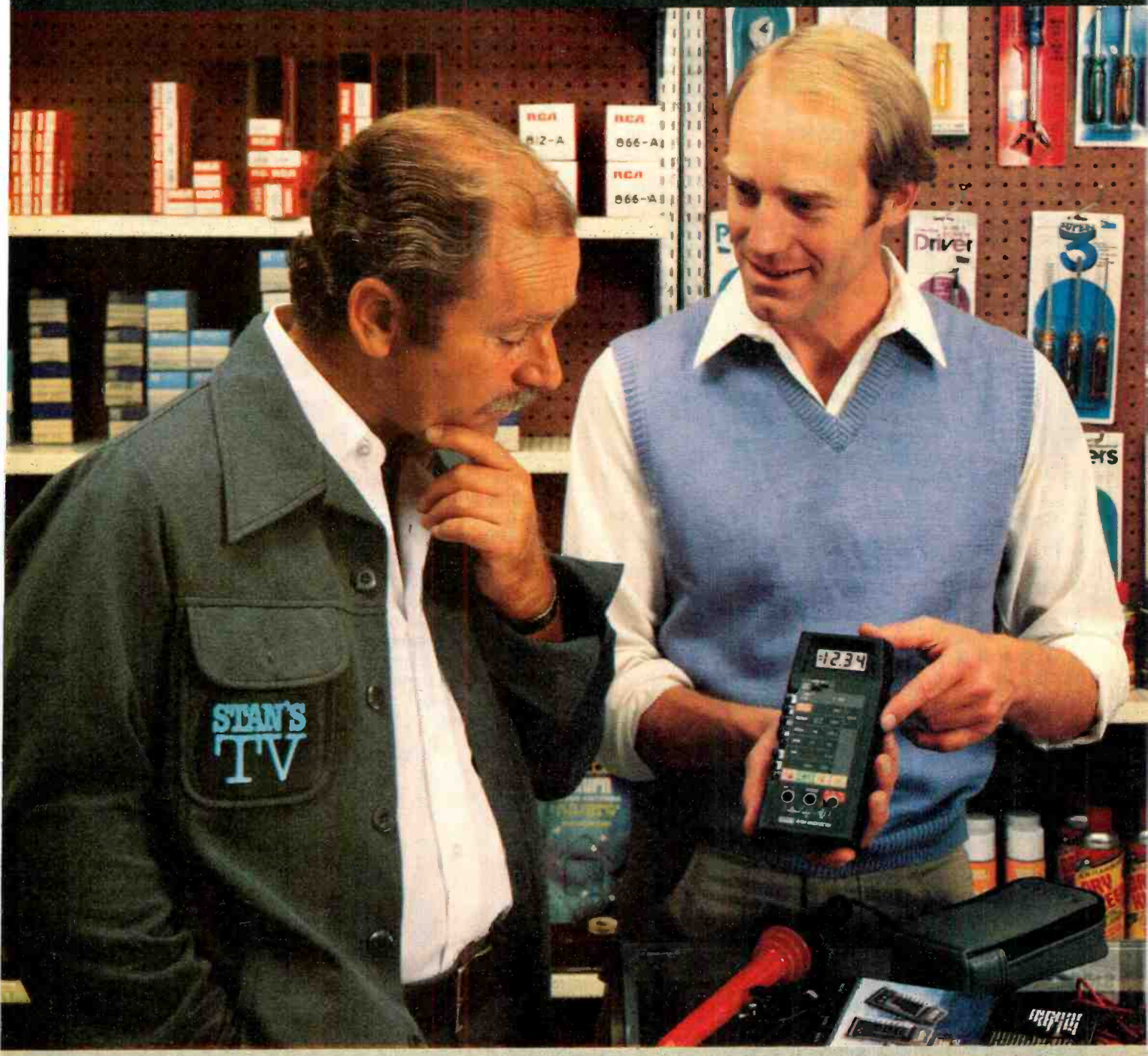
From the world leader in DMM's. Now we've designed one for you.



*Suggested U.S. list price

For technical data circle no.
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If your dealer doesn't carry Series D Multimeters yet, call this number. We'll be happy to tell you who does. 1-800-426-9182

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Pick a strong partner

A computer purchase is the beginning of a long term partnership between you and the people you buy from. Your ongoing need for software and accessories requires a partner who will stand by you with a growing line of products. And nowhere will you find a more complete line of hardware, software and accessories than at your Heathkit Electronic Center. Here are twelve strong reasons to make Heath/Zenith your partner.

1. The All-In-One Computer

The heart of the Heath/Zenith line is the stand-alone *89 Computer.* It's a complete system with built-in 5¼-inch floppy disk drive, professional keyboard and keypad, smart video terminal, two Z80 microprocessors, and two RS-232C serial I/O ports. It comes with 16K RAM, expandable to 64K.

2. Peripherals

These include the popular *Heath/Zenith 19 Smart Video Terminal,* loaded with professional features. And the *14 Line Printer,* priced as low as $495. Other printer brands are on display, including high-speed, typewriter-quality printers.

3. Software

Word processing, includes reliable, easy-to-use Zenith Electronic Typing and powerful, full-featured WORDSTAR.

Small Business Programs, feature General Ledger and Inventory Control.

HUG, Heath Users' Group, offers members a library of over 500 low-cost programs for home, work or play.

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5. Operating Systems

Three versatile systems give you the capability to perform your specific tasks.

CP/M by Digital Research makes your system compatible with thousands of popular CP/M programs.

UCSD P-System with Pascal is a complete program development and execution environment.

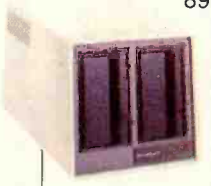
HDOS, Heath Disk Operating System gives you a sophisticated, flexible environment for program construction, storage and editing.

6. Utility Software

Expand the performance range of your computer with a broad selection of utility tools, including the best of *Digital Research* and the complete line of innovative *Softstuff* products.

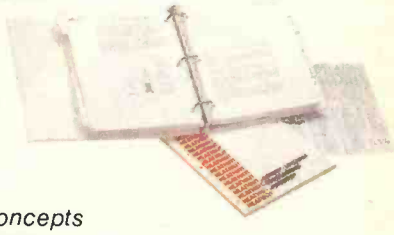
7. Disk Systems

The 8-inch Heath/Zenith 47 Dual Disk System adds over 2 megabytes of storage to your 89 Computer. Diskettes are standard IBM 3740 format, double-sided, double-density.



The 5¼-inch 87 Dual Disk System adds 200K bytes of storage to your 89. Both disk systems feature read/write protection and easy plug-in adaptability.

8. Self-Study Courses



Learn at your own pace with *Programming Courses* that teach you to write and run your own programs in Assembly, BASIC, Pascal or COBOL.

A course on *Computer Concepts for Small Business* gives you the understanding to evaluate the ways a computer can benefit your business.

Personal Computing is a complete introduction to the fundamentals for the novice. Every Heathkit/Zenith course is professionally designed for easy, step-by-step learning.

All Heath/Zenith Computer Products are available completely assembled and tested for commercial use. Or in easy-to-build, money-saving kits.

REASONS TO MAKE COMPUTER PARTNER

9. Expansion Options

Communicate with the outside world through a *Three-port EIA RS-232C Serial Interface*.

Expand RAM to 64K with easy-to-install *expansion chips*.

10. Accessories

Your Heathkit Electronic Center has the latest in modems, black-and-white and color video monitors, computer furniture and a full line of supplies, accessories, books and parts.

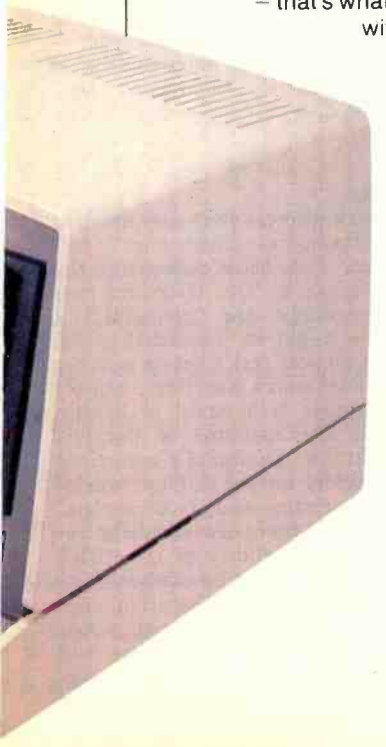
11. Service

No one stands by you like Heath/Zenith. We help you get your system up and running smoothly. Service is available from trained technicians, over the phone or at one of 56 Heathkit Electronic Centers.

12. Value

Your money buys you more because Heath/Zenith prices are among the industry's most competitive. Make your own comparison and find out how much you can save.

Complete, integrated computer hardware and software, designed to serve you and to grow with you – that's what to look for in a strong partner. And with Heath/Zenith you get it all under one roof.



All at your Heathkit Electronic Center

Pick the store nearest you from the list at right. And stop in today for a demonstration of the Heath/Zenith 89 Computer System. If you can't get to a store, send $1.00 for the latest Heathkit® Catalog and the new Zenith Data Systems Catalog of assembled commercial computers. Write to Heath Co., Dept. 010-814 Benton Harbor, MI 49022.

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LETTERS

Motorcycle Headlight Precautions

Anyone planning to build the "Headlight Modulator for Cycle Safety" (June 1981) should be aware of the following restrictions and precautions:

(1) In some states (including Maryland), a headlight modulator is illegal except on emergency vehicles. Check the requirements with your state's motor vehicle authorities.

(2) The U.S. Dept. of Transportation and other agencies have conducted tests whose results indicate that the modulator may confuse others rather than identify the motorcycle.

(3) On all recent-model motorcycles the headlights are turned "on" automatically when the starter is activated. Additional aids to cycle conspicuity are bright headgear and clothing and reflective items either worn or on the bike. —*R. J. Salehar, Automotive Safety Engineer, Maryland Dept. of Transportation, Glen Burnie, MD.*

Technicolor VCR

In the article "A Buyer's Guide: Video Cassette Recorders" (July 1981), it should have been stated that Technicolor does have a tuner (Model 5112) to go with its video cassette recorder—whose model number, incidentally, is 212. —*Dave Gassner, Technicolor, Inc., Costa Mesa, CA.*

Testing Stress

I read with interest your comments in the "Entertainment Electronics" column in your June issue concerning the alleged findings by Dr. Diamond that digital recordings are "stressful." I thought you might be interested in the results of a clinical test wherein another one of Dr. Diamond's assertions, namely that rock music is harmful to health, was tested. The outcome of the test showed that Dr. Diamond's assertions are based solely on the dubious use of "BK" muscle testing and are erroneous.

Dr. Greenhill gave an excellent review of the poor validity of the "BK" testing approach when he explained its effects on the basis of expectation, suggestion, and just plain poor testing controls. The only likely harm that will come to an individual who listens to digital recordings is that he may enjoy it so much he misses dinner!—*Dr. L.G. Morgan, Morgan Chiropractic Clinic, Nampa, ID.*

illegitimate child

Rip-off or spin-off, you've never heard sound like you'll hear from the headphones you can get for only $5 pictured below. But there's a catch.

It was spawned by Sony. And, it's an entirely new technology. No more cheap paper speakers and heavy magnets. Sound is reproduced with such clarity and power that it will send shivers up and down your spine.

Sony's MDR-3 headphones sell for about $50, and they've been worth it. Now you can have DAK's for only $5. We challenge you to take them to your favorite Hi Fi store and compare them to Sony's. But there are 2 things you ought to know.

Thing One. If you can hear a difference, any difference at all, not only can you return them and get your money back, but we'll also give you a free gift for your trouble.

YOU'VE BEEN THERE BEFORE

You may already be familiar with the sound produced by these headphones. If you've ever sat in the very front row during a symphony concert, or right in the middle of a live jazz band, you know the spine tingling thrill of the full rich sound that envelops you.

If you sit even 10 rows back, you lose the feeling. You still listen to the music, but you can't touch or taste the sound.

It's only when you sit right up front that the sound is alive with electricity. It's the same sound you get with Sony's MDR—3s and DAK's $5 stereophones.

ILLEGITIMATE CHILD

Not recognized by law as a lawful offspring.

The technology is new. Up until the Sony featherweight headphones were introduced, most headphones were simply uncomfortable miniature speaker systems that you wore on your ears.

The Sony breakthrough was made possible by changing the cheap paper speaker cones to mylar diaphragms, and by using the powerful rare earth magnet Samarium to move the diaphragms.

The mylar diaphragms are much more accurate than paper and have a drastically improved dynamic range. The result is a headphone that weighs less than 2 ounces and yet produces 20—20,000hz sounds better than a theater sized loud speaker system.

Sony fathered the technology for these headphones and obviously has no connection to DAK, but the technological heritage will become vividly apparent when you compare the sound of these marvelous headphones side by side. DAK's come with a full one year limited warranty.

THE CATCH

Thing two. Frankly we are losing our shirts on the headphones, but we're taking a gamble because we want you to try our audio cassettes.

In order to get the $50 value pair of featherweight headphones for only $5, we want you to try 10 DAK High Energy, Normal Bias 90 minute cassettes for only $2.19 each.

DAK's price is less than half the price of the competition, and each cassette comes with a deluxe index insert card, a box and a one year guarantee.

You're very valuable to us in the form of future business. DAK has excited over 80,000 of you valuable customers with special bonuses like the headphones. We find most of you keep buying once you try our cassettes and our prices; and that's a gamble worth taking.

NOT A BAD CATCH

DAK manufactures a cassette that you can really forget about. Great sound, and no problems.

We make mostly industrial cassettes for high speed duplication. We've developed a special jam proof cassette. It uses a spring tension liner within the cassette that guides the tape as it winds.

We coat these liners with a new chemical called Molysulfide which drastically reduces friction within the cassette.

Hi Frequency Protection! As tape moves within the cassette friction causes the build up of static electricity. Static electricity is drastically reduced by the low friction of the Molysulfide and so is its tendency to erase very high frequencies. A very important consideration for often played tapes.

MAXELL 'TAPE' IS BETTER

Yes, honestly, if you own a $1000 cassette deck like a Nakamichi, the frequency responses of Maxell UDXL or TDK SA are slightly superior and you just might be able to hear a difference.

DAK ML has a frequency response that is flat from 40—14,500hz ±3db. Virtually all cassette recorders priced under $600 are flat ±3db from 40hz to about 12,500hz, so we have over 2000hz to spare, and you'll probably never notice the difference.

No apology. We feel that we have equaled or exceeded the mechanical reliability of virtually all cassettes and offer one of the best frequency responses in the industry.

TRY DAK ML90 CASSETTES RISK FREE

Try these high energy cassettes and the featherweight headphones in your own home for 30 days. If you aren't 100% satisfied for any reason, return only 9 of the 10 cassettes and the headphones for a courteous refund. The 10th cassette is a gift from DAK for your time.

To order your 10 DAK ML 90 minute high energy cassettes at $2.19 each and get the headphones for only $5 with your credit card, call the DAK toll free number below, or send your check for only **$21.90** for the tapes, plus **$5** for the headphones, and **$3** for postage and handling for each group. Order No 9186 (CA residents please add 6% sales tax).

Why not order an extra group of 10 DAK ML90 cassettes. We will add one free ML90 cassette to each additional group you buy and of course you can get a headphone for $5 with each group.

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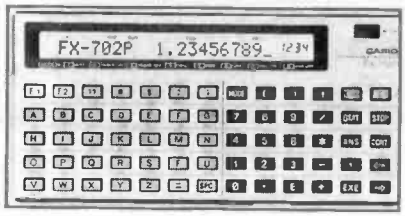
CIRCLE 19 ON READER SERVICE CARD

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.

Hand-Held Computer

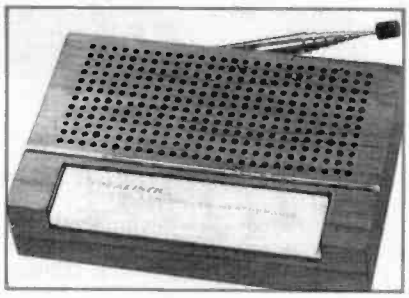


Casio's FX-702P hand-held computer has an alphanumeric keyboard, and uses BASIC as its programming language. It has a memory capacity of 1,680 steps (26 variables). The unit can interface with a printer, and is capable of accepting a ROM package to expand programming capacity. It can also transfer programs directly to a cassette recorder. $249.95.

CIRCLE NO. 88 ON FREE INFORMATION CARD

Weather Radio Receiver

Radio Shack has announced a new three-channel weather broadcast receiver. Model 12-152 allows instant station selection with a three-position switch. Each position is crystal-tuned to one of the three vhf FM stations used by the NOAA: 162.550, 162.475, or 162.400 MHz. A telescoping antenna is attached. Power is provided by a 9-volt battery or an optional ac adapter. With a maximum specified range of 50 miles, the receiver is said to be effective anywhere in the United States. $24.95.



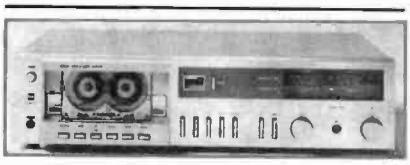
CIRCLE NO. 91 ON FREE INFORMATION CARD

Subwoofer Kit From Heath

The AS-1320 has an 8-ohm, 15-inch, long-throw driver with 2-inch, four-layer voice coil in a vented enclosure. A 6-inch tuned vent is loaded into the floor. Frequency response is rated as 22 to 500 Hz ±3 dB, while overall frequency range is claimed to be 15 to 750 Hz. Amplifier power of at least 30 watts is necessary to ensure adequate listening levels without clipping. The AS-1320 requires either the Heathkit ASA-1320-1 Passive Crossover ($45), or the Heathkit AD-1702 Electronic Crossover ($195). Subwoofer measures 64.5" H x 21.5" W x 17" D. A removable panel allows for future expansion to a full-range system. $300.

CIRCLE NO. 90 ON FREE INFORMATION CARD

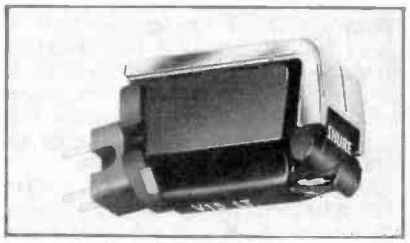
Audio Cassette Deck



The Model 814 cassette deck from Dual features a Direct Lock and Load system that eliminates the usual door between user and cassette. Also featured are meters that respond to the signal after it has been equalized for recording. An electronic tape-motion sensor stops the transport if a cassette jams or spills. Bias/equalization settings are provided for ferric, ferrichrome, chrome, and metal tape types; and a fifth setting will sense the bias/eq automatically for precoded tapes. $300.

CIRCLE NO. 92 ON FREE INFORMATION CARD

Linear Tracking Cartridge



Shure has introduced a version of its V-15 Type IV cartridge designed to fit the Technics SL-Series linear-tracking turntables. The V15 LT has a hyperelliptical stylus and can be used with other linear-tracking or single-pivot tonearms via an adapter. Using a cantilever bearing independently optimized for low and high frequencies, the unit provides a frequency response that extends from 10 to 25,000 Hz, with a channel balance of ±2 dB. Output voltage is 4.0 mV per channel for 5 cm/s recorded velocity at 1 kHz; optimum load per channel is 47 kΩ (70 kΩ maximum) in parallel with 200 to 300 pF capacitance. Inductance is 500 mH; dc resistance, 1380 Ω. Net weight, 6 g. $130.

CIRCLE NO. 93 ON FREE INFORMATION CARD

Portable TV with Built-in VCR

Technicolor Inc. has unveiled a television receiver that is integrated with a VCR. Called "Video Showcase," the unit measures 18" x 13" x 8½", weighs about 20 lb, and has a 7.7" color picture tube. The VCR uses ¼" video tape in two-ounce cassettes that play/record for 45 minutes. Tapes can be recorded either with a Technicolor video camera (in the ¼" format) or with a standard-format camera via an adapter. The VCR has a memory counter, slow-motion, freeze-frame, and sound-dubbing. Another adapter permits tapes in any format to be recorded on or from the Technicolor cassette. Operates from ac or car/boat battery systems. $1725 with vhf/uhf tuner; $1595 less tuner.

CIRCLE NO. 89 ON FREE INFORMATION CARD

Combination Pulse/Function Generator

Model 524 from Exact Electronics combines a pulse generator with a function generator in one enclosure. The function generator offers sine, square, and triangle waves with variable symmetry, trigger

Steal One

The Bone Fone was a big success at $69.95. Can you imagine the success at $49.95?

This photograph appeared in millions of pages of print promoting the Bone Fone at $69.95. Will its new price cause a sellout?

It was a hit. The Bone Fone was one of our best-selling products when we introduced it in the fall of 1979.

And like all successful products, it soon made its way into retail stores too. Over 100,000 of the unusual stereo radios were sold and worn by joggers, sports spectators or just plain music lovers. But then the story of the Bone Fone took an unusual twist. But to understand the twist, you first have to understand the Bone Fone.

UNDERSTANDING THE THING

The Bone Fone is an AM/FM radio that drapes around your neck like a scarf. Special speakers, located near your ears, not only play the music but they also vibrate. The vibrations are picked up by your bones. The sound sensation will amaze you and continues to amaze the thousands who wear it today.

A lady in Helena, Montana who bought the unit for her son told us, "It's made a significant contribution to my sanity. No more rock n' roll blasting through the house. The sound goes where my son goes."

A jogger in Rowlett, Texas wrote us, "Amazing separation, fantastic stereo response helps my jogging tremendously. I wasn't really expecting this type of quality through a magazine ad at this price."

One of the most unexpected letters came from a man in Belle Center, Ohio. "You don't have to be young and jog to enjoy Bone Fone. You see, I'm 73 years old. I just sit and listen."

STORY TAKES TWIST

What made the Bone Fone particularly appealing was both its portability and the fact that it did not disturb those nearby. Even more important (and here's where our story takes the twist), it didn't require headphones.

With today's super lightweight headphones, you might think, "So what. Headphones are not a disadvantage." Bone Fone felt that headphones were indeed a disadvantage.

After awhile, headphones feel uncomfortable to the wearer. It's difficult to jog or do any strenuous outside activity with headphones. And finally and most importantly, they are to a certain extent dangerous because they block out the sounds around you—some of which could be warning you of danger.

PERFECTLY SAFE

With the Bone Fone, not only can you hear beautiful music, but you can hear a car turning a corner or a person shouting. Earphones isolate you from the world around you.

Soon the earphone cassette players started to multiply like rabbits. Prices started to drop, plunging all the way to $69.95 and putting tremendous pressure on the relatively new Bone Fone stereo.

But the death blow really came when the super small headphones went into major production and manufacturers in Hong Kong started producing a headphone AM/FM radio to sell for only $49.95. Now the pressure was really on Bone Fone. Sales slowed and the competition was being felt. Where to now?

BIG PROBLEMS APPEAR

Bone Fone Corporation couldn't afford to drop its price. The Bone Fone is built like an expensive AM/FM stereo receiver. It also has an inner sleeve to protect its electronics from moisture and a blue Lycra outer sleeve to give it its distinctive appearance. Bone Fone Corporation was stuck. They couldn't lower their price, and the public was not buying the Bone Fone at $69.95. Enter JS&A.

JS&A made a large purchase directly from Bone Fone Corporation and can still sell the product to the consumer at the lowest possible price while still making a small but reasonable profit.

In fact, the important role that mail order companies can indeed play is clear from this example. JS&A took most of the current inventory of Bone Fones, and we're ready to offer them at the low price of $49.95.

TRY IT FOR 30 DAYS

Order a Bone Fone stereo by sending in your check or charging it on your credit card account. When you receive it, try it out. Put it over your shoulders. See how light it feels and how incredible the music sounds. Attach it to your body with its strap. Jog, walk your dog, or even just plain relax and listen to good music.

Then decide within 30 days if you want to keep it. If you do, you'll own one of the finest ideas in AM/FM stereo radios since the radio became portable. If not, no problem. Return your unit and we'll send you a prompt and courteous refund plus your $3.00 for postage and handling.

Your unit comes complete with straps for wearing while you jog or run, complete instructions and a 90-day limited warranty. Service should never be required but if it is, Bone Fone and JS&A maintain their own service organization. JS&A is America's premiere electronics mail order company and a champion against the bureaucratic forces of the FTC.

To order, simply send your check for $49.95 plus $3.00 for postage and handling per shipment (Illinois residents add 6% sales tax). That's right—no matter how many Bone Fones you order, the cost for postage and handling is only $3.00. So order enough of them while our supply of units lasts. (We have plenty, so don't worry.) We'll send your Bone Fones complete with batteries, instructions and 90-day limited warranty.

Thanks to the efficiencies of mail order and Bone Fone's problems, JS&A is once again offering a great product at a great new value. Order your genuine Bone Fone stereo at no obligation, today.

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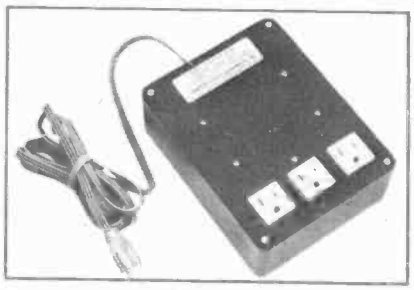
and gate operation, and output levels up to 30 V P-P. Operating from 0.001 Hz to 20 MHz attenuated in 80-dB steps, the frequency/period dial has 10-turn and 3-decade single-turn modes. Also included are variable dc offset, voltage-controlled

frequency input, and sync output. A separate pulse-generator section provides single, double, and delayed pulses over a frequency range from 0.001 Hz to 50 MHz. The period can be adjusted from 20 ns to 1000 s. Pulse width and delay are adjustable from 10 ns to 10 ms. Simultaneous outputs from five connectors give TTL, $\overline{\text{TTL}}$, ECL, $\overline{\text{ECL}}$ as well as pulse output from the main amplifier. Pulse baseline is set from zero to ±15 V, with 80 dB of attenuation provided in 10-dB steps. Pulse rise and fall times are rated: 2 ns at the ECL outputs, 7 ns at the TTL outputs, 15 ns or less at the main putput. $1195.

CIRCLE NO. 94 ON FREE INFORMATION CARD

Video Pollution Control



Electronics Specialists has announced a device said to eliminate the video flashes and picture jitter associated with noise and spikes from power lines, heavy machinery, and lightning. Called the Super Isolator (Model ISO-3), the unit offers 3 dual-balanced pi-filtered ac sockets. Each socket individually handles up to 1 kW. Total capacity is 1875 W. $94.95. **Address:** Electronic Specialists, Inc., 171 S. Main St., Natick, MA 01760.

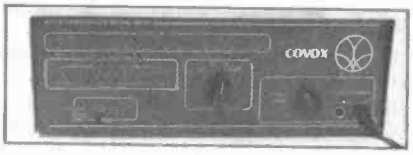
CIRCLE NO. 96 ON FREE INFORMATION CARD

Portable FM Stereo Radio

Weighing less than 1 lb, the Model 7-1000 is General Electric's entry into the portable FM stereo market (it also plays AM). Features include vernier tuning, left and right channel controls, a LED FM stereo indicator, and built-in afc. The headphone cord serves as the antenna, and there is an additional headphone jack. A ferrite magnet with a rated impedance of 32 ohms drives the headphone speakers. Headphone weight is 2 oz. The 7-1000 operates on 3 AA batteries, or on ac with an optional 4.5-V converter. Dimensions are 4½"H × 3⅛"W × 1¼"D. $74.95.

CIRCLE NO. 97 ON FREE INFORMATION CARD

Voice Recognition System



The Covox Model I voice controller is said to be capable of recognizing the spoken phrases, "di", "dah", and long "dah" when voiced in Morse, Binary, or RTTY code. The system, it is claimed, can pick out a human voice in extraneous noise ten times louder than the voice itself. Not a complete speech recognizer, the Model I can be programmed to recognize 16 Morse-encoded words in its stand-alone mode, or can interface with one or more microprocessors. Applications include access control, process control, and "speech-to-touch" assistance for the profoundly deaf and deaf/blind. $389. **Address:** Covox Co., Box 2342, Santa Maria, CA 93455.

Sonic Localizer

A signal processor said to improve stereo imaging has been introduced by Phase Linear. The Model 180 Dimensional Sonic Localizer (DSL) is designed for either headphones or loudspeakers, connecting to a preamp or receiver via the tape-monitor loop. The DSL can also operate on a mono signal, producing a synthetic stereo effect. Without the time-delay circuit, THD at 0.5-V output (20 to 20,000 Hz) is 0.009%; IM is 0.004%. Other specifications: S/N, 83 dB up to 0.5-V output; input level, 150 mV rms; input impedance, 20 kΩ; maximum output voltage, 10 V rms into 10 kΩ. $149.95.

CIRCLE NO. 98 ON FREE INFORMATION CARD

4½-Digit Hand-Held DMM

Data Precision's new Model 945 is a portable 4½-digit LCD multimeter. It measures dc and ac voltages up to 1000 V dc and 700 V ac in 5 ranges, both with a resolution of 10 μV. Resistance, in 6 ranges, is measured from 200 Ω, with 10-MΩ resolution, to 20 MΩ. Five ranges of dc and ac current are measured from 10 nA to 2 A. Basic resistance-measuring accuracy is said to be 0.08%; the claim for dc measurement is 0.015% basic accuracy, while ac is said to be accurate to 0.5%. The Model 945 offers a constant-current source for resistance measurements, permitting a direct display of voltage drop across a load. Powered by a 9-volt battery, the unit weighs 13 oz. $265.

CIRCLE NO. 95 ON FREE INFORMATION CARD

Lexan-Shell Audio Cassettes

The Loranger Manufacturing Co. has entered the consumer audio cassette tape market with chrome and ferric-oxide formulations packaged in Lexan shells. Marketed under the name, Loran, cost is reported to be $1 to $2 higher than current top-of-the-line cassettes. Frequency response for the high-bias tape is given as −11.5 dB at 15.5 Hz and a 0-dB recording level. Without Dolby, dynamic range is 62 dB (S/N 56 dB); with a sensitivity of ±0.5 dB.

CIRCLE NO. 99 ON FREE INFORMATION CARD

NEW PRODUCT

Fresh Air Bubble

Surround your body or your work place with ion-controlled fresh air in America's first bipolar electrostatic home precipitator.

The unit measures only 2" x 4" x 7" and its black appearance will fit into most decor.

There's a danger. And this invisible menace will affect nearly everybody reading this ad.

The danger is pollution—but not the ordinary kind. In fact, ten years ago, we didn't have this new kind of pollution. Let us explain.

Ten years ago, cars didn't have catalytic converters. Today, these catalytic converters "grind up" the car exhaust into particles so small they form micron soot, and micron soot is so fine, it can be easily absorbed into your lungs. Even the EPA has stated, "Because it is so fine, such soot particles stay longer and cause more damage in the respiratory tract."

Ten years ago, homes were able to "breathe" or exchange air between the outdoors and indoors four or five times a day. Today, with our well-insulated energy-conscious buildings our homes literally create and trap pollution that we breathe unwittingly.

OTHER PROBLEMS

There are other problems too. Add the daily soot, dust, smoke and other impurities in the air and you've created pollution problems even worse than they were ten years ago—so bad in fact that environmental groups are especially concerned over this new "time bomb" lurking in our environment.

But American ingenuity hasn't been sitting still. A rash of small devices containing charcoal filters with fans and selling for around $30 have literally flooded the market. The problem is that these devices only remove particles 5 microns or larger. Today's micron soot is one micron or smaller. Cigarette smoke for example is 2 to 3 microns or smaller.

70,000 UNITS SOLD

In 1978, JS&A introduced the negative ion generator in a national advertising campaign and sold over 70,000 units. It was a device that cleaned the air by electrostatically removing particles even smaller than one micron. Hospital burn centers soon began using commercial versions of the negative ion generator.

Removing sub micron particles from the air was very important, but there was also a surprising second benefit. The unit added negatively charged ions to the air.

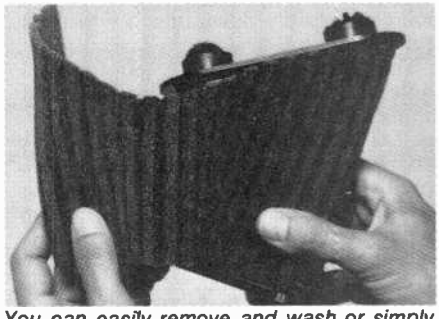
We've all felt the effects of negative ions after a thunderstorm. When you take a deep breath, the air smells good and you feel good.

The opposite is true of positive ions which can be found in polluted environments, air conditioned office buildings and in automobiles. Many scientists believe that positive ions make you feel moody, depressed, irritable and restless. A negative ion generator cancels out the positive ions and fills the air with negative ions.

AN EXPERIMENT

When you blow smoke into an inverted glass bowl and put it over an ion generator, the smoke immediately vanishes. Or if you place the ion generator in an odor-filled room, the room soon smells fresh.

It was these experiments that really convinced the public that the JS&A ion generator was a valuable new home appliance. Soon the market was flooded with competitive ion generators. Many were not as efficient as JS&A's first model. Some emitted very few ions and one actually emitted dangerous levels of ozone. JS&A conducted independent laboratory tests and publicized the results which showed that JS&A's unit was indeed the best.



You can easily remove and wash or simply replace the ion filter after it collects the soot. Extra filters are only $1.00 each and should be replaced or washed once every two months.

That's the history. But like any new technology, there's sure to be improvements. The first ion generator produced negatively charged ions which attached themselves to the pollutants and then fell to the ground. You ended up with clean, fresh air but also dirty rugs and walls.

In winter, the units created electrostatic discharges which can be uncomfortable when touching a door knob or someone else.

CONTROLLED ION ENVIRONMENT

So American scientists created an ion generator using a bipolar emitter which emits a balanced amount of negative ions to create a controlled ion environment. One emitter produces negative ions and the other controls and shapes those ions to create an ion bubble.

The end result is a unit which leaves just the right amount of negative ions in a large room, attracts the pollution particles and deposits them on a washable collector plate while keeping your floors and walls free of dirt. You're actually placed in a fresh air bubble while you work, sleep or relax and with no uncomfortable electrostatic charge.

I urge you to try the JS&A ion generator in your home or office for 30 days. Put one on your desk or in any smoke-filled room. Notice the refreshing difference in your work environment. Take it home and plug it in next to your bed. Chances are, you'll want to buy another one before our 30-day trial period ends.

SATISFACTION GUARANTEED

But if you are not pleased with your unit for any reason whatsoever, please return it within 30 days and we'll send you a prompt and courteous refund including your $4.00 postage and handling. JS&A is America's premiere electronics company—a substantial organization that guarantees your satisfaction.

To order, send your check for **$89.95** plus $4.00 postage and handling (Illinois residents please add 6% sales tax) or credit card buyers may call our toll-free service line below.

We'll send you the JS&A ion generator complete with instructions and a 90-day limited warranty. Then plug it in and leave it run all day and night. The cost to run the unit is only a few cents per day.

The era of the ion generator as a standard household appliance is here. Order the newest and best unit available at no obligation, today.

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ENTERTAINMENT ELECTRONICS

By Ivan Berger

Video Accessories from the Camera Store

A CAMERA is a camera is a camera. And, therefore, many of the accessories sold at camera stores are as useful for video as for photography.

Take tripods. There are some special video models (for example, those combined with video equipment carts); but, for the most part, any good photo (or, better, movie) tripod will provide steadier video pictures. What makes a tripod good? A lot of factors, some of them mutually contradictory. As a case in point, heavy tripods are more stable, but light ones are easier to carry. For video or movie use, the tripod should have a "pan" head, with separate pan (rotate) and tilt adjustments and a handle that extends far enough back to be accessible when your camera is mounted. (Don't use a tripod with a ball-joint head.) It's easier to adjust camera height if your tripod has an adjustable center "elevator" section than if you have to adjust all three legs; but use the legs to get as close as possible to the desired height, so you can minimize elevator extension. That way, the camera has a steadier support.

Make sure, also, that the tripod can stand high enough to put the camera's finder at your eye-level; bending over for a long while is tough on your back. (Most cameras with electronic viewfinders let you aim the finder up, so you can look comfortably down into it when it's at a low angle.)

There are small tripods, too, for low-angle use or for use on table-tops and the like. Most of these are a bit flimsy, but Leica makes a good (and expensive) one, with heavy, cast legs that rotate around the central camera mounting screw to nest flat for carrying. A similar model, sold in Japan by Stitz, is available under some other brand names here. Bolex makes a weirdly jointed camera stand that looks like a praying mantis when unfolded for use; it can be folded to fit a broad variety of situations, and to give a broad enough base to support most home video cameras.

Camera stores sometimes carry shoulder pods or "gunstocks" (most of which look nothing like guns) that can be adjusted to fit most still, cine or video cameras. Since personal fit and comfort are factors here, it pays either to bring your video camera to the store for a fitting or to buy the shoulder pod on a money-back guarantee basis.

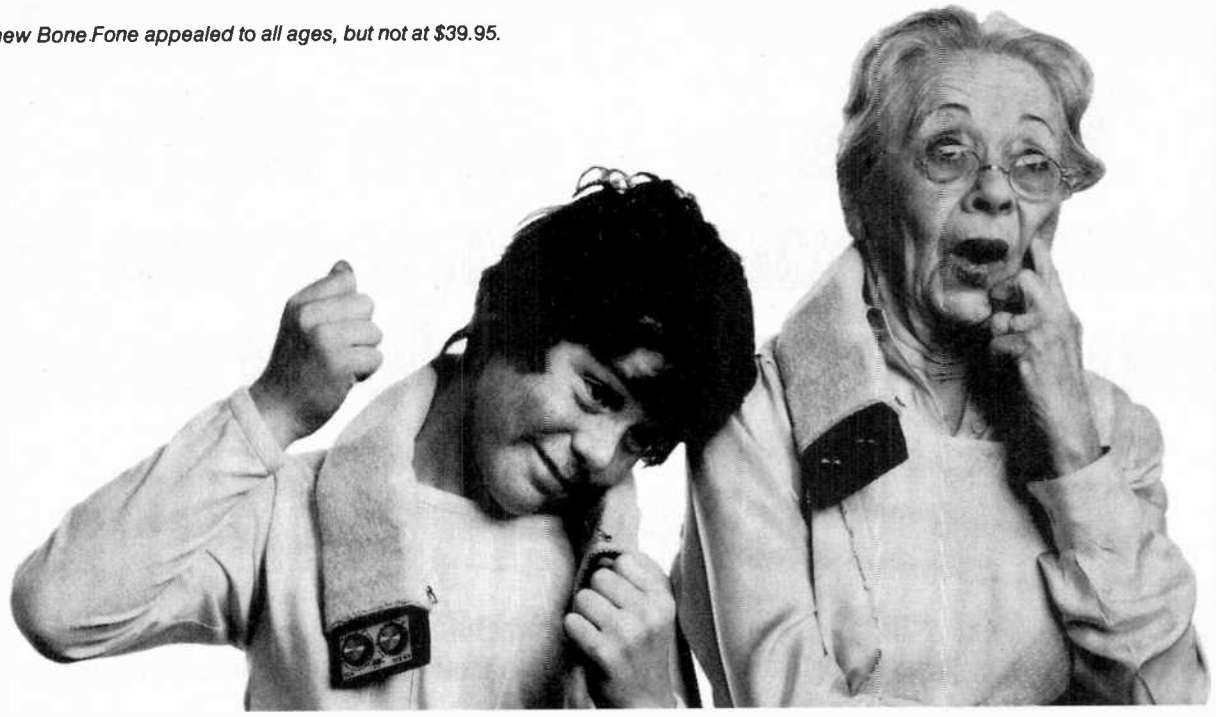
Filters. Most of the attachments made to fit in front of film camera lenses also work on video cameras. There are attachments for straight and fancy color filtering, for fancy optical effects, for closeups, and to change your lens's focal length.

In video, filters are mainly for special effects. Most cameras have some kind of color balance control, which should at least eliminate the need for conversion filters to match day or indoor light. To get weird colors for special effects, you might be able to use the same controls (it depends on the camera). But you'd be better off with filters, since they give deeper hues and a wider choice of colors, and spare you recalibration of the camera settings when you want things to look normal again.

Filters made for color photography primarily give the effect of changing the color of the light. Though you won't usually need indoor/day conversion filters, you may want to try "FL-D" or "FL-B" filters to reduce the excess green of fluorescent light, mild color-warming filters to take the "chill" off a

Medium-duty tripods such as the Slik M410 provide a steady base for your camera. (The head shown here is actually for a 35-mm camera.)

The new Bone Fone appealed to all ages, but not at $39.95.



Colossal Failure

The Bone Fone was a great success, but its little brother laid a big bomb.

It really flopped. And it was such a flop that we were totally unprepared for it. Here's what happened.

The story actually started out with a product called the Bone Fone, an AM/FM stereo radio that draped around your neck like a scarf. The Bone Fone played stereo music that you actually felt through your bones as well as through your ears. The beautiful effect was hard to describe.

JS&A's earlier advertisements sold the Bone Fone quite well. Soon over 100,000 of them were draped around the necks of music lovers all over the nation and JS&A had a hit. But wait. Our luck was soon to run out.

The AM/FM stereo Bone Fone sold for $69.95 so it would seem logical that a less expensive unit at $39.95 that played only AM stations would be a natural winner too. After all, the two speakers on the less expensive Bone Fone were sure to make any AM station sound almost like stereo. Logical, yes, but then some very confident people went a little overboard.

Our ad manager went overboard with a brilliant name for the product–NUTS–the radio for music nuts, sports nuts, news nuts or anybody just nuts enough to wear the thing.

And our product designers went overboard too. Instead of a basic AM radio, they built a unit that was vastly superior to any pocket radio, in fact equal or better than many AM/FM radios. There was an integrated circuit, and a pair of large 3" speakers with big magnets that could really blast out with solid AM music. Remember, the AM unit was not stereo but it seemed that way with its two large speakers.

The sound was so good that even the engineers went overboard adding a tone control and boosting the power the speakers could take from 0.2 watts to 0.5 watts–all powered by a 6-volt battery system instead of the traditional 3-volt system. Indeed, the unit was built like something the military would design and all put together by one of the best factories in Hong Kong.

Even our purchasing department went bananas and ordered 30,000 of the monsters without testing to see if the product would sell.

Well, if you're sensing that we're about to tell you about a mistake, a gross miscalculation, or even a major disaster, you're right. When we tested the product to see if it would sell, we found out it couldn't. Consumers were buying the stereo Bone Fone at $69.95 ten to one over the $39.95 NUTS.

The ad agency was shocked, the product designers and engineers were perplexed, and our purchasing agent was worried. We ended up with 29,940 in stock.

What do you do when everybody goofs? Simple. You lower the price. But from experience we know that even at $29.95 we're not going to sell out even if we triple our sales. The price had to be dramatic. A real shock. The price had to be so low that a sell-out would be assured. "O.K., $24.95," said our executive vice president. But she was vetoed. "$19.95," announced our president. And so it was.

If you realized the value that NUTS represents at $19.95, you'd buy all you could for gifts this Christmas even though it's months away. But we're sorry, there's a limit: 144 per person or 967 per family. You see, we're anxious to dump the little buggers.

The NUTS comes with a terry cloth sleeve that fits over the unit to make it comfortable to wear for jogging or just plain walking. Take NUTS with you to a sporting event and hear the play by play while still experiencing the sound of the crowd. A strap firmly secures the NUTS to your body so you can jog or do any physical exercise while the unit stays secure.

If the sleeve gets dirty, don't worry. Just throw it in the washing machine and wash it like a towel. Don't forget, of course, to first remove the radio.

NUTS comes with a 90-day limited warranty but it's built like a battleship so nothing should ever go wrong. But ah, if it does, simply send it to our service-by-mail facility and we'll quickly repair it and have it back pronto.

JS&A is famous for its space-age products since 1971 and its FTC battle since 1979. We're a responsible company that built our reputation on providing service to our customers and fighting off federal bureaucrats.

To order, simply send your check for **$19.95** plus $3.00 per order for postage and handling (Illinois residents add 6% sales tax) to the address below or, credit card buyers may call our toll-free order service below. We'll send you your unit complete with instructions and a 90-day limited warranty backed by JS&A's service-by-mail center. (Four AA cell batteries not included.)

If you've ever had a great opportunity to buy a truly great bargain, it's now. But like we said, once we're sold out, that's it. Only 29,940 left. Order yours at no obligation, today.

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What's new with NRI's home-training program in communications electronics?

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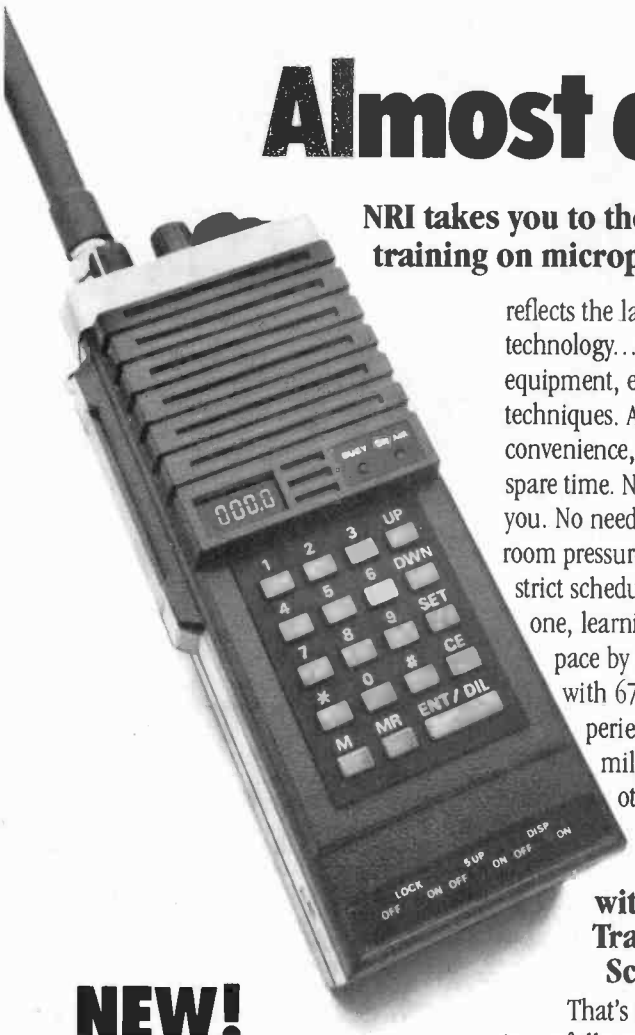

NEW!
hand-held, microprocessor-based 2-meter scanning transceiver

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Now, NRI's renowned home-study course in Communications Electronics reflects the latest, state-of-the-art technology...includes up-to-the-minute equipment, experiments, and training techniques. And you learn it all at your convenience, in your own home in your spare time. NRI brings your training to you. No need for night school, classroom pressures, travel expenses, or strict schedules. You're a class of one, learning at your own pace by methods proven with 67 years of experience and over a million and a half other students.

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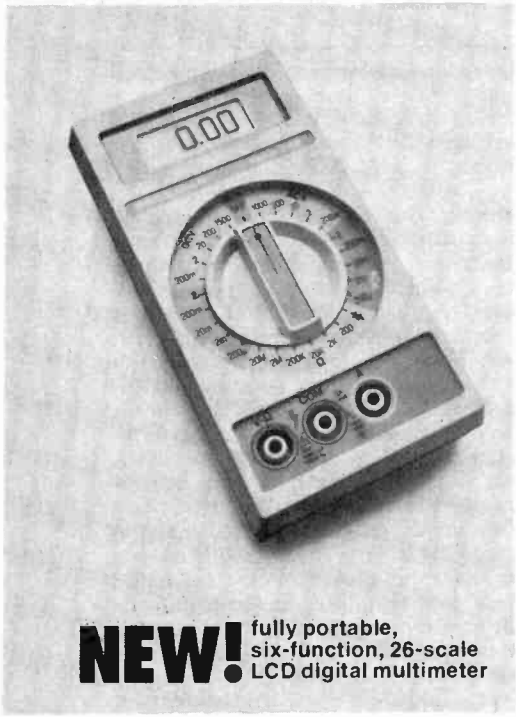
NEW! **programmable, microprocessor-based, synthesized five-band scanning monitor receiver**



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grey day, and bluish, "cooling" filters to make a sunny day look overcast or add moonlight effects to daylight shots. Filters made for black-and-white photography are generally of deep, solid colors such as red, blue, yellow, green and orange. Using them on a color camera will usually give bizarre effects, which may, at times, be just what you want.

Polarizing and neutral-density filters are the only ones made for both black-and-white and color film. Polarizers can be used to take the detail-reducing glare off shiny, nonmetallic objects, to shoot through glass, and so on. They also deepen the blue in the part of the sky 90° from the sun. Although expensive, polarizers can often save the day. They're most useful with electronic-finder cameras, which let you check their effects, and a bit less so with through-the-lens finders, which show their effects somewhat less clearly.

Neutral-density filters are used when the light is too bright for even the smallest lens opening and lowest camera-sensitivity setting, and to let you use a wider lens opening in bright light. A wider opening reduces depth of field, letting you throw distracting backgrounds out of focus.

Lenses. Some really creative special effects can be achieved with new lens-attachment systems from companies like Cokin (distributed by Minolta), Acme, Ambico, Tiffen and Spiratone though they become tiresome if overused. These systems are based on holders that attach to your lens, plus a variety of square filters and accessories for many purposes. Available filters include: mist, fog and diffusion filters, color filters with clear centers, and filters that are half colored and half clear. (You could use the colored half to change the color of the sky while leaving the land unaffected, for example.) There are also filter-like attachments that create parallel or concentric multiple images and "vignetters" that frame your picture in a circle, heart, or other shape. Cokin, at least, has holders for lenses with front filter threads up to 82 mm, Spiratone to 77 mm.

Closeup lenses, which attach like filters, can be used to focus on objects closer than your lens's normal near-focusing limit, or into the gap that frequently exists between the far limit of a lens's macro-focusing range (if it has one) and the near limit of its normal focus range. These come in a variety of strengths, and can be stacked, so an assortment of +1, +2 and +3 lenses can be used in any combination up to +6. You'll probably not need more than about a +1, though, especially if your camera has a macro range. There are also split-field closeup lenses that allow you to focus very closely on one half of your image and all the way to infinity on the other half.

Here and there you'll run across wide-angle and telephoto converters designed to fit in front of your camera lens. They're not easy to find, though, especially in sizes to match large video zooms (JVC sells some that may fit competing cameras). Telephoto converters to fit behind the lens are common in still photography, but I know of none to fit the "C" mounts used by most video cameras. If you own a still camera with interchangeable lenses, you can get adapters to fit those lenses onto your C-mount video camera, for really long telephoto shots. (Video lenses rarely get much longer than 75 mm or so, while still camera lenses from 135 to 250 mm are common, and lenses up to 2000 mm are available.) Be sure to use a tripod, with any extreme telephoto lens. Telephotos magnify everything, including camera shake.

One of my favorite accessories is not for cameras but for portable VCRs. If you walk about with a portable hanging from your shoulder, Spiratone's "Postman's Pad" ($6.95) will make that weight more tolerable than anything else I've tried. Unlike most shoulder pads, its thick, firm, and tapered to match the slope of average shoulders. ◇

Audio Product of the Month

CHOSEN BY THE EDITORS OF POPULAR ELECTRONICS

Bang & Olufsen Beogram 8000

THE Bang & Olufsen Beogram 8000 turntable is a refined version of that company's well-known and basically similar 4000-series record players. Like them, it features a servo-driven, low-mass, radial-tracking tonearm integrated with a low-mass, high-quality magnetic cartridge, completely automatic operation, and foolproof stylus protection.

The B&O Model 8000 differs from its predecessors in that it has a novel direct-drive

motor (the 4000-series used belt drive) and a microprocessor control system. It measures about 19¼"W × 14¾"D × 3½"H with its hinged clear plastic cover lowered and weighs about 20 pounds. It is finished in brushed aluminum and black, with rosewood grain trim. Suggested retail price is $995.

General Description. The direct-drive motor of the B&O Model 8000 is described by the manufacturer as a "magnetic drive servo-controlled dc motor," with no elaboration. Examination of the motor, with the aluminum platter removed, reveals that the flanged rim of a smaller inner "platter" (the actual rotor) fits into a narrow gap between two large magnetic coil structures. There is no evidence of the complex windings used on many direct-drive motors.

Its appearance suggests that this is an eddy-current motor, not unlike the revolving disc in a conventional home watt-hour meter. Turning with the platter is an optical tachometer disc that supplies a feedback frequency to the servo control circuits, where it is compared to a frequency derived from a quartz crystal oscillator. The microprocessor establishes the necessary frequency division ratios for varying the turntable speeds within ±3% of the nominal 33⅓ and 45 rpm.

The aluminum platter is a light disc (about ⅛" thick), and the total rotating mass is about 1¾ pounds. Instead of the usual rubber mat, the top of the platter has an array of 24 radial black plastic "spokes" that support the record above the metal surface. They also serve an important role in the automatic operation of the record player.

The tonearm consists of two straight parallel tubes of square cross section about 6 inches long. The one closest to the turntable center has a downward-facing light and photocell in its tip. As the arm moves over the rotating turntable, the light reflected from the surface tells the control system whether a record is present and what size it is. If no record is present, the spoke pattern interrupts the light reflected to the sensor, causing the arm to move to the center until a smaller diameter record (if present) is found, or to eventually return to its rest and shut off the unit. The pickup cannot descend to an empty platter.

When the sensor reaches the edge of a record and the reflected light pattern is interrupted, it continues to move inward by an amount equal to the spacing be-

OPERATING CONTROLS:
(All pushbuttons)

TURN: Runs motor while depressed without initiating arm cycle. For use with record cleaning brushes, etc.

PAUSE: Raises arm for temporary interruption of play. After 10 seconds, arm returns to its rest and motor stops but lifting position is held in memory for 30 minutes and arm returns there automatically when PLAY is pressed.

PLAY: Initiates automatic play cycle. Record size and speed are set automatically.

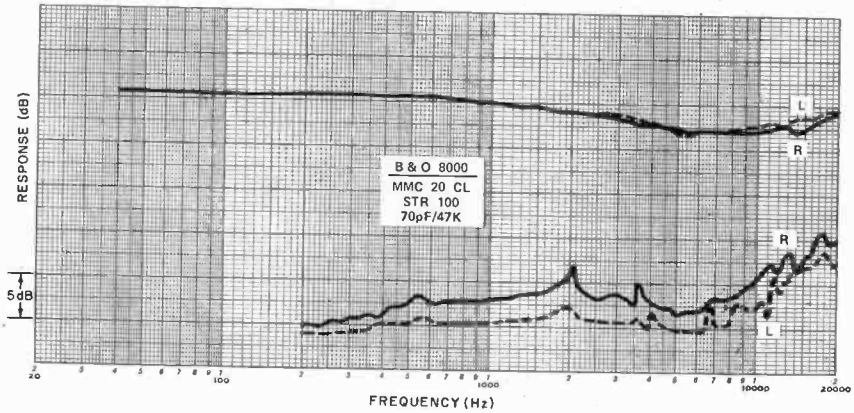
STOP: Terminates playing and shuts off the unit.

33,45: Selects turntable speed for nonstandard records.

+,− : Varies speed in discrete increments. (Actual speed is shown on a four-digit numerical display.)

≪ <, > ≫ Fast arm movement (slew) controls. Arm lifts and moves slowly on light touch. More pressure speeds up slew speed.

Other Features: 7-pin DIN socket in rear for interface with Model 8000 receiver (for remote switching and control of record player). Stylus force sliding adjustment on arm tube, calibrated from 0 to 2 grams at intervals of 0.1 gram.



Frequency response and channel separation of both channels using the CBS STR-100 test record.

The HE Family:
Hyperelliptical-Equipped

V15 Type IV
½-1¼ grams

MV30HE
¾-1¼ grams

V15 LT
1¼ grams

V15 Type III-HE
¾-1¼ grams

M97HE
¾-1½ grams

M97HE-AH
(with attached headshell)
¾-1½ grams

M97 LT
1½ grams

M95HE
¾-1½ grams

M75HE Type 2
¾-1½ grams

M75HE-J Type 2
1¾-2½ grams

When you're ready to "face" the music we have a tip for reduced distortion

Whether you are seeking to reproduce the full dynamic range in the grooves of today's new superdiscs, or simply to obtain maximum listening pleasure from treasured "oldies" in your record collection, you need a phono cartridge that will deliver optimum trackability with minimum distortion.

Because the phono cartridge is the only point of direct contact between the record and your entire stereo system, its role is critical to faithful sound re-creation. That's why upgrading your phono cartridge is the single most significant (and generally least costly) improvement you can make to your stereo system.

To that end Shure now offers the Hyperelliptical Stylus Tip configuration—first introduced on the critically acclaimed V15 Type IV—in a *full line* of cartridges with a broad range of prices.

The Hyperelliptical Stylus Tip has been called the most significant advance in decades in tip geometry. It has a narrower and more uniform elongated contact area that results in significantly reduced intermodulation and harmonic distortion.

Look over the list at left to see which Shure HE cartridge best matches your tracking force requirements.

Shure has been the top-selling cartridge manufacturer for the past 23 years. For full details on this remarkable line of cartridges write for AL667.

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CIRCLE NO. 26 ON READER SERVICE CARD

tween the arm tubes (about 1 inch). Then it stops and lowers the second arm (containing the cartridge) to the record.

The platter always starts at 33⅓ rpm, but if no record has been found outside of a 10-inch diameter, it automatically changes to 45 rpm. Either speed can be selected at any time by the pushbuttons, however. After the record has been played, the arm returns to its rest position and the motor shuts off. Each time the pickup enters or leaves its rest, the stylus is cleaned of lint by a soft brush.

The cartridge supplied with the Model 8000 is the B&O MMC20CL, the top-of-the-line model. It is a moving-iron cartridge with a single-crystal sapphire cantilever and a diamond stylus having an extended line-contact shape for improved tracing of high-frequency groove modulation. It is designed to track at 1 gram.

Like any other tangential-arm record player, the 8000 is free of skating forces and the need for compensation. As a result, its pickup goes straight up and down when the cueing mechanism is used, and returns to the same groove from which it was raised. The microprocessor of the Model 8000 "remembers" the position on the record from which the cartridge was raised by the PAUSE control and, up to 30 minutes later, can return it to the same spot. (The pickup remains over the record for only about 10 seconds before returning to its rest position.) Another feature of the Model 8000 is its ability to repeat a record if the PLAY button is touched while it is playing (it finishes the play before repeating, however).

Laboratory Measurements. The B&O MMC20CL cartridge (also available separately with a mounting adapter for conventional arms) had a frequency response flat within +0, −3 dB from 40 to 20,000 Hz with the CBS STR 100 test record, and within +0, −3 dB from 1 to 30 kHz with the JVC 1005 test record (it was down 5 dB at 40 kHz on the latter). The response curve had a broad, shallow dip between 3 and 15 kHz. Channel separation was 20 to 25 dB over most of the audio range and about 15 dB at 50 kHz. The frequency response and crosstalk curves were nearly identical for both channels.

These measurements were made with a cartridge load of 47,000 ohms and 70 picofarads (plus the capacitance of the integral signal cables). Increasing the load capacitance to 440 picofarads had little effect on the frequency response (it actually improved by about 1 dB in the high-frequency range up to 20,000 Hz).

The low effective mass of the arm and cartridge resulted in a relatively high resonance frequency of 12 to 13 Hz, with an amplitude of about 6 dB, falling off to 3 dB at 20 Hz and becoming negligible at higher frequencies. Signal output was about 2.9 millivolts at a 3.54 cm/s velocity. At the rated 1-gram force, the cartridge tracked our high-velocity test records easily, including the 70-micrometer level of the German Hi-Fi #2 test record. The vertical angle of the stylus was 24 degrees.

In subjective tracking tests with the Shure "Audio Obstacle Course" records, the MMC20CL was able to play the entire ERA III record. With the ERA IV record, we heard the beginning of mistracking on the highest level of most of the bands. This is a very severe test, and the cartridge should have no difficulty coping with the levels on almost any commercial record.

Turntable rumble was very low, reading −38 dB in an unweighted measurement and −61 dB with ARLL weighting. The rumble spectrum was mostly at 5 and 14 Hz, with smaller peaks at 40 and 60 Hz. Flutter was 0.05% wrms, and ±0.06% weighted peak (nearly as low as can be measured using test records). Its spectrum had peaks at 3, 10, and 14 Hz, dropping off at higher frequencies.

The turntable speeds were as exact as we could measure at the indicated nominal values, and could be varied over about ±3.3% in steps of either 0.05 or 0.07 rpm, depending on the speed. The automatic cycle times were shorter than on most automatic record players, with 4 seconds required to start playing after the PLAY button was touched, and 6 seconds for the shutdown after play. In the fast (slew) mode, a 12-inch record was covered in 4 seconds. The pause (lift, or cueing) action was perfect, with absolutely no lateral shift during the process, even when we waited for the memory system to take control. Although lift and descent were so rapid as to seem instantaneous, they were gentle and smooth.

In checking the suspension, we found a single transmission response at 30 Hz. The isolation of the Model 8000 was better than any turntable we have measured. Its margin of superiority was 10 to 20 dB over the better units, and 30 to 40 dB better than average.

User Comment. This is a deluxe record player for people who want to listen to records for enjoyment. Hardware-oriented hobbyists who want to change cartridges as new models become available will find the unit frustrating. Its totally integrated design makes such experimentation impossible. The turntable itself is one of the finest we have used; the arm and cartridge rank with the best on any objective basis; and the ergonomics of the entire record player are (in our view) a resounding success. In addition, this turntable is unmatched in immunity to acoustic feedback.

After using the Model 8000 for an extended period, we frankly do not have a single complaint about its performance. Even its high price seems quite reasonable, considering what it does and how well it does it.—*Julian D. Hirsch*

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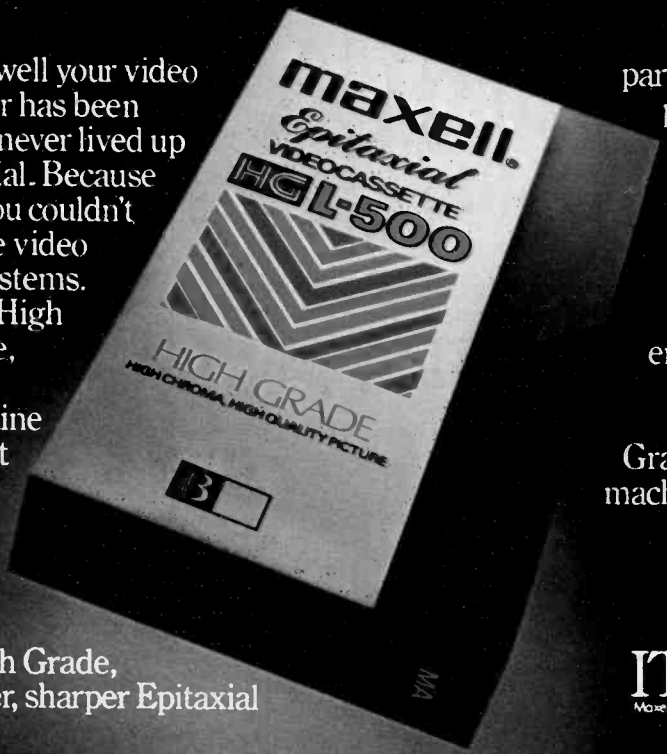

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CIRCLE NO. 48 ON FREE INFORMATION CARD

Popular Electronics Tests

Screen Picture by Discovision

The Sampo Model 9519 19" Color TV Receiver

THE Sampo Model 9519 is a 19" color receiver with two 5" black and white monitors nested alongside. Packaged in a mahogany veneer wood cabinet 25¾"W × 19 11/16"D × 22"H, it has sensor touch tuning and a 4-inch oval speaker. The unit can be used with an infrared remote control, which has volume up/down, channel select, sound muting, and power on/off. Suggested retail price is $995.

General Description. The block diagram (Fig. 1) of the main set shows a conventional 4-IC receiver with all luminance, power, outputs and sync functions performed by 28 discrete transistors and a bridge-rectifier diode power supply. The four ICs furnish i-f amplification, agc, automatic fine tuning (aft), FM detection, plus chroma processing and demodulation. A single SCR removes dc operating potential from the 120-V supply, should high voltage rise beyond normal levels. The main dc supply has a 4-transistor power regulator containing the usual sensor and feedback loop. It also offers an additional transistor, shunted across the power driver and regulator, that will shut down the low-voltage supply if too much current is drawn.

Both auxiliary 5-inch monitors have similar power supplies and (because of their dual receiver/monitor functions) are isolated from the ac line. These medium-resolution monochrome sets are constructed of discrete transistors, three i-f stages, dual i-f/r-f agc adjustments, and varactor tuner elements with voltage U/V switching and broadband dc tuning. There are no audio outputs provided (Fig. 2).

In contrast to the main color set, which has 12-channel tuning, only two channels can be selected manually on the two monitor/receivers; or they can be used to receive a single direct-video input from a camera, video cassette or disc, or other baseband producer. Surprisingly, the auxiliary receivers process a full 4-MHz bandpass versus 3 MHz for the large screen color set. But, because there are no focus controls on the small sets and owing to limitations on tube resolution, the black and white images aren't exceptionally sharp. Brightness and contrast, however, are adequate.

These minisets can be used with a monochrome surveillance camera and will reproduce a fairly accurate picture. A well-lighted and easily defined scene should be highly visible, but a dimly outlined area will produce a much poorer image. The VC-1001 camera recommended by Sampo for use with the 9519 retails for $250 and has focus control only. Battery packs are $75.

Baseband inputs to the monitors may range between 1 and 3+ volts, with negative-going sync. The monitors can be operated on baseband, independent of the main unit.

The tuning system is unusual. The touch of a finger induces a signal that (after its negative portion is clipped) forward biases an npn transistor. This, in turn, lights a sensor lamp and delivers a negative pulse to one end of the appropriate tuning potentiometer. Each individual tuning potentiometer is coupled to the 16-line inverter-buffer of Sensor Touch 1902, and manual bandswitch el-

ements for vhf and uhf selection. With its division ratio preset, the potentiometer delivers the appropriate voltage to the U/V tuners via an emitter follower.

With remote control, however, the scan/select voltages are generated by the infrared transmitter. The optically encoded signal is sensed by a photodiode in the IR receiver whose output is shaped and then routed to a remote-control encoder-decoder. This circuit performs the channel select and maintains the channel voltage in memory.

Remote-control sound is handled somewhat differently. Audio inputs combine through a volume step counter, a muting gate, and a separate volume control via an AND-switch within the processor. The output voltage is dc-controlled, resulting in a low that is inverted and routed to the base of the sound controller. When the set is turned off (but still connected to house current), a memory function maintains volume level. Receiver tuning, however, always reverts to Ch. 1 (channel 2).

Analysis. Multiburst in Fig. 3 shows sloping low- to high-frequency outputs of up to 4 MHz at the single-diode video demodulator, but barely 3 MHz at the picture tube. In Fig. 4, 3.08-to-4.08-MHz chroma is apparent, and there is a very passable response in the lower swept chroma waveform at the picture tube. The vector, however, is somewhat jittery, and yellow-oranges are squeezed toward reds for easy fleshtones. The chroma pattern is not as distinct and symmetrical as it should be, including the jitter, which doesn't show in the final picture on the screen.

Figure 5 is taken from a multiburst through r-f to the picture tube from the No. 1 monitor, and at the camera input with baseband at monitor No. 2. Monitor No. 1 requires some i-f alignment to push the 3.58-MHz multiburst down, but the response is basically good. Camera input shows horizontal sync and blanking as well as some well-defined video modulation.

Comments. The idea of a multiscreen set with surveillance capability could appeal to homeowners and businessmen who are concerned about security. However, a focus potentiometer for the two black-and-white monitors would be a welcome addition to obtain more distinct viewing.

The touch-tuning response is slow, unless you generate a lot of static elec-

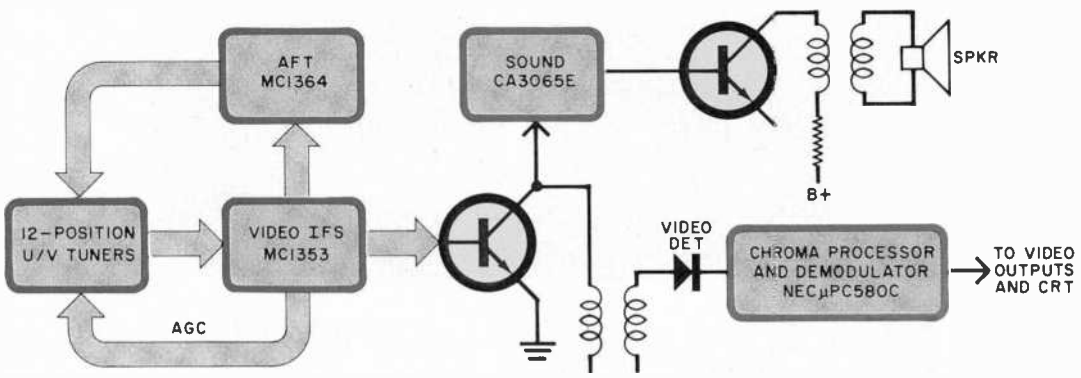

Fig. 1. Simplified block diagram of the main color chassis. Functions are performed by four ICs and 28 discrete transistors.

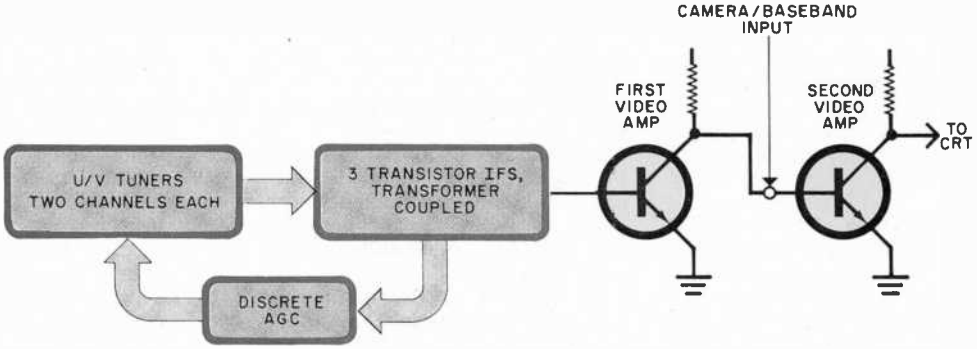

Fig. 2. Simplified block diagram of the chassis for one monitor, using all discrete transistors. The two 5-inch monochrome channels are identical.

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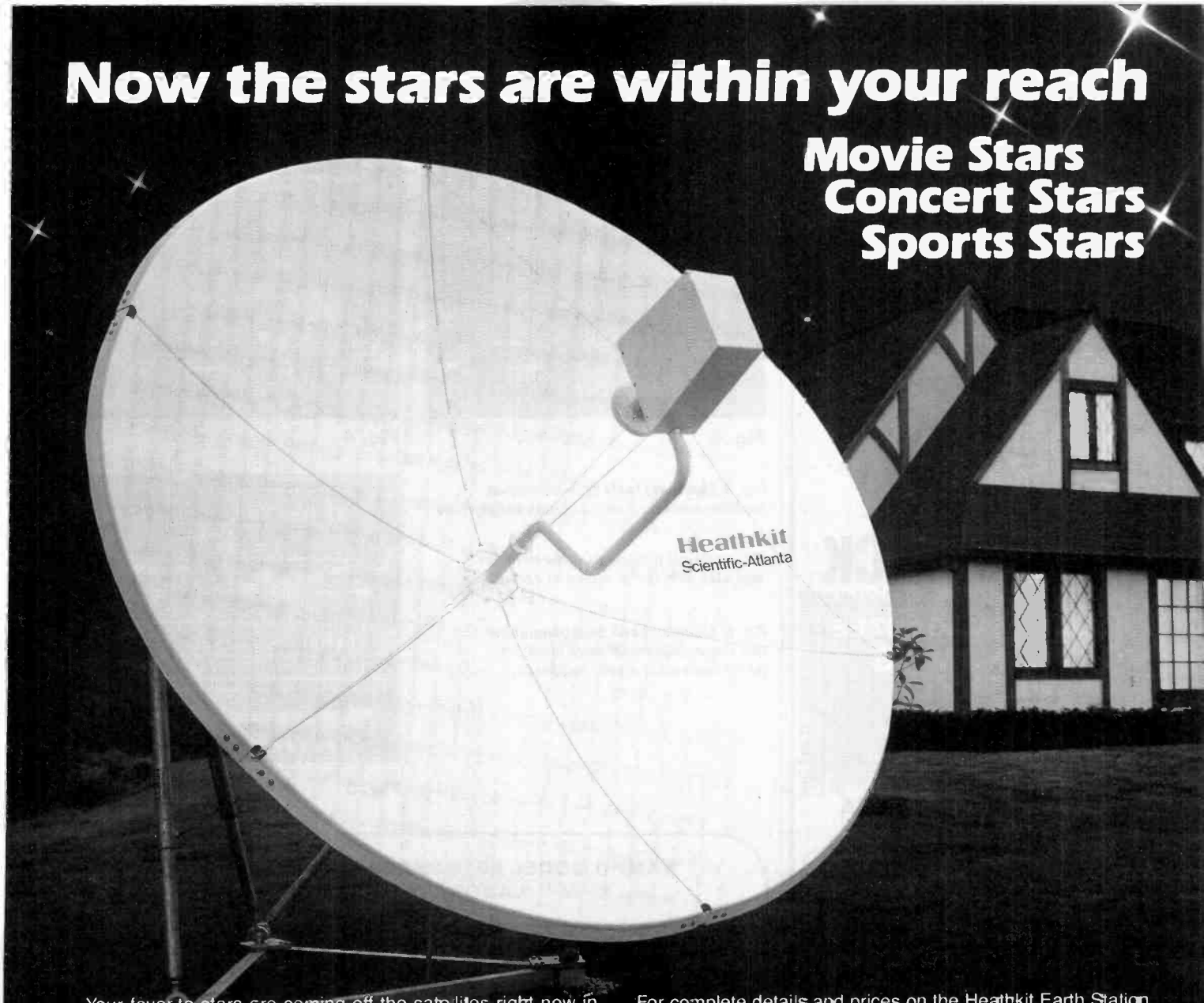

Your favorite stars are coming off the satellites right now in one of the greatest selections of family and adult entertainment ever offered. And now there's a new satellite receiver system that puts it all within your reach — at a price that's within reach.

The new Heathkit Earth Station

It includes a *3-meter Satellite Antenna* with a single-axis adjustable mount that lets you direct your antenna to receive signals from the entire satellite arc. It's a heavy-duty, commercial-quality antenna, made by Scientific-Atlanta and designed for long, reliable performance.

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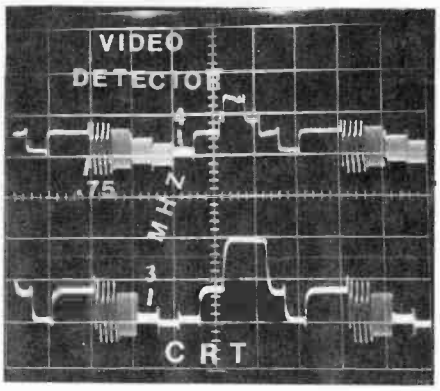


Fig. 3

Fig. 3. Multiburst tests on main-screen receiver showing 3 MHz at chathode ray tube.

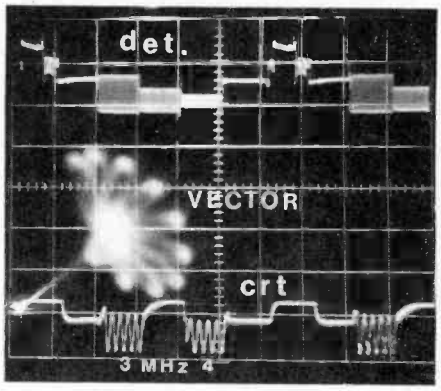


Fig. 4

Fig. 4. Swept chroma at video detector and CRT with vector shape at center.

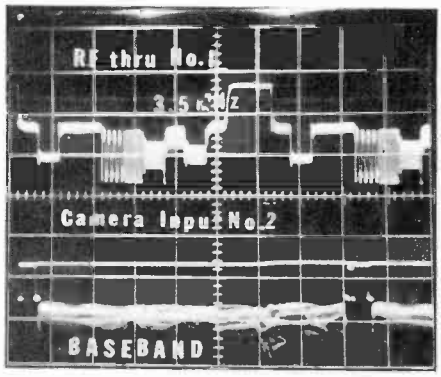


Fig. 5

Fig. 5. Multiburst and baseband at the two 5-inch black-and-white monitors which have a full 4-MHz bandpass.

SAMPO MODEL 9519 THREE-SCREEN RECEIVER LABORATORY DATA

Parameter	Measurement
Tuner/receiver sensitivity (min. signal for snow-free picture):	vhf (Ch. 8): −6 dBmV uhf (Ch. 30): −4 dBmV
Voltage regulation (line varied from 105 to 130 V):	Low voltage: 120-V supply—93.7% 24-V supply—93.9% High voltage: 26-kV supply—90.1%
Luminance bandpass at CRT:	3 MHz
Luminance bandpass at video detector:	4 MHz
S/N at CRT:	40 dB
Horizontal overscan:	15%
Agc signal range:	63 dB
Convergence:	99.9%
Barreling and pincushion effects:	None
CB interference at 60 ft on Chs. 2, 4, 5:	None
Audio bandpass (3 dB down):	130 Hz to 4.1 kHz
Power requirement (3 screens):	123 W
(19" screen only):	107 W

Note: Instruments used in these measurements are: Tektronix/Telequipment D66, D67A oscilloscopes; Sadelco FS-3D-VU f/s meter; Data Precision 245, 1350, 1750 multimeters; B&K Precision 1248, 1250 color bar generators; Sencore VA48 (modified), CG169 color bar generator and PR 57 power supply; Winegard DX-300 amplifier; and Tektronix, Canon, and Polaroid cameras.

tricity. Wearing crepe-soled shoes, you'll have to wait a number of seconds between channel changes for a new charge to build up. The infrared tuning is wholly satisfactory.

Servicing the monochrome sets could be difficult because they are recessed within the cabinet, and not mounted on slide rails. For example, it has an almost completely unpluggable chassis. The main 19-inch color receiver's performance is about average among high-end import models. All in all, its conservative design provides a good picture.

— *Stan Prentiss*

Popular Electronics Tests

The Sencore SC60 Widebander Dual Trace Oscilloscope

THE Sencore SC60 Widebander 60-MHz Dual Trace Oscilloscope operates from dc to 60 MHz and is specifically designed for observation of narrow, fast-rising pulses found in digital circuits, as well as for conventional signal observation and measurement from audio to r-f. This new scope is aimed at engineers and service technicians who realize that 60- to 100-MHz scopes are becoming a necessity when designing or servicing modern, state-of-the-art electronic equipment.


CERTIFICATE OF CALIBRATION

LOCKHEED ELECTRONICS COMPANY, INC.

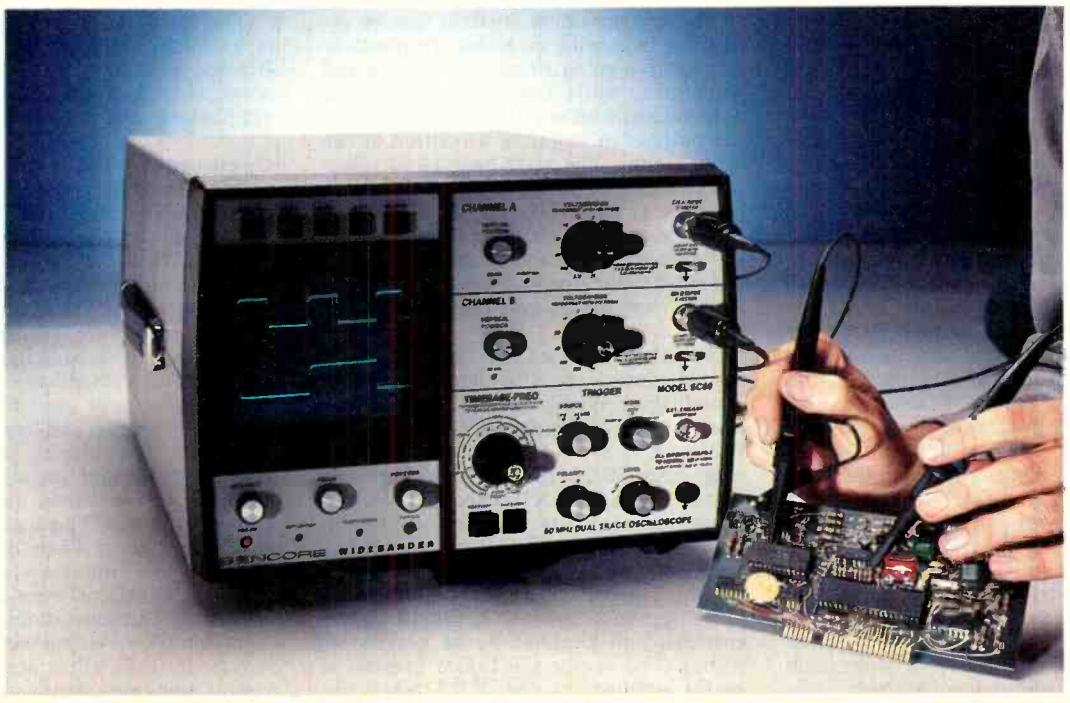
Because of the 6-ns risetime of the vertical amplifiers, this new scope is able to display waveforms up to 100 MHz. The input level to each channel can be from 5 mV to 1.6 kV peak-to-peak. The vector function, provided for color-video servicing, operates to 5 MHz.

Optional accessories include the WBA52 Wideband Amplifier that provides 30 dB of gain between 1 and 100 MHz; the DBA220 20 dB Audio Amplifier that provides 20 dB of gain between 30 Hz and 20 kHz; and the PL207 RF Pickup Loop ("Snoop Loop") that provides inductively coupled r-f signals for high-frequency measurement and observation. The SC60 comes with a pair of 39G149 X10 Low Capacity probes, a 66K28 Vector Graticule Film, and a 48" black test lead.

The SC60 measures 9.5"H x 12"W x 17"D and weighs 25 pounds. Power requirement is 105 to 130 volts, 50/60 Hz, at 35 watts. It can be converted to 210 to 250 volts, 50/60 Hz. Suggested retail price is $1895.

General Description. Unlike most scopes, the SC60 has two independent tilt stands, one at the front and the other at the rear of the enclosure. This permits the use of the front tilt stand as normal, and when the rear tilt stand is snapped out, the scope rides about 3" above the work surface. Both tilt stands have skid-proof pads. The rear of the enclosure supports four ac line-cord wrappers, a snap-fastened probe storage compartment, a dc output jack to provide 10-to-15-volt dc at 100 mA to power optional accessories, the Z-axis BNC input connector, and the ac line fuse.

On the front panel are the CRT and its controls—INTENSITY (with POWER ON OFF switch), FOCUS, and HORIZ POS directly below. Under these controls are the PWR ON indicator, the ASTIGMATISM and TRACE ROTATION recessed controls, and the 1V PP CAL feedthrough. Five display pushbuttons for BEAM FIND, CHAN A, CHAN B, A&B, and VECTOR modes are arranged over the CRT bezel. Access to all controls is easy, without disturbing another control. A simplified instruction pull-out card is accessed by pulling it from its compartment on the underside of the enclosure.



MANUFACTURER'S SPECIFICATIONS

CRT
- **Display area:** 8 x 10 cm (rectangular)
- **Phosphor:** P31 (blue)
- **Accelerating potential:** 6 kV
- **Graticule:** built in, 0, 10, 90 and 100% markings
- **Beam finder**

Vertical Amplifier (A and B)
- **Bandwidth:** dc-60 MHz, ±3 dB, −6 dB at 80 MHz, −12 dB at 100 MHz; ac mode is from 10 Hz to 60 MHz, ±3 dB
- **Risetime:** 6 nanoseconds
- **Sensitivity:** 5 mV/div to 20 V/div in 12 steps, 1-2-5 sequence with variable vernier; 0.05 V/div to 200 V/div using 39G149 X10 Low Capacitance Probe
- **Accuracy:** ±4% from 20° to 30°C; ±6% from 0° to 40° C; 10% for A+B, or B−A displays
- **Input impedance:** 10 megohms/ 15 pF using 39G149 probe; 1 megohm/50 pF direct input
- **Max. input voltage:** 2 kV peak-to-peak (dc + peak ac) using the 39G149 probe; 500 V (dc + peak ac) using direct input. Derates with frequency.
- **Display modes:** A, inverted A, B, A & B, A + B, B − A, vector.

Horizontal Deflection
- **Sweep rate:** 100 ms/div to 0.1 μs/div, 1-2-5 sequence, 19 steps, with variable vernier; special pushbuttons select 2 cycles vertical or horizontal of NTSC composite video.
- **Accuracy:** ±4% typical
- **X10 magnification:** Sweep becomes 10 ms/div to 10 ns/div; accuracy is ±5%, except on .1, .2, and .5 μs/div where it is ±8%.

Triggering
- **Source:** channel A, B, ac line, external
- **Mode:** normal, auto, video
- **Polarity:** +, −
- **Internal trigger sensitivity:** ac coupled is 0.5 div of deflection between 10 Hz and 20 MHz; 1 division of deflection from 20 to 60 MHz; 3 divisions of deflection at 100 MHz.
- **External trigger sensitivity:** 100 mV to 40 MHz; triggerable to 100 MHz.
- **External trigger max input:** 500 V (peak ac + dc)
- **Video trigger sensitivity:** 1 division of deflection

Vector (X-Y Mode)
- **Bandwidth:** dc to 5 MHz ±3 dB
- **Phase shift:** ±3 degrees, dc to 5 MHz
- **Input:** channel A is Y axis, B is X axis
- **Sensitivity:** same as vertical channels

Z Axis
- **Beam blanking:** 5 V positive
- **Beam intensification:** 5 V negative
- **Input:** dc coupled
- **Frequency range:** dc to 5 MHz
- **Max. input voltage:** 50 V (dc plus peak ac)

Output
- **Calibration signal:** 1 V p-p, 2-kHz square wave

Physical
- **Weight:** 25 pounds
- **Height:** 9.5 in.
- **Width:** 12 in.
- **Depth:** 17 in.

Power Requirements
- **Normal:** 105 to 130 V, 50/60 Hz; 35 W; field adjustable to 210 to 250 V, 50/60 Hz.

Supplied Accessories: two 39G149 X10 Low Capacity Test Probes; one 66K28 Vector Graticule Film; one 48" black test lead.

Optional Accessories: DBA220 X10 Low Level AC Amplifier to increase audio sensitivity by 20 dB; WBA52 Wideband Amplifier to raise 1-to-100-MHz signals by 30 dB; and PL207 r-f Pickup Loop for indirect high-frequency measurement.

There are three controls for each vertical channel—the AC/DC/GND input selector; a 23-position (arranged 1-2-5) VOLTS/DIVISION selector switch with a coaxial vernier, and a VERTICAL POSITION control. Each channel also provides a recessed control for DC BAL. The channel-A position control can be pulled out to invert the channel-A signal only. Because of this, channel A is also provided with a recessed INVERT CAL control. Both vertical channels are provided with a BNC input connector and a banana-type ground connector.

The trigger SOURCE can be selected from CHAN A, CHAN B, AC LINE, or from the EXT input, which is also provided with a BNC input connector. The trigger MODE can be selected from NORM, which shows a trace only when the triggering circuits are fully locked to the input signal, from AUTO, which displays a trace whether the triggering circuits are locked or not, from EXT, which allows external triggering, and from VIDEO, which uses sync separators to lock to video sync pulses. The latter mode works in conjunction with the VIDEO HORIZ and VIDEO VERT pushbuttons to display two or more horizontal lines or video fields.

The trigger LEVEL control can be set to allow triggering on either the positive- or negative-going slope of the displayed waveform, while the trigger POLARITY determines whether the trace starts on the positive or negative transition of the input signal. The TIME-BASE-FREQ selector switch has 19 positions (in a 1-2-5 sequence), from 100 ms/division to .1 μs/division. The 20th position of this switch, VIDEO PRESET, enables the internal sync separators—there are two, one for the horizontal and one for vertical sync.

Some older scopes use the 60-Hz power-line frequency for viewing video waveforms. With chroma signals, the sync will be unsteady since chroma vertical sync is 59.94 Hz for interlaced signals, and 60.02 Hz for noninterlaced signals. When the X10 expansion switch (mounted coaxially with the HORIZ POS control) is operated, sweep speed becomes 10 ms/div to 10 ns/div. Depressing the VECTOR pushbutton allows X-Y operation with channel A providing the vertical, and channel B the horizontal signal. The vector CRT film overlay is easily applied to the CRT graticule window.

The manual accompanying the SC60 is excellent, and profusely illustrated. Besides a complete discussion of the scope, there is a lengthy section covering applications and maintenance.

Comments. The manufacturer's specifications for the SC60 are shown in the table. The SC60 was checked by the Lockheed Instrumentation Measurement Laboratory (Plainfield, NJ) against standards traceable to the National Bureau of Standards. The Lab issued a certificate testifying that the SC60 met or exceeded its claimed specifications in all respects.

The SC60 was used on a test bench for a few weeks and was found to be excellent. The clarity of the control identifications and the wide spacing between controls made this instrument very easy to use. The traces were bright and sharp, even when displaying fast-risetime, low-frequency signals. Sweep sync was excellent, even at extremes of frequency and amplitude. Of particular value for TV servicing were the two sync separators that allow stable viewing of almost any video signal. —*Les Solomon*

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Our complete ADC Sound Shaper IC line* has an equalizer that is right for you and your system. The SS-110 ten-band full octave equalizer, a step up from our SS-1, features LED-lit slide controls and one-way tape dubbing. If you desire even more control, our twelve-band SS-II and top-of-the-line SS-III include two-way tape dubbing and sub-sonic filters. Our SS-III Paragraphic™ with 24 ancillary switches that enable you to control 36 bands per channel combines

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All of our equalizers feature LED-lit slide controls allowing for visual plotting of the equalization curve. And all ADC Sound Shapers embody the outstanding ADC technology that has made us the leaders in the industry.

To really complete your custom-tailored control-ability, our ADC Real Time Spectrum Analyzer is a must. Equipped with its own pink noise generator and calibrated microphone, the SA-1 provides a visual presentation of the changing spectrum through 132 LED displays. So you can actually see proof of the equalized sound you've achieved.

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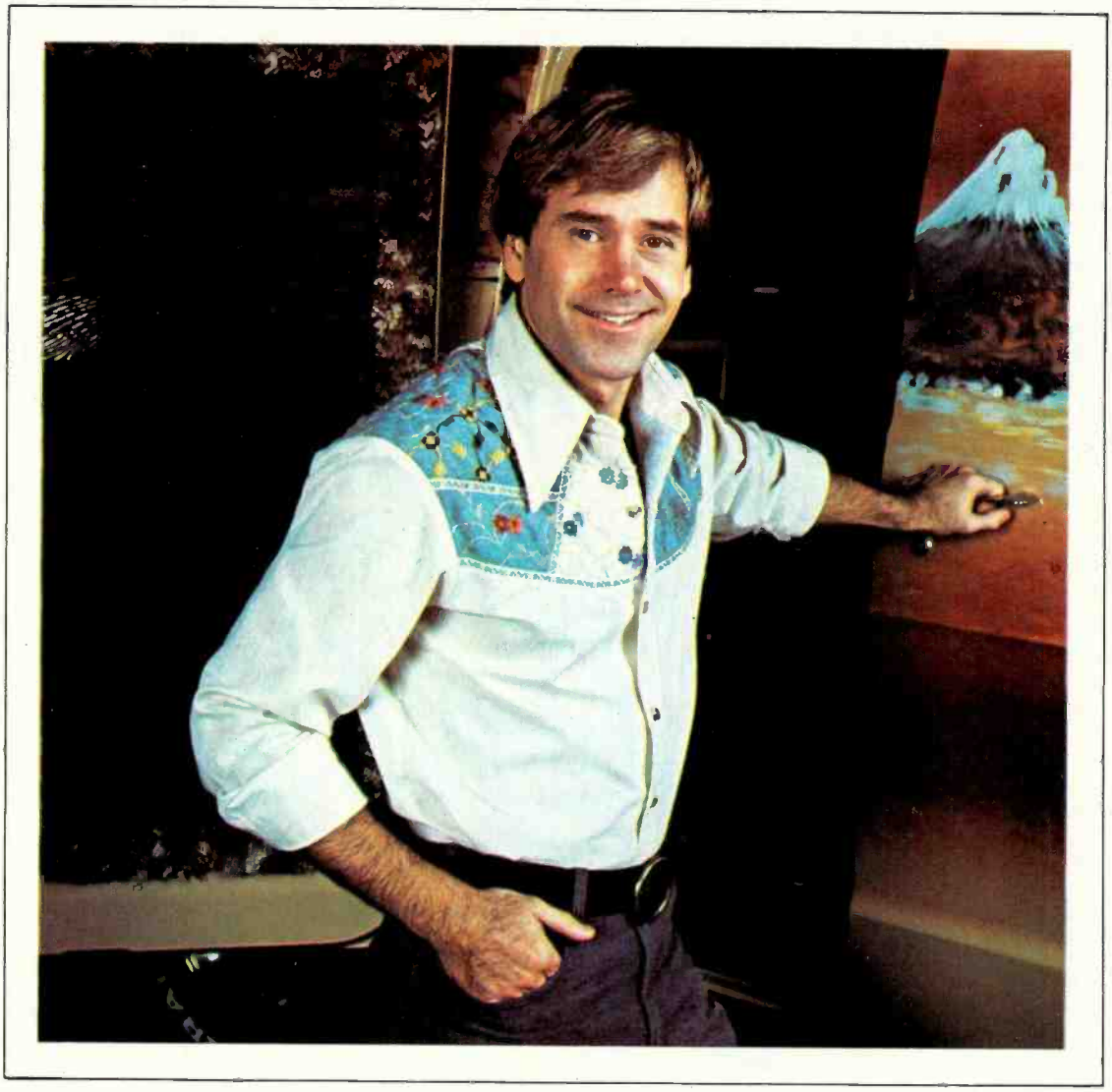
You gotta shop around.



When you do, you'll probably pick CIE. You can't afford to settle for less when it comes to something like electronics training that could affect your whole life.

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* * *

If you talked to some of our graduates, chances are you'd find a lot of them shopped around for their training. They pretty much knew what was available. And they picked CIE as number one.

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We hope you'll shop around. Because, frankly, CIE isn't for everyone.

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Part of what makes electronics so interesting is it's based on scientific discoveries—on ideas! So the first thing to look for is a program that starts with ideas and builds on them!

That's what happens with CIE's Auto-Programmed® Lessons. Each lesson takes one or two principles and helps you master them—before you start using them!

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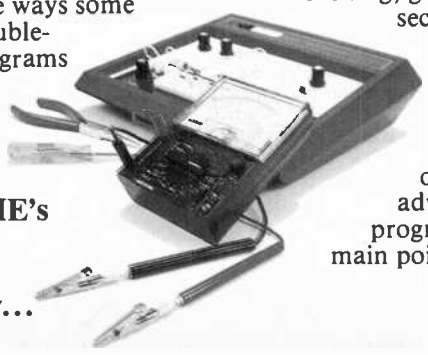
Here are ways some of CIE's troubleshooting programs help you get your "hands-on" training...



With CIE's Personal Training Laboratory... you learn and review the basics—perform dozens of experiments. Plus, you use a 3-in-1 precision Multimeter to learn testing, checking, analyzing!

When you build your own 5 MHz Triggered-Sweep, Solid-State Oscilloscope you take your first real professional step. You use it as a doctor uses an X-ray machine— to "read" waveform patterns... lock them in...study, understand and interpret them!

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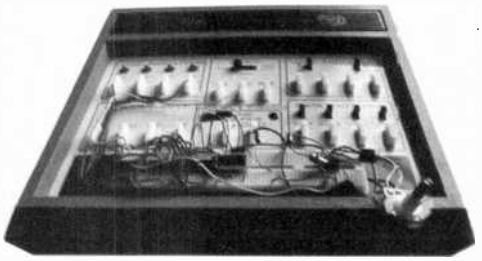

Of course, CIE offers even more advanced training programs, too. But the main point is simply this:

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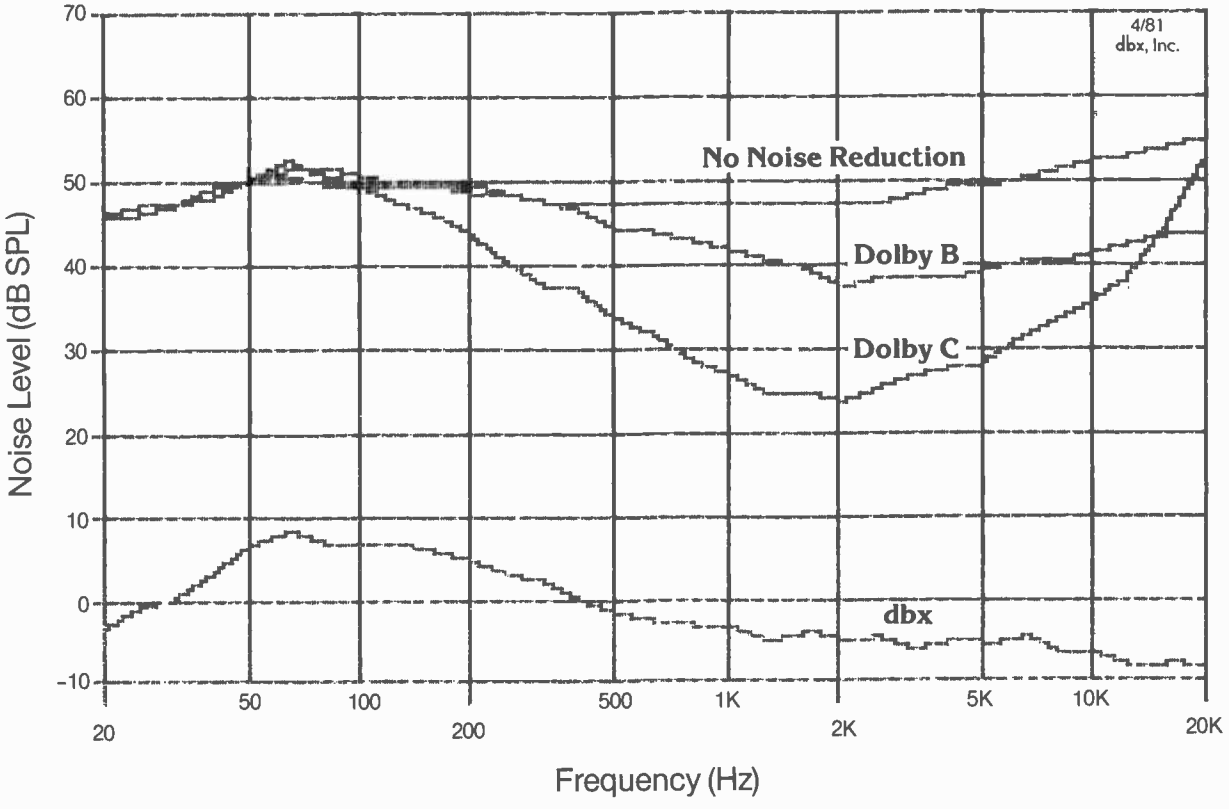
dbx has been silent too long.



Noise from biased Chromium Dioxide cassette tape, comparing Dolby and dbx noise reduction systems. One third octave analysis. Tape noise level referenced to 200 nWb/m = 110dB SPL.

For years Dolby* has been trying to reduce tape noise.

First came Dolby B. Then Dolby HX. Now there's Dolby C.

At dbx, we think it's time to set the record straight. You see, we've never tried to reduce tape noise. We've never had to.

Because from the beginning, dbx has done what Dolby keeps trying to do: *eliminate* tape noise.

Just compare Dolby's latest attempt with dbx.

Where Dolby C reaches a maximum noise reduction of 20 dB, dbx reaches 50 dB. In a CCIR-weighted noise measurement analysis, Dolby C manages only 18 dB, while dbx achieves 55 dB.

What do these numbers actually mean?

Simply this. When you push the Dolby C button, tape noise decreases. When you push the dbx button, tape noise disappears. (You can perform this test yourself using any blank cassette tape.)

The dbx system reduces tape noise so effectively, that it's beneath the noise floor of even the quietest living rooms. Unlike Dolby C, dbx is effective in more than just the mid-range. It operates across the entire frequency spectrum. There's no low-frequency noise. No high-frequency noise. No noise, period.

No wonder Technics, Onkyo, Yamaha, TEAC and others have designed their newest generation of tape decks with dbx.

There's more to this story, too. With the dbx tape noise reduction system, you're also equipped to play the widely acclaimed dbx Discs, the world's only Full Dynamic Range Records — and the first discs that eliminate record surface noise.

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So before you rush out to buy a tape deck with Dolby C, we have a suggestion.

Listen to the new tape decks with dbx. Or hear what a dbx Model 222 or 224 can do for your existing system.

At dbx, we've been silent too long.

The fact is, Dolby just reduces noise.

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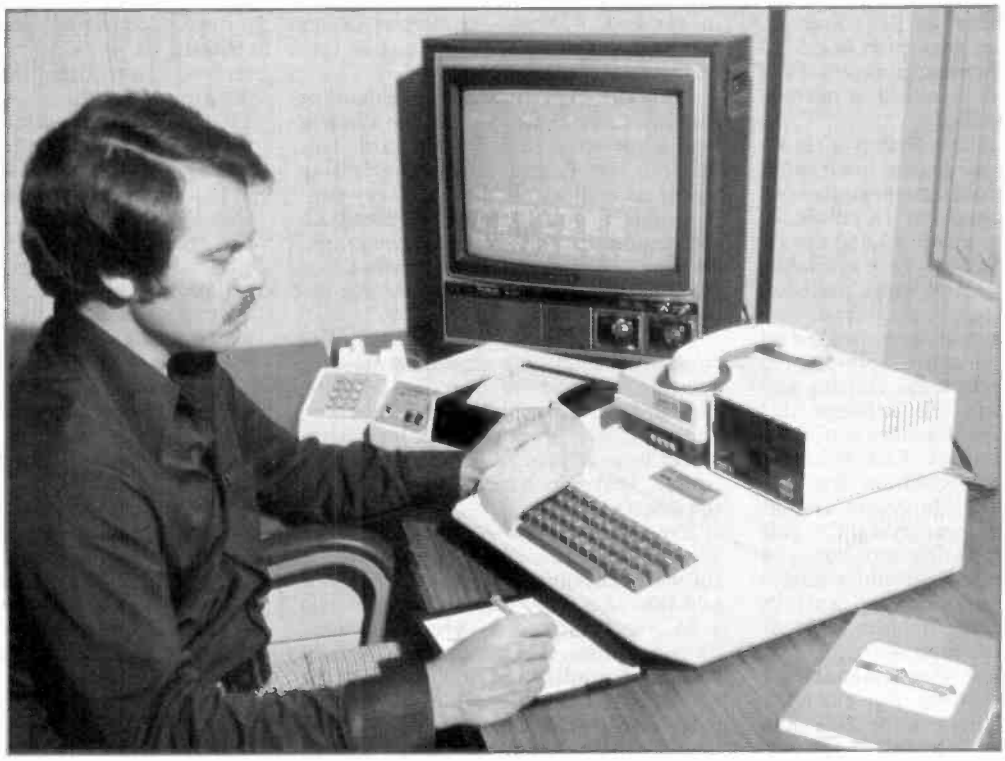
Popular Electronics Tests



The Apple II Plus Personal Computer System

ALTHOUGH it is not a new entry to the world of personal computers, the Apple II Plus is by far one of the most flexible and powerful machines available. Based on the 6502 microprocessor and an 8-bit bidirectional bus with eight so-called peripheral slots, the system can accommodate a wide range of applications. Essentially, the Apple II Plus is an upgraded version of the Apple II, containing built-in Applesoft and with the Integer BASIC dropped.

As designed, the Apple II Plus can operate with either a conventional TV receiver or a video monitor. When used with the former, the system needs an r-f modulator that meets FCC requirements. Performance is good either way, but the monitor is the best choice when color of very high quality is required.

The computer's enclosure is compact enough to be easily portable, and has a pleasing color. Other accessories, such as the video monitor, disks and printers, are outboard to the main unit. A carrying case, with pockets for cables, is provided for the main-frame section.

A basic Apple II Plus system with 16K bytes of RAM, ROM- resident Applesoft Extended BASIC, Auto-Start ROM, disassembler, and reference manuals—of which there are many—is priced at $1330. However, locating a 16K system may be difficult, as Apple has elected to provide only 48K systems (which cost $1530) to distributors. This has caused retailers some consternation, but, in our opinion, an extra 32K bytes of RAM for $200 represents a good buy.

The configuration that we used for our evaluation consisted of:

Apple II Plus with 48K RAM and all standard features	$1,530
Disks II, a 16-sector 5.25-inch single-density floppy with interface and DOS 3.3	645
Second disk drive	525
12-inch monochrome Sanyo monitor	320
Silentype printer with Apple II interface	635
Language System with Apple Pascal	495
SSM Microcomputer Products AIO serial and parallel Apple interface	195
Microsoft RAMcard	195
Z-80 Softcard	349
	$4,919

In addition to the above, Personal Software has made available: VisiCalc, Visidex, Visitrend/Visiplot, and Visiterm. Agent Computer Services provided the Buffered Modem program for testing the viability of communications, and Vista provided the Model-150 40-character keyboard buffer.

General Description. The Apple II Plus consists of a molded, high-impact plastic case that houses the 6502 CPU, a high-efficiency switching power supply with sufficient shielding to avoid EMI and RFI difficulties, a 52-key typewriter-style full-stroke keyboard, cassette recorder input and ouput jacks, and video display output jack. The system backplane contains eight peripheral slots.

The system keyboard sports 2-key rollover and four special-function keys: CTRL (control), ESC (escape), RESET (used to restart the system), and REPT (repeat—provides automatic repetition of a depressed key). The coding is upper-case ASCII. Lower case is omitted, but can be added by plugging in a PROM with a new character set.

(Continued on page 40)

(Continued from page 39)

The standard display is memory mapped into system RAM and provides three display modes: text, low-resolution graphics, and high-resolution graphics. In the text mode, the display is 960 characters (25 lines × 40 columns), with each character generated in a 5×7 dot matrix. Upper-case characters, 64 in all, are generated in either a normal, inverse, or flashing mode.

The hallmark of the system is its sophisticated graphics. In the low-resolution mode, 1920 blocks are available (40 × 48 array) in a total of 16 colors. In the high-resolution mode, 53,760 dot locations (280 × 192 array) are available, and up to six colors (black, white, red, blue, green, and violet) can be displayed.

Because it is memory mapped, exact locations on screen can be pin-pointed by software to create some exciting and spectacular displays. To enhance this capability, the screen memory is divided into two areas, or pages. This primary/secondary page configuration lets you flip pages in and out to create animation. Moreover, by employing the soft switches of the operating monitor, you can invoke a variety of graphics modes and mixed modes (graphics and text). In addition, the system includes a loudspeaker and joystick controllers.

Numerous well-written manuals are supplied with the system. For example, to get you going, there is the 200-page *Apple II Reference Manual*. This manual provides information on the basic working of the system (including schematics) and supplies such data as important screen addresses and a listing of the ROM monitor. Other manuals explain—in similar detail—Applesoft BASIC, and PASCAL, as well as the use of the DOS.

Our sample system used the language card that bundled PASCAL. Recently, Apple has unbundled the PASCAL portion, offering the upgrade in memory separately. This is probably for compatibility with the Microsoft RAMcard, which was designed to work with existing Apple software and PASCAL.

The Plus II comes equipped with integer ROM-based BASIC and disk-extended Applesoft BASIC. The integer version doesn't support floating-point arithmetic and is like an expanded tiny BASIC. The extended version, however, offers complete BASIC capabilities, including a full set of graphics primitives, and peripheral controller calls such as PDL for paddle. (This function returns the current value from 0 to 255 of the game control specified as the argument. Unfortunately, we didn't have game controls, but are reasonably sure that everything works as advertised.)

The disk subsystem we used, a controller, and two drives, derives power right from the bus, thus reducing the number of wires hanging from the back of the enclosure. The only cable connections run from the controller card to the drives.

In a system of this size, two drives—all that are generally used—seem to be more than sufficient. However, you can add additional controllers and have as many as six drives. One interesting approach is to add an 8-inch controller and use both the 5.25-inch and 8-inch drives in tandem. Adding the larger drives means that power for them must be taken from external power plugs.

Like the disk system, the Silentype thermal printer works in conjunction with a bus-oriented controller card. This fits into slot-1, and provides operating power as well as all the necessary control signals. The Silentype handles both alphanumerics and graphics. The graphics are presented in a raster format that permits the printing of complete dot-by-dot pictures.

Unfortunately, to get multiple copies from the printer, you must do a multiple printing. This can be overcome by using an SSM AIO serial/parallel card and adding either a dot-matrix or daisy-wheel impact printer. This assumes, of course, that you have an open slot for the interface.

Even though the Apple is designed around the 6502 and is meant to use software developed for that CPU, the addition of a Z-80 microprocessor—via a Microsoft Softcard—greatly extends its capabilities. This, moreover, is done without degrading the functioning of the 6502. The Softcard provides all the features one would expect from a Z-80, including support of the CP/M operating system. However, operation is more complex than it may seem. The Z-80 provides computing power, while the 6502 handles all I/O including operation of the screen display under Z-80 supervision. This arrangement is both speedy and efficient.

Evaluation. The Apple II, almost regardless of configuration, is easy to use. Because of the very carefully written, concise manuals, setting up a system like the one we used is straightforward, and takes only about 30 minutes.

Although not CP/M compatible, the disk operating system (DOS3.3) handles simple jobs extremely well. For example, initializing a disk is done by formatting it via a utility, then writing a Hello program under BASIC. This we found intriguing, as it meant we could be very inventive in our sign-on messages. Furthermore, for turnkey-type operation, our sign-on could be a unique program that interfaces to a larger program or other programs—a menu system, if you will.

When the system is first turned on, the unit begins looking for a disk to load. This is a function of the Auto-Start ROM and can be quite disconcerting at first, especially if you were planning to go into ROMBASIC. To suppress disk operation, simply hold down the RESET key while powering up. Should you power up and want to stop the disk, depressing RESET, will drop you into the ROM-resident language and stop the drives. If RESET is not used, the drives will run without timing out, which could be a minor problem.

Rumors have circulated concerning the Apple's susceptibility to heat, especially after it has run for long intervals of time. But try as we might, running it for extended periods and deliberately restricting its ventilation, we could induce no heat-related malfunctions, even with the air around the main circuit board at 110°F. We conclude, therefore, that whatever problems the system had in this area have been solved.

Evaluating the system further, we took a program that would link to other files, read and hold tax tables, and update other files. The purpose was to determine whether or not the data would always be accurate as it transferred between files and out to a printer. We set an arbitrary limit of 500 items.

The whole process took about 1 hour and 30 minutes to generate, and another hour and 15 minutes to perform the swaps and sorts. In our test, no data was lost.

Going further, we tried a program that would generate graphics on the screen, using the database already generated. That data was handled with accuracy, but not with dispatch. (However, it must be remembered this is a floppy-based system and speed is not one of its prime virtues.)

Our next test used Personal Software's Visidex, which is designed to take information in any format and return it either on the screen or printer, sorted or unsorted. This program relies on the channel speed of the disk system to display information quickly. Access to a disk record is almost instantaneous. Furthermore, the software package is time-oriented so that records can be related either to system time (date and clock time) or actual time, assuming that you have a real-time clock.

Next, we tested to see if quickly raising and lowering line voltages would damage the rather large database we maintain under Visidex. It did not. Operation was unaffected by line voltages from 75% to 130% of nominal.

One annoying shortcoming was the lack of upper/lower case character set. Even though correctable through purchase of an ROM for about $65 this omission seems out of place in an otherwise sophisticated system. Furthermore, the location of the arrowed keys is a problem since it is easy to hit one when your goal is the RETURN key. Even worse is the location of the RESET key directly above RETURN. We would have also liked to see some special-function keys, either fixed or user-definable.

Although the backplane design offers flexibility by memory-mapping devices into the system, it does assume that the operator has intimate knowledge of the machine. What would have been nice is a utility program under DOS that would check each slot for a device and determine if it could be properly interfaced. Should the installed card not be of Apple origin or directly supported by Ap-

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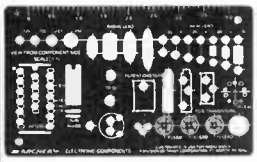

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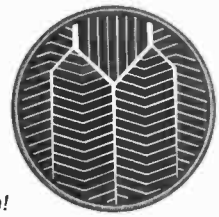

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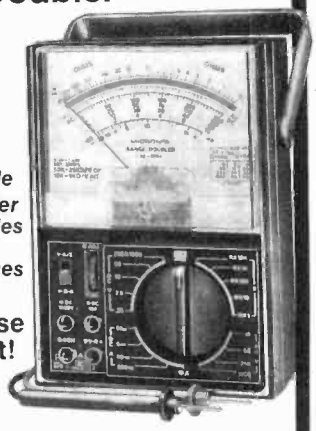

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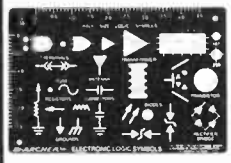

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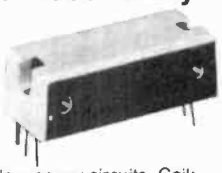

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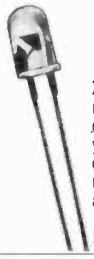

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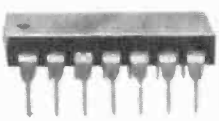

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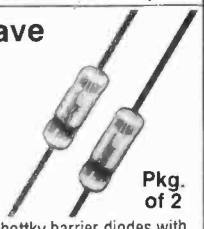

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ple, its attributes could then be requested and held in a system map file. Application programs could use this file by simply calling the device.

As described, we encountered no problems with heat or, for that matter, bus loading. But we noticed that it does become a tight fit when you start adding cards to the backplane; such is the price of ready portability. And speaking of portability, a card-restraint cage would be a nice touch, even at a slight cost.

Comments. The Apple is one of the most widely supported machines on the personal computer market today, with over 300 companies providing hardware, software or both. Additionally, numerous manufacturers see the machine as a low-cost entry to the high-end graphics marketplace.

Interestingly, though this may be strictly our perception, the audio aspect of the machine has not caught on. But this may be changing. According to some observers, sophisticated voice-output devices will make the machine downright conversational.

As far as we are concerned, the Apple II Plus gets high marks and has no serious shortcomings anywhere. But as capable as this machine is, we aren't convinced that it is ideal for business. We do believe, however, that it fits well into environments requiring rapid data collection and into graphic arts. In fact, the machine has found a home in numerous schools that use it for teaching everything from computer science to manufacturing skills. —*Carl Warren*

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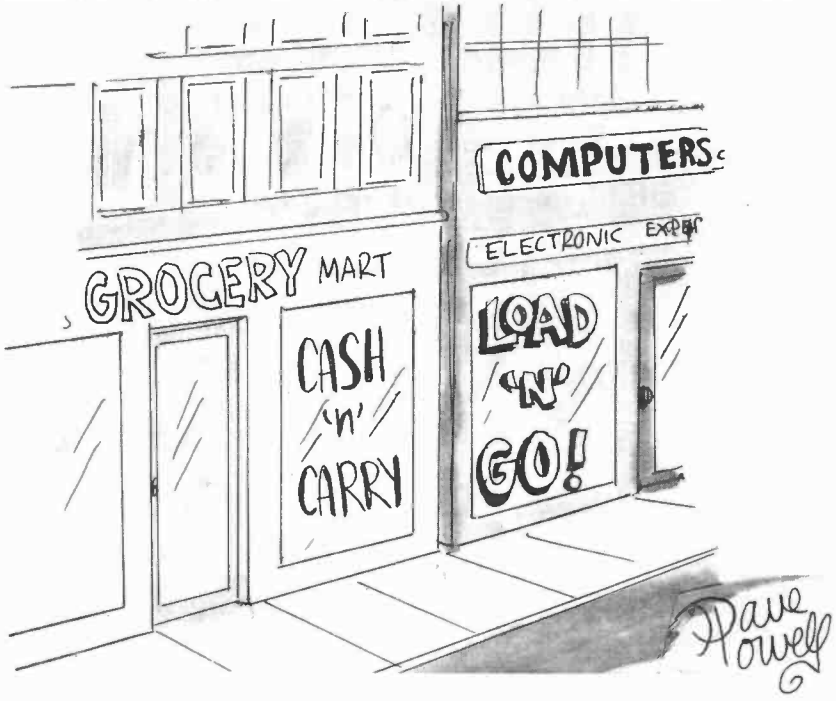

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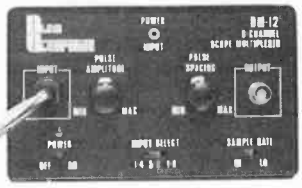

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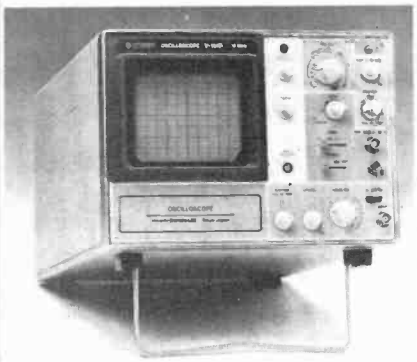

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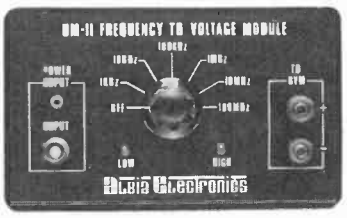

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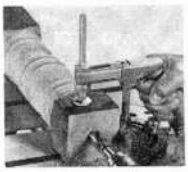

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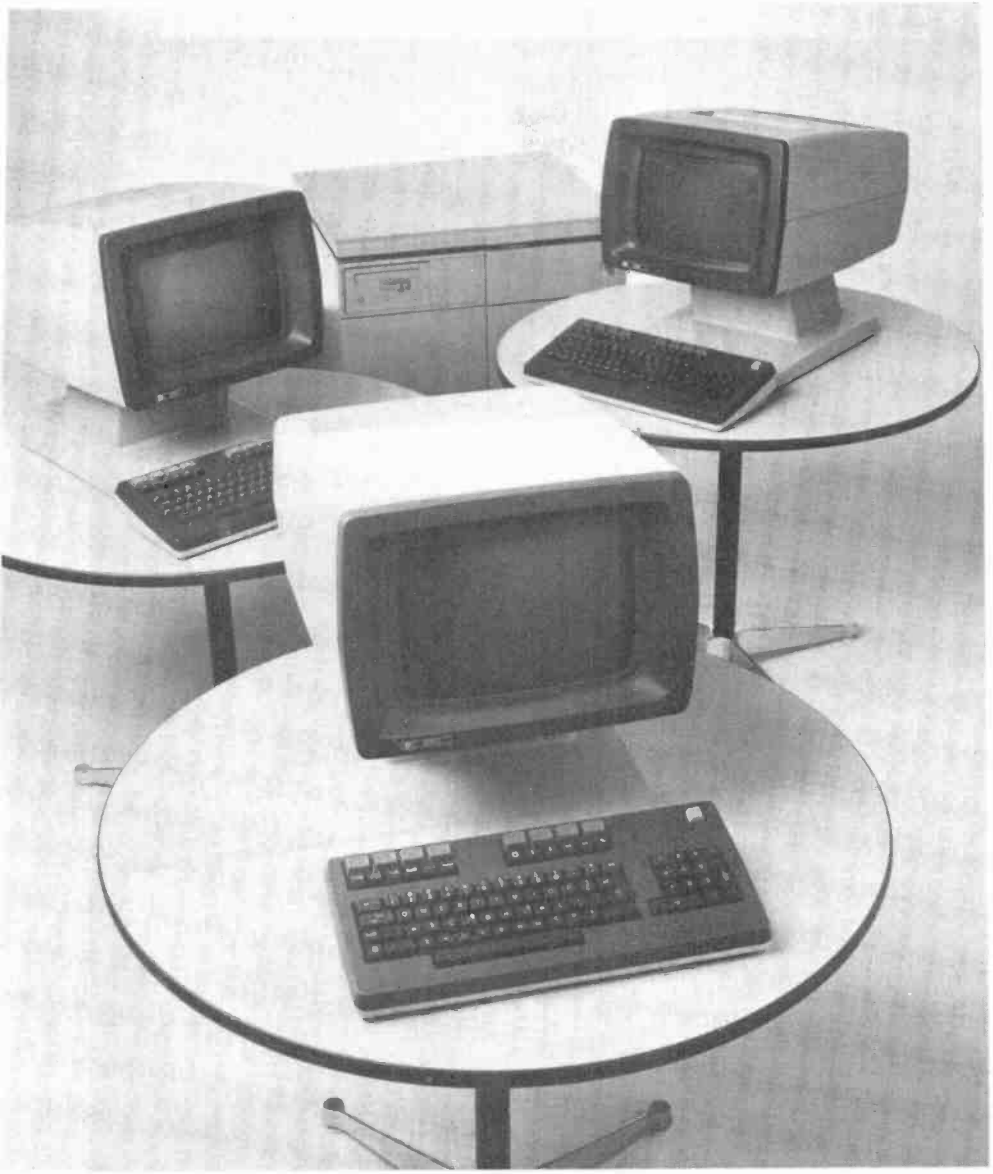
COMPUTER BITS

By Carl Warren

High-End Systems (for Low-End Buyers)

TWO prestigious companies, Xerox and Hewlett-Packard, have added their names in the very-small-business computer field. Both manufacturers have introduced powerful word- and data-processing microcomputer systems featuring the versatile industry-recognized standard operating system, CP/M. Both systems are in the low (less than $3,000) to medium ($10,000) price range.

The principal significance of these developments is that the professional systems approach has entered the world of small systems. For example, the Xerox 820 sports a full-screen display (80 × 24) with reverse video and full-screen mapping, a detachable full-function



The Hewlett-Packard HP-125 microcomputer system supports two RS-232C serial ports and employs two Z-80A microprocessors.

keyboard, a choice of 5.25-in. or 8-in. floppy disks, and a full range of CP/M-compatible software. Some very sophisticated communications features are provided, too. Specifically, the 820 supports the 872/873 Communication Server, which provides for *Ethernet* compatibility for future expansion of the machine. Because it is generally agreed that software is the primary ingredient in the success of any computer, Xerox is offering a version of Micropro's WordStar wordprocessing system, Sorcim's Supercalc electronic worksheet, and other CP/M-compatible packages.

The 820 is priced at $2,995 for CRT, keyboard, 64K bytes of memory, and two 5.25-in single-density floppy disks. Adding the optional 40-cps daisywheel printer (Diablo Model 630) brings the price to $5,895.

Although Xerox chose not to bundle any software into the basic package, it is offered at standard prices. For example, the word-processing package carries a $500 price tag regardless of disk size, 8- or 5.25- in. CP/M is an extra $200.

Hewlett-Packard's HP-125 CP/M system is $6,960. This is a Z-80-based system with dual 5.25-in. disk drives, two RS-232C communication ports and an integrated 80-cps thermal printer. Unlike Xerox, Hewlett-Packard includes CP/M in the base price, but you should expect to pay extra for additional software. Among the software options offered by HP are: VisiCalc/125, $200; Word/125, $500 (a version of WordStar); Graphics/125, $200 (a version of Personal Software's Visitrend/Visiplot package, designed for creating graphs and doing trend analysis); BASIC 80, $325; Link/125, $150; and a CP/M utility package, $125.

HP, like Xerox, has allowed for communications applications and future growth. Hardware and software provisions have been made to permit the 125 to operate in the company's HP-3000 EDP network or other large mainframe systems.

The HP-125 employs dual Z-80A microprocessors and sports a full 64K bytes of RAM memory. One processor serves the computation requirements of the system, while the other handles the screen/terminal chores.

Xerox and HP have paid close attention to the human engineering needs of the intended user. The 820 and 125 use easy-to -understand menus to guide you in the use of the system(s). Moreover, specific functions such as screen scrolling are assigned individual keys.

Enter IBM. There are more introductions forthcoming, but from more traditional computer manufacturers. The long-awaited IBM entry is imminent, but it will not be based on the S-100 bus, nor will it be greeted with open arms as some "experts" have predicted. As evidenced by the 5110 and 5120, IBM (its position as undisputed leader in new high technology notwithstanding) is unable to offer the level of support required by the small-system user.

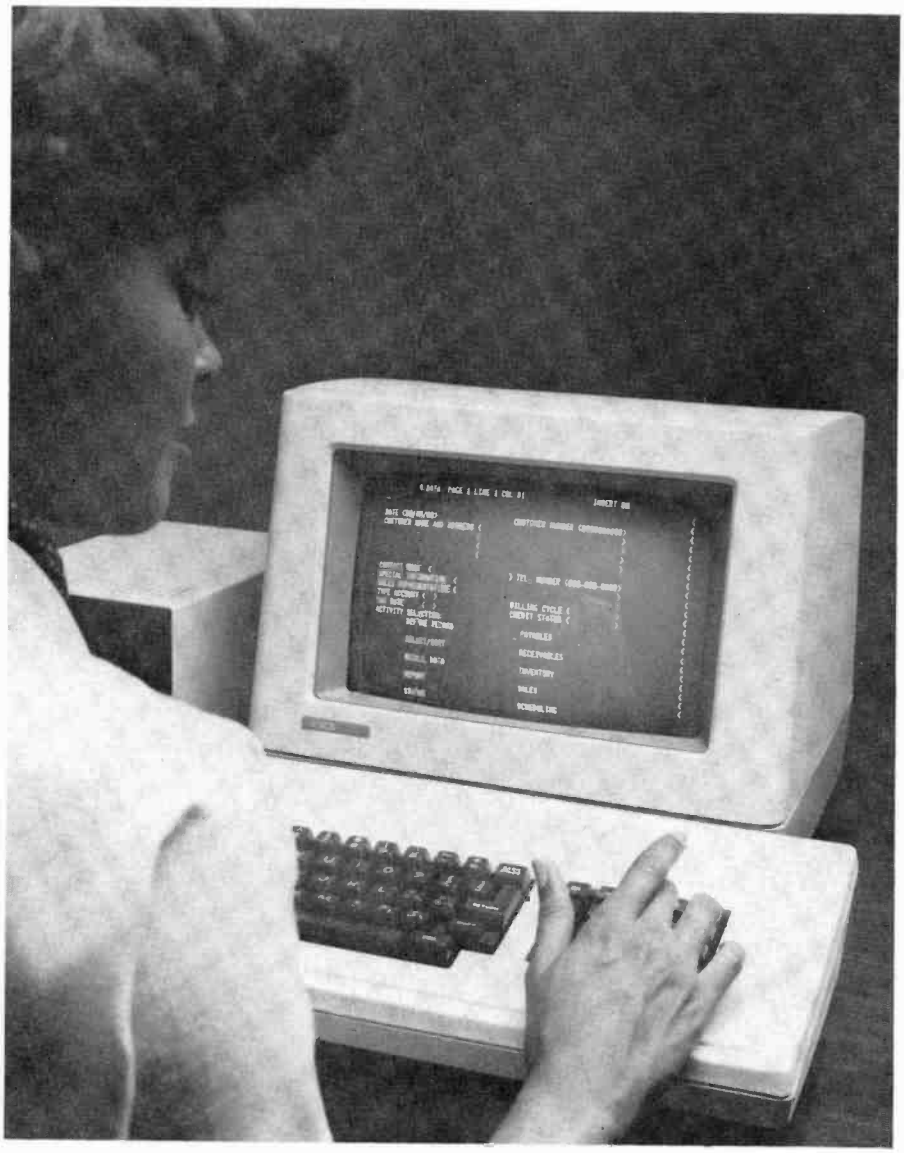
The IBM product is believed to be the system that has been under development at the General Systems Division in Boca Raton, FL. The unit reportedly is built around Intel's 8088 microprocessor and will use the operating system designed by Microsoft. This operating system is supposed to be like the CP/M system, and many believe that it may be CP/M 86, rather than the Unix-like Microsoft version. The system supposedly will support up to 256K bytes of RAM and employ dual-tandem double-density (96-tpi) floppy drives.

To support the lowest end of the personal computer spectrum, observers speculate that IBM will offer a stripped-down version for less than $1,000 when the larger unit is introduced. Interestingly, both IBM systems are based on its 3101 terminal with add-ons.

Whatever the fate of IBM's entries into this market, software incompatibilities will apparently not be a problem. Sources close to the computer giant say that agreements are in the making for the use of MBASIC, SuperCalc, dBase II, and a variety of other popular software products, including those of Personal Software, but neither IBM nor the suppliers would comment.

From the miniworld, you can probably expect to see low-end (less than $1,000) entrants from both Digital Equipment and Data General. Whether or not these machines will be CP/M compatible is anyone's guess; right now no one will say.

Computer Networks. Due to typographical errors three numbers shown in the June, 1981 column are in error. These are 503-641-5510, 503-641-9029 and 817-776-1325. Please do not call these numbers as they are private residences. We apologize for the error. Also, the listing of 915-584-5393 is no longer available. ◇



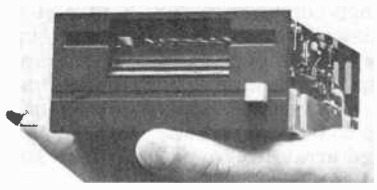
The Xerox 820 information system includes a Z-80 microprocessor, 64K bytes of RAM, detachable keyboard, and is CP/M compatible.

COMPUTER SOURCES

By Leslie Solomon
Senior Technical Editor

Hardware

3.5" Floppy Disk. The Sony 3.5-inch "Micro Floppydisk Drive" features 437.5K bytes double-density, single-side unformatted and 322.5K bytes formatted. The transfer rate is 500K bits/s,



latency is 50 ms, and access time track-to-track is 15 ms. The drive is 2"H × 4"W × 5.1"D and weighs 1.7 pounds. A special hard-cover diskette is used. Power dissipation is 7.5 watts continuous, 3.3 watts standby. $400. Diskettes are $5 each. **Address:** Sony Data Products Div., 15 Essex Rd., Paramus, NJ 07652 (Tel: 201-368-5000).

Computer Percussion. The Rhythm Box is a computer peripheral that synthesizes the sounds of seven different percussion instruments including bass drum, wood block, snare drum, short cymbals, long cymbals, hand clap, and tom-toms. It is programmed in Level II BASIC or assembly language using a single OUT instruction. It comes with two interface options; Model RBX-T ($149) for the TRS-80 Model I Level II and the RBX-S ($179) for other computers, and connects to any standard 9600-baud serial port with RS232 or 20-mA provisions. **Address:** Newtech Computer Systems, Inc., 230 Clinton St., Brooklyn, NY 11201 (Tel: 212-625-6220).

Single-Board Computer. The CPU-1 is an 8085-based system similar to the Intel 80/04. It operates at 3 MHz, and includes 256 bytes of RAM, 22 I/O lines, serial I/O port, programmable counter/timer, and two sockets for EPROM, expandable on board to 512 bytes of RAM, 44 I/O lines, and two clock timers. The EPROM can be 2708, 2716, 2758, or TMS 2716. It has power-on reset, manual reset and it supports the 8085 interrupt structure. The power supply is on board and only an external transformer is required. It also has a wire-wrap area. $185. CPU-1A (512 bytes RAM, 44 I/O lines, two timers) is $220. **Address:** Pragmatic Designs Inc., 950 Benicia Ave., Sunnyvale, CA 94086 (Tel: 408-736-8670).

6800 Trainer. "Trainer 1" is a two-board computer using a 6808 CPU with 1¼K RAM, provisions for 4K PROM and onboard I/O. It has an 8-digit display, hex keypad, Tbug 2K monitor, and hardware trace. Optional equipment includes KC cassette I/O, parallel I/O, serial (RS232/20 mA) port, crystal-controlled baud rate generator, and expansion cards. Starts at $349. **Address:** Omnibyte Corp., 245 W. Roosevelt Rd (1-5), West Chicago, IL 60185 (Tel: 312-231-6880).

Apple Parallel I/O. The APIO allows 8-bit parallel access to Apple II and Apple II Plus systems. The board provides 16 bidirectional data lines, and four handshaking lines for two 8-bit bidirectional interface ports. The direction of the data lines is under software control. On-board PROM operates a printer and makes the board independent of Apple slots. $109 assembled, $79 kit. **Address:** SSM Microcomputer Products Inc., 2190 Paragon Drive, San Jose, CA 95131 (Tel: 408-946-7400).

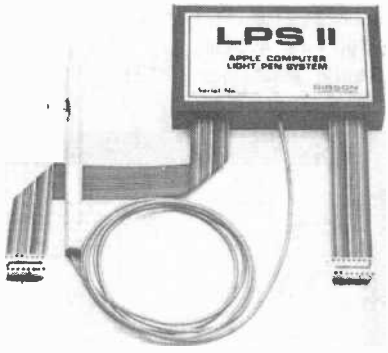
Tiny BASIC Module. The K-8073 uses the INS8073 CPU with Tiny BASIC, and includes an RS-232 I/O port, cassette port, 8K EPROM, with one slot, 1K RAM, with internal expansion to 8K, STD Bus, Asynchronous Rec/Trans remote controller for single-wire data control and retrieval of 8-bit words from 128 remote slave stations. It has PPI with 24 bi-directional I/O lines, and a real-time clock. Unit is on a 4.5" × 6.5" card and requires 5 volts. $388. **Address:** Transwave Corp., RD 1, Box 489, Vanderbilt, PA 15486 (Tel: 412-628-6303).

Color Printer Interface. The CPRINT module allows a Centronics-type parallel port for the TRS-80 Color Computer. Firmware allows all LLIST and PRINT #-2 outputs, a screen-print function can be initiated at any time, line width can be set, graphics in the LPVII can be accessed, page length can be set, and blank lines inserted between pages. The CPRINT module is a fully buffered 8-bit I/O port that can interface with any Model I/III which plug into the printer port. It is compatible with all versions of the Color Computer and requires no extra memory. $49.95 Address: Micro-Labs, Inc., 902 Pinecrest, Richardson, TX 75080. (Tel: 214-235-0915).

CMOS Computer. The BASYS/1 is an all CMOS computer designed around the CDP1802 CPU, with up to 2K of RAM and 8K of ROM. It has a flexible I/O circuit. Power requirements are 4 to 6 volts dc at 10 mA. Features include RS-232 or current-loop, parallel I/O, multiplexed I/O that can handle 10 digits and 80 keys, and a ROM monitor. A bus interface is provided. Price ranges from $175 to $300 depending on options. **Address:** Technical Micro Systems, Inc., 366 Cloverdale, Ann Arbor, MI 48105 (Tel: 313-994-0784).

Printers. The Sprinter-20 prints 20 characters wide, optionally sideways or upside down lines, at a normal print speed of 1.5 ips. Up to 5 different character sizes can be selected via ASCII control codes or 140 × *n* dot matrix in graphics mode. It measures 7.5" W × 5" D × 3" H ($175). The Sprinter-40 prints 40 characters wide, at a selectable print speed of 2,3, or 4 ips. Wraparound facility permits printing of lines greater than 40 characters. In graphics mode, it has 280 × *n* dot matrix. It measures 10.5" W × 7.5" D × 4" H ($295). Interface is parallel, 7-bit ASCII plus Strobe, Busy and Acknowledge. Serial RS-232 to 9600 baud, 1 or 2 stop bits. **Address:** Alphacom, Inc., 2323 So. Bascom Ave., Campbell, CA 95008 (Tel: 408-249-2152).

Apple Light Pen. The LPS II light pen allows high-resolution (280 × 192) graphics on an Apple II. It is compatible with all languages, and usable in every



screen mode. It provides 60-Hz coordinate generation, and can be installed on the Apple motherboard so no slots are required. $285. **Address:** Gibson Labs., Building 10, 406 Orange Blossom, Irvine, CA 92714 (Tel: 714-559-8727).

Ham TRS-80. The "Terminall" converts any TRS-80 into a flexible amateur radio terminal. It contains the necessary interface, audio demodulation, AFSK tone generator and transmitter keying hardware. Plug it into the receiver headphone jack and copy Morse code, with code speed displayed on status line, Baudot, or ASCII. ASCII capability provides upper- and lower-case, control codes, even/odd/no parity, 6/7/8 data bits, 75/110 baud. Software is on cas-

sette or diskette and all you have to do is enter your callsign and time to initiate the program. Text can be typed while receiving or transmitting. Terminall T1 requires Model I with 16K RAM and Level II BASIC. Terminall T3 requires Model III with 16K RAM and Model III BASIC. **Address:** Macrotronics, Inc., 1125 N. Golden State Blvd., Turlock, CA 95380 (Tel: 209-667-2888 or 634-8888).

Software

Talking Dump. Designed for 6800/6809 SS-50 systems (and soon available for Radio Shack Color Computer), NEWTALK is a completely relocatable utility that does a byte-by-byte memory dump of a selected memory area and prints the output on screen as well as speaking it out through a loudspeaker. $35 on disk or cassette. **Address:** Star-Kits, Box 209, Mt. Kisco, NY 10549.

Apple Games. "Three Mile Island" is a quick-response machine language game that simulates TMI in action. It features six full-color displays and auto/demo and fast/normal modes ($39.95). "The Best of Muse" includes five games with two three-dimensional maze puzzles, "Tank War," "Music Box," and six mini games. $64.75. Both require an Apple with disk. **Address:** MUSE, 330 N. Charles St., Baltimore, MD 21201 (Tel: 301-659-7212).

Medical Software. Medirec is a total medical history and report preparation program for office forms, patient and family history, symptoms, diagnosis, and treatments. It can prepare referral requests, patient history summaries, and referral reports. The diskette records 550 visits (per diskette). Individual records can be recalled, linked and printed either whole or in parts. It also contains a full complement of office routines. It requires a 48K Apple, an 80-column printer, and two disk drives. A Corvus system is also available. $199.95. **Address:** Charles Mann & Associates, Micro Software Div., 7594 San Remo Trail, Yucca Valley, CA 92284 (Tel: 714-365-9718).

Color Computer Utilities. The "Color Editor" designed for the Radio Shack Color Computer allows both upper- and lower-case features and will print via the RS232 port. It has change and search commands, and can copy or move sentences or paragraphs to different locations ($24.95). The "Color Assembler" is a 6809 type that supports all mnemonics and addressing modes along with standard assembler options and directives. It is a two-pass assembler ($29.95). The Power Pack plugs into the interface slot and provides up to 6K additonal RAM and a 2K monitor. A diagnostic cassette is included ($159). **Address:** Computerware, Box 668, 1512 Encinitas Blvd., Encinitas, CA 92024 (Tel: 714-436-3512).

New Language. HI is a general-purpose microlanguage that fits in 3K bytes and features an incremental compiler using selective threaded-code techniques to produce portable ROM-able code. Data declarations allow character, byte, and integer types using upper- and lower-case symbolic names of unlimited length. It has fast integer math supported with decimal, hex, octal, or binary-bases; 14 statements allow multiple statements per line; 11 control structures allow input and timed input conditionals, single, double or multiple branch conditionals, pre- and post-loop testing, and machine-language calls. Five assignment modes provide implied assignment, multiple assignment, multiple equivalence, automatic dynamic type conversion, pointer referencing, indexed arrays, bidimensional files, string

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truncation, string length and random number operators, and array assignments in load and unload forms. Complete Z80 listing is $24. **Address:** Systemed, Box 18, Mountain City, TN 37683 (Tel: 615-727-6000).

CP/M Utilities. "Unprotect" provides the original source code for any program that is saved in a protected format. An 8" diskette and CP/M 2.0 or later are required ($70). "Undelete" restores a file just as it was before the kill or erase command, unless the directory entry has been overwritten. It allows a sector-by-sector inspection with selective restoration of "lost" data ($45). **Address:** Systemation Inc., Box 75, Richton Park, IL 60471 (Tel: 312-481-2420).

ZX80 Group. Licensed hams using the Sinclair ZX80 or Microace now have a user net on single sideband. Contact Marty Irons, K2MI, 46 Magic Circle Drive, Goshen, NY 10924.

CP/M Unerase Utility. The UNERA program can be used to recover one or more ERAsed programs in a CP/M system. When entered, the program will recatalog the file back on the disk directory. It can also work its way through the directory and display each ERAsed file and allow the user to recatalog if desired. It also allows printing the user list. It works on both multi- and single-disk systems, and comes on either 5" or 8" diskettes. $35 plus $1.50 handling. **Address:** Elliam Associates, 24000 Bessemer St., Woodland Hills, CA 91367.

TRS-80 Users Group. The Computer Information Exchange is a nonprofit national TRS-80 user group that is introducing inexpensive new software for the TRS-80, besides allowing members to purchase hardware items on a group basis. For further information contact Computer Information Exchange, Inc., Box 159, San Luis Rey, CA 92068 (Tel: 714-757-4849).

Information Management. INF080 is an automatic information filing and management system for the TRS-80 Model I and Model III. It creates a virtual dictionary of information that can be quickly located. It supports continuously variable record input length and automatically extends disk files. The cross-referencing has an infinitely long data base, spanning any number of diskettes. Two global commands locate general or specific information over any number of diskettes. It is supplied in object code directly executable from TRSDOS. $100 on data diskette, $115 on TRSDOS diskette. **Address:** Bluebird Computer Software, 2267 23rd St., Wyandotte, MI 48192 (Tel: 313-285-4455).

TRS-80 Cross Assembler. These TRS-80-compatible assembler/editors cover the Intel 8048 (ASMB-48), the RCA 1802/1804 (ASMB-18), National COP400 (ASMB-CP4), Zilog Z-8 (ASMB-Z8), Fairchild/Mostek 3870 (ASMB-F8), and the AMI S2000 (ASMB-20). Each assembler shares a common operational structure. With minor exceptions, the assemblers feature instruction mnemonics and syntax as defined by the processor manufacturer. Source files can be saved on tape or disk, and programs must be off-loaded to target processor. Each development system is $75 on cassette or MOD II diskette and requires a TRS-80 Model I or Model III with 32K RAM. **Address:** Allen Ashley, 395 Sierra Madre Villa, Pasadena, CA 91107 (Tel: 213-793-5748).

Invaders for Color Computer. Color Invaders is an arcade game in color and with sound with 8 levels of play for the TRS-80 Color Computer. It requires 16K and Power Pack. $19.95. **Address:** Computerware, Box 668, Encinitas, CA 92024 (Tel: 714-436-35112).

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The trouble with most pulse meters is that they use an older, temperamental monitoring process. They read blood density through your skin with a projection of infrared light. The slightest movement, light, or pressure can throw them off completely.

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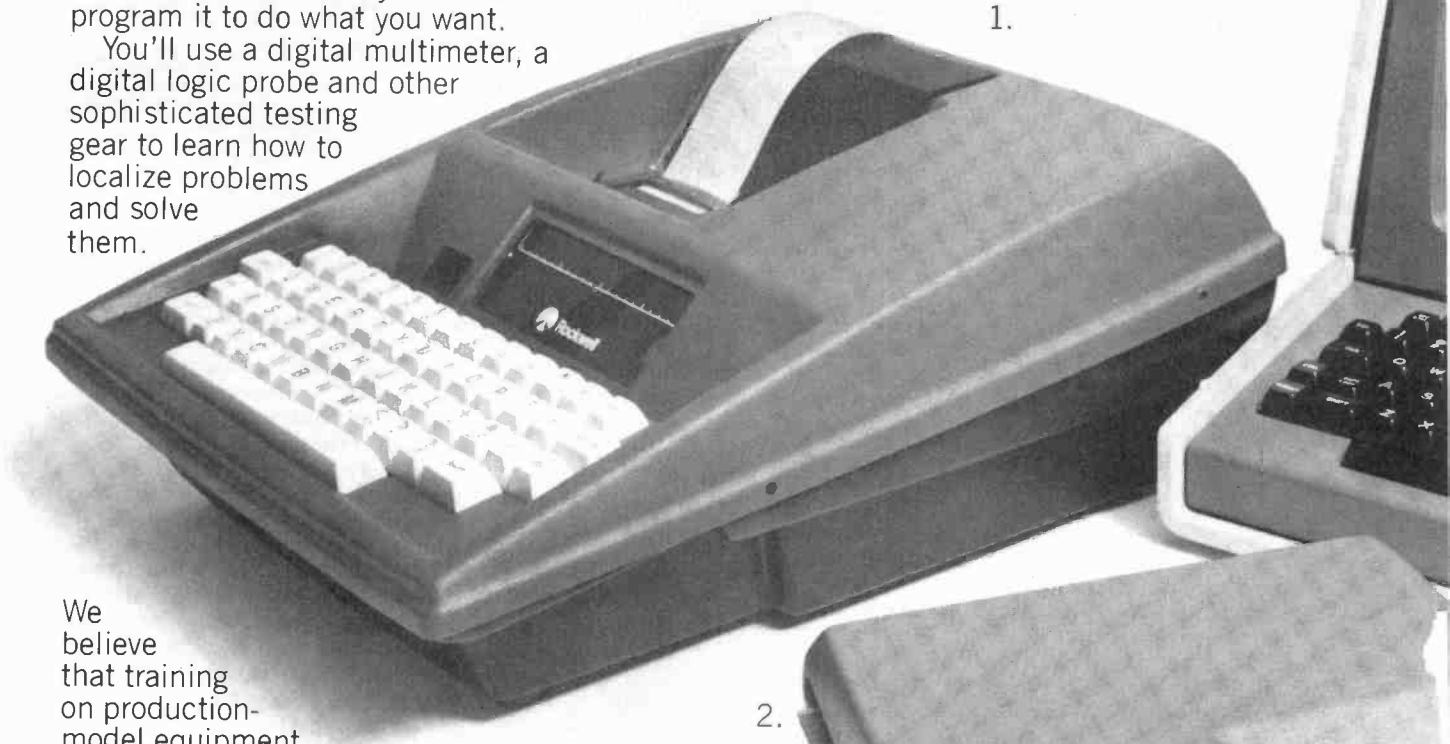

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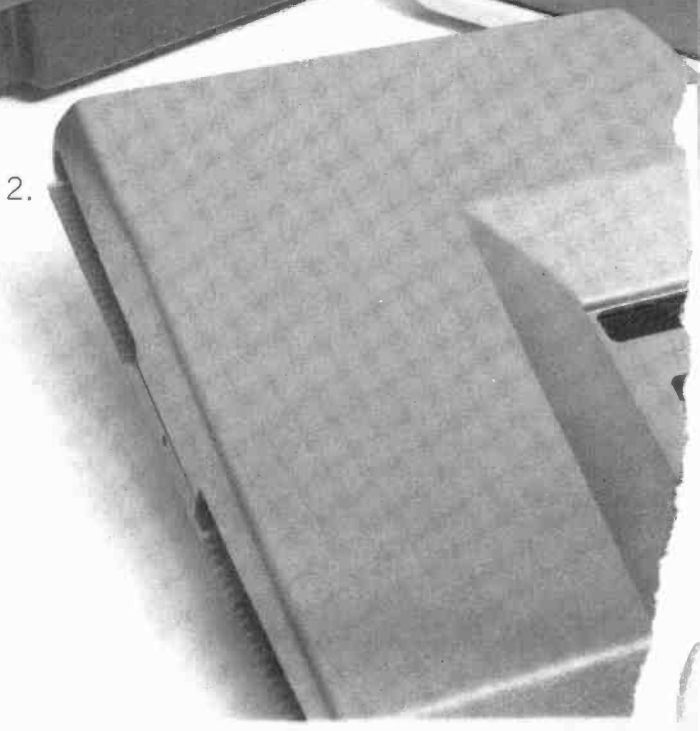

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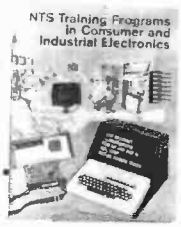

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Popular Electronics
SEPTEMBER 1981

BY RANDY CARLSTROM

DESIGNING WITH THE 8080 MICROPROCESSOR

Part 1: The Basic System

With the widely used 8080 as a model, the basic features of a central processing system are explored

IN ADDITION to its obvious application as the central processing unit (CPU) of a computer system, the microprocessor has found its way into a variety of products ranging from kitchen equipment to sophisticated laboratory data-acquisition systems. The key to this widespread utility is flexibility, which in turn comes from the microprocessor's unique ability to alter its internal logic in response to an external program. Since the response to inputs from the program is extremely rapid—on the order of a few microseconds—the processor can change its electrical configuration practically instantaneously, usually fast enough to convince a human correspondent that it is performing several activities simultaneously.

Given the speed and flexibility of microprocessors, and the fact that they are available at very reasonable prices, it is often economical to use a single processor rather than a great many simpler chips to synthesize logic functions, act as a controller, or the like. To accomplish this, however, it is necessary to understand the architecture of the processor, its needs in terms of support circuitry, how to program it, and how to interface it with the "outside world." Development of the necessary understanding is the goal of this multipart series.

Microprocessors vary in design, with each design programmable only via its own set of instructions. The unit that will be covered in detail in this series is the 8080. Since this CPU is the grandfather of a growing family of processors, including the Z80, 8048, and 8085, all with a common internal programming language, most of the information will apply to the entire family as well. Instructions not used by the 8080 will not, however, be covered.

The Basic System. Like many processors and logic elements, the 8080 requires a small number of support ICs in order to function. An 8080 along with its support chips is called a *CPU module*.

The program that determines the internal states taken on by the CPU is supplied to it in the form of electrical signals. To generate these signals as required and in the proper order, the program must be stored in some form of "memory" device. These devices represent the binary digits (1, 0) by means of "on-off" switching devices or analogous circuit elements. The binary code in which program instructions are expressed is called *machine language*. Each microprocessor (or microprocessor family) has its own machine language.

Binary instructions or data that are not subject to change can be stored permanently in ROM (read-only memory). Elements that are variable must be stored in RAM (random-access memory), which can be written, erased, and rewritten by the CPU.

To affect or control devices that interact with the outside world, the processor must deliver signals to them. It does this by means of an I/O (input/output) port. As the name implies, an I/O port can also deliver signals to the CPU from devices that sense external parameters.

Electrical signals representing data, instructions, and addresses (the locations of particular items in memory) pass between the CPU, memory devices, and I/O ports via a set of dedicated lines known collectively as *buses*. A typical bus (Fig. 1) also supplies dc operating power to the elements of the system.

Bus System. There are many versions of the bus system currently used, with the S-100 and SS50 being two of the most common. Although different mechanically, they all contain three major elements: the address bus, the data bus, and the control bus. (Figure 1 does not show the power supply lines and common ground usually carried on the bus system.)

In most systems, there are 16 lines in the address bus, thus enabling 2^{16} or 65,536 (64K) unique addresses. In an 8-bit system, there are 8 lines on the data

bus, allowing 2^8 or 256 data combinations. The control bus carries all system synchronization signals including the "clock" that keeps all CPU module events in step.

Memory. A computer memory is formed from a large array of semiconductor elements, each capable of storing a single binary 1 or 0, organized into groups of *bits* (short for "binary digits") often called *words*. The number of bits in each word is determined by the size of the CPU *registers* (storage locations internal to the microprocessor) and the number of data lines. A typical RAM arrangement is shown in Fig. 2. A memory word of eight bits is often referred to as a *byte*. Each byte represents one of 2^8 or 256 unique values (0-255). As the 8080 microprocessor uses this memory structure, it is considered a byte-oriented device.

Each memory location contains one word of memory bits, and is identified by a unique number, or *address*, assigned to it. The CPU gains access to the contents of any memory location by means of its address. A memory word may represent the encoded form of an instruction, or may be data to be processed by the CPU.

The CPU has control of memory in the sense that it can read data and instructions from memory and write data back into memory. Only when the CPU receives a direct memory access (DMA) signal via the control bus does it relinquish control of memory. DMA allows a high-speed device such as a magnetic disk to gain access to memory and control it. As noted earlier, memory that can be read and written or altered is termed read/write memory, or random-access memory (RAM). Memory that can be read, but not altered by writing, is termed read-only memory (ROM).

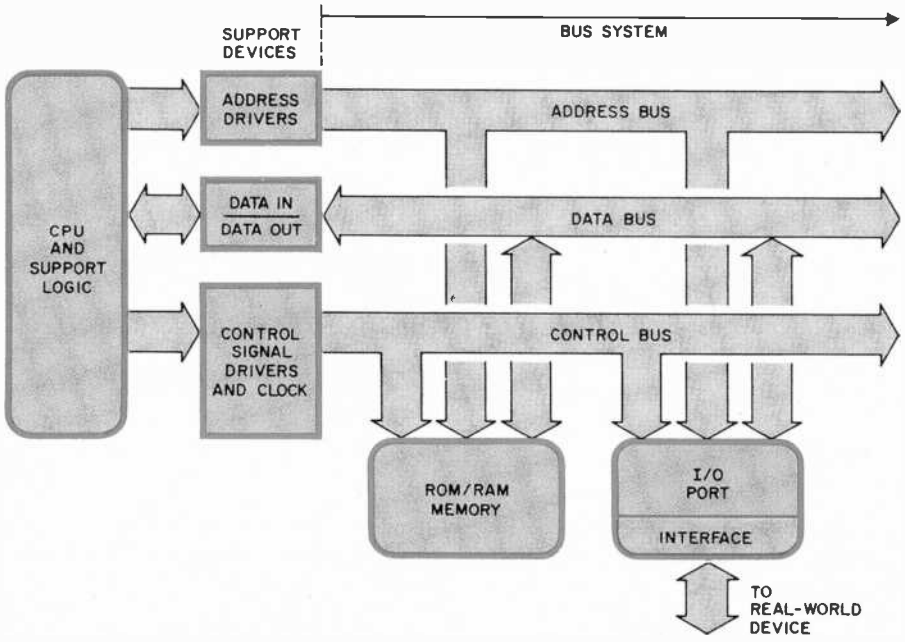


Fig. 1. A typical bus system contains three major elements: address bus, data bus, and control bus.

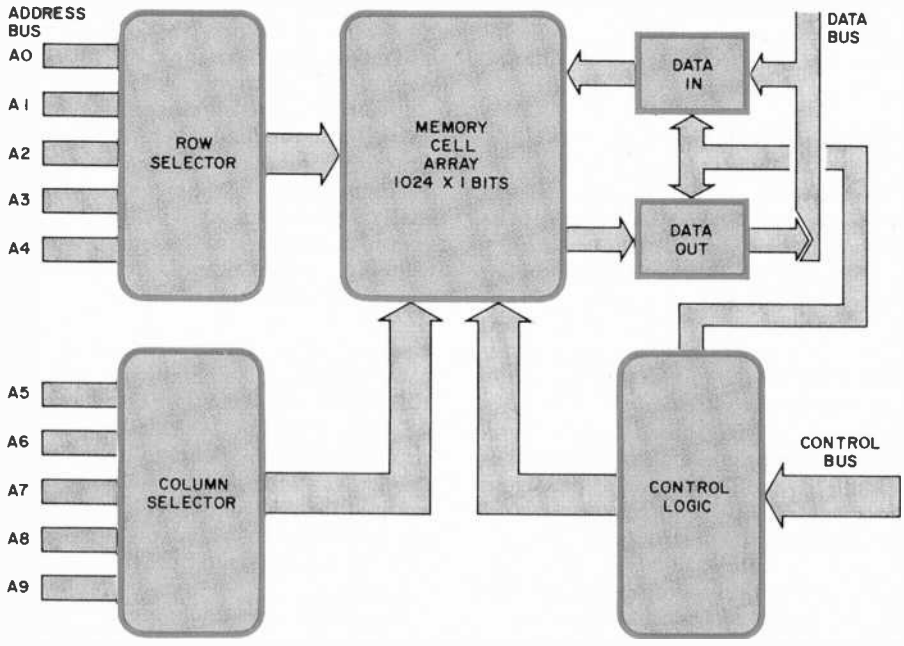


Fig. 2. Arrangement of a 2102 random-access memory. Eight of these are needed for 1024 by 8 bits.

Input/Output. To the 8080, the outside world may consist of up to 256 input and 256 output devices. These are usually referred to as peripherals, and may include keyboards, printers, displays, etc. Each peripheral communicates with the CPU by exchange of data bytes sent via its associated I/O port and the data bus (Fig. 3). Each peripheral is assigned an addresss from 0 to 255, much as each memory location is assigned an address. The portion of the I/O system that actually conditions data for input and output is known as the *interface* and generally there is one interface for each peripheral. The use of a port for input or output is done under program control.

Communication between the computer and a peripheral is done in one of two formats—serial or parallel. In parallel data transfer, all eight bits of the data byte are handled simultaneously. This permits rapid movement of data. In serial transfer, data is handled bit-by-bit instead of a byte at a time. This is slower, but has the advantage of using simple hardware (for example, a two-conductor cable or a telephone circuit instead of a multiconductor bus). When two computers exchange data via, say, an intercom line, the parallel data from buses of both computers is converted to serial form and transmitted bit-by-bit down the cable. The IC that performs the conversion from parallel to bit-serial form (and vice versa) belongs to a family of components known as UARTs (Universal Asynchronous Receiver-Transmitter). If used, the UART is part of the computer's I/O interface since it is used for conditioning data for input and output.

There are two basic types of serial communication—RS232 and what is called the 20-mA current loop. Basically, RS232 is a voltage circuit where a logic 0 is a positive voltage, and a logic 1 is a negative voltage. The newest version

of this voltage interface is RS422—which uses balanced transmission lines and differential current sensing to eliminate noise. The other commonly used serial port is the 20-mA current loop in which a flow of 20 mA in the series circuit produces a logic 1 while an absence of current denotes a logic 0. Both of these serial ports are controlled by a baud rate generator that "clocks" the operational speed of the port. Most peripherals use either the RS232 or 20-mA loops for communication.

Program Interrupt I/O improves the efficiency of CPU operation while data is being transferred to or from a peripheral that is many times slower than the CPU itself. Consider a computer processing large amounts of data, portions of which are to be output to a printer. When the peripheral is ready for data, it signals the CPU through a program interrupt. When the CPU acknowledges the interrupt, it completes the current instruction being executed in the main program and then automatically branches to a routine that will output the next data byte. After the byte is output to the printer, the CPU returns to where it left off in the main program. The 8080 is capable of handling up to eight interrupts from eight I/O devices using a special instruction of its instruction set. Data input is similarly handled.

Three-State Logic. There can be many peripherals connected to, and communicating along, the same bus lines. Thus, unless some form of "traffic control" is used, confusion can reign. Keeping order is the purpose of the three-state devices, shown in Fig. 4.

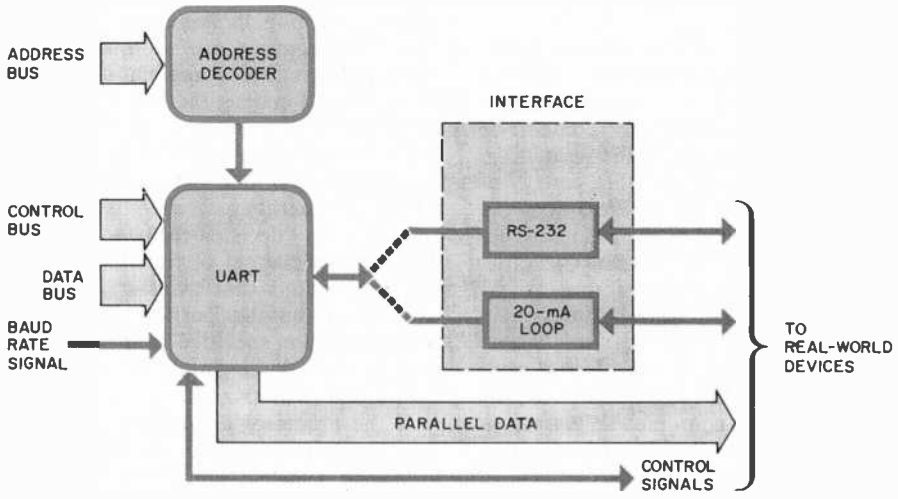


Fig. 3. Each peripheral communicates with the CPU through an associated I/O port and data bus.

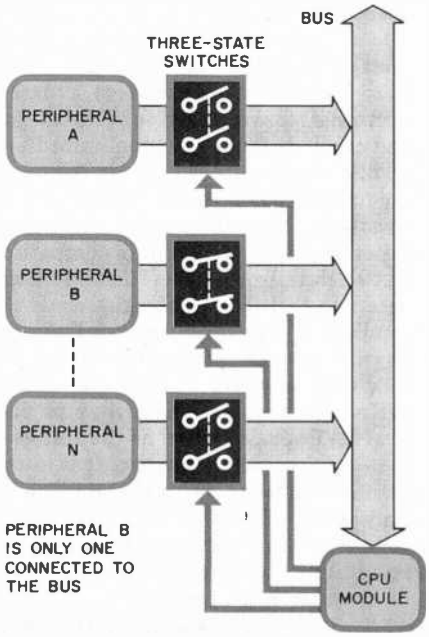


Fig. 4. A three-state device is an electronic switch connected between each bus line and associated logic.

Simply, a three-state device can be thought of as an electronic switch connected between each bus line and its associated logic. When the switch is closed, the associated logic can accept or deliver signals to the bus. But, when the switch is open, the bus does not "see" the logic—in effect, the logic does not exist for the bus.

Programming. A program for a computer or processor consists of a sequence of operational instructions stored in memory. Each instruction enables a single elementary operation such as the movement of a data byte, an arithmetic or logical operation on a data byte, or a change in instruction execution sequence. The set of all instructions common to a given CPU is referred to as its *instruction set*. The size of the instruction set is a measure of the CPU's capabilities. Another such measure is the length of the binary words the CPU can work with. Generally speaking, the larger the instruction set, or word size, the more powerful the CPU. The 8080 (an 8-bit CPU with 72 instructions) is thus more powerful than the 4040 (a 4-bit CPU with 60 instructions). Some microprocessor instruction sets may approach 200 instructions in length.

A program is stored in memory (RAM or ROM) as a sequence of bytes that represent the instructions. The memory address of the next instruction to be executed is held in an internal register of the CPU called the *Program Counter*. Early in the execution phase of each instruction, the program counter is automatically advanced to the address of the next sequential instruction in memory. Thus, program execution proceeds sequentially (i.e. memory location 213 is executed after location 212 is executed, etc.) unless a transfer-of-control, or BRANCH instruction (8080 JUMP, CALL, or RETURN) is executed, which causes the program counter to be set to a specified memory address. Program execution would then continue sequentially from this new memory location. The JUMP instruction specifies the address to be jumped to, which can be anywhere in memory. During execution of a JUMP, the CPU replaces the contents of the Program Counter with the address contained in the JUMP instruction.

Subroutines. A special type of jump occurs when the stored program CALLS, or accesses, a subroutine (a program within a program). Usually, a subroutine is a set of instructions that must be executed repeatedly in the course of running the main program. Algorithms that calculate mathematical functions and routines to input or output data to a peripheral device are often programmed as subroutines. The subroutine type of

jump requires the CPU to store the contents of the program counter at the time the jump occurs (when the CALL instruction is executed). This enables the processor to resume execution of the main program after the last instruction of the subroutine has been executed.

The processor has a special method of handling subroutines to insure an orderly return to the main program. When the CPU receives a CALL instruction from memory, it advances the Program Counter to the address of the next sequential instruction, and saves the Counter's contents in a special memory area known as the *Stack*. The latter holds the memory address of the instruction to be executed after the subroutine is completed. The processor then loads the address specified in the CALL instruction into its Program Counter. Consequently, the next instruction that is to be executed will be the first step of the subroutine.

Normally the last step of any subroutine is a RETURN instruction. When the processor executes the RETURN instruction, it replaces the current contents of the Program Counter with the address contained on the "top" (last entry) of the Stack. Since this address was the one originally saved by the CALL instruction, the processor will resume execution of the calling (main) program at the point immediately following the original CALL instruction. Note that this operation is very similar to executing a JUMP instruction, the difference being that the JUMP address is contained in the Stack area rather than in the JUMP instruction itself.

A subroutine may CALL another subroutine. This is called "nesting subroutines." If the microprocessor being used has a Stack for storing RETURN addresses, the maximum depth of nesting subroutines is determined solely by the depth of the Stack itself. So if the Stack has space for saving five return addresses, then five levels of subroutines can be accommodated.

Microprocessors have different methods of maintaining their Stack. Some store the RETURN addresses within registers in the processor, but this limits the levels of subroutine nesting. Others, such as the 8080, use a reserved area of RAM for the Stack and maintain a *Stack Pointer* (an internal register of the CPU) which contains the address of the most recent Stack entry; *i.e.*, the Stack Pointer always "points" to the top of the Stack. This type of Stack may be looked upon as a last-in-first-out (LIFO) memory, and allows virtually unlimited subroutine nesting.

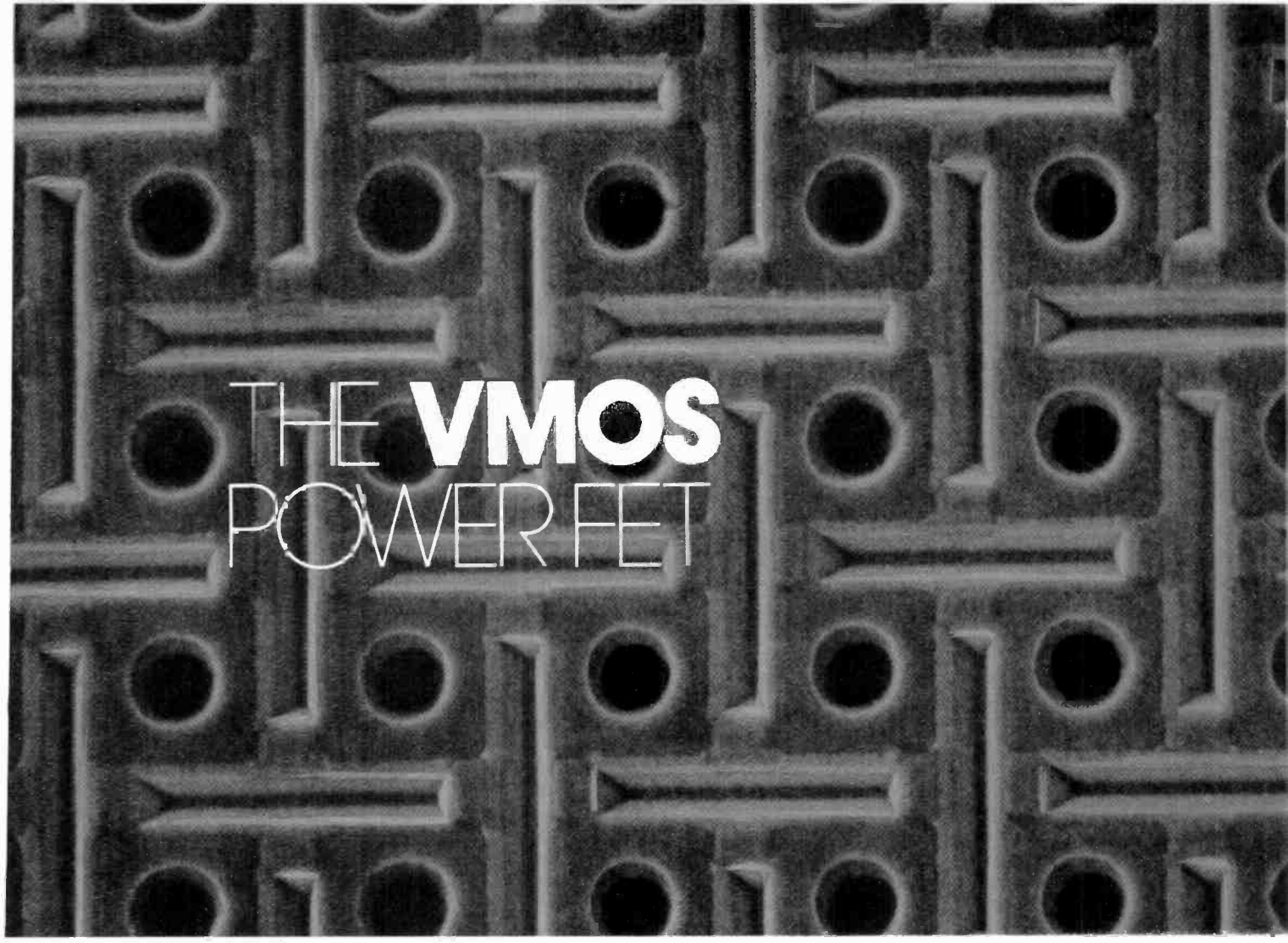
Flags. The CPU has a set of flags, or internal flip-flops that are set or cleared (i.e., set to a logic 1 or 0, respectively) depending upon the results of certain instructions as they are executed. Two flags of the 8080 are: The "Zero Flag," which is set if the accumulator is 0 (actually 00000000 binary), and the "Carry Flag," which may be set when an arithmetic instruction causes the accumulator to overflow (*i.e.*, carry or borrow from an addition or subtraction). In most microprocessors there are other flags besides these. The 8080 has a total of five.

Most processors have instructions available that will store the accumulator and other general-purpose registers and flags on the Stack temporarily. Likewise, there are instructions available to reload the general-purpose registers and flags with data contained on the top of the Stack. This allows the contents of the registers and flags to be saved so that they may be used in another activity, as for example, a subroutine. Just before returning to the main program from a subroutine, the subroutine will restore the registers and flags it used (assuming, of course, that the same registers and flags were saved on the Stack prior to using them in the subroutine).

Let's go over one last concept of a CPU's instruction set, which gives the computer its "decision-making" power. This is a special set of transfer-of-control instructions that transfer program execution to another portion of memory if the condition specified in the instruction is met. An example is the 8080 instruction JUMP-IF-ZERO.

If the processor encounters a conditional transfer-of-control (or "conditional branch") instruction, it checks to see if the specified condition is met. The "condition" is always related to one of the flags. In the case of JUMP-IF-ZERO, program execution is transferred to the JUMP address contained in the instruction in the same manner as the unconditional JUMP *if* the Zero Flag is set. If the Zero Flag is not set (cleared), program execution assumes its sequential flow and executes the instruction immediately following the JUMP-IF-ZERO. A processor usually has a set of "Compare" instructions, that set and/or clear flags depending upon the result of comparison of two data words (the 8080 can compare two registers, or a register and the contents of a memory location). A conditional branch instruction will often follow a Compare instruction, so that the proper execution path may be chosen (the decision) based on the results of the flags from the Compare. It is in this manner that the CPU makes its "logical decisions." The 8080 also has various conditional calls and conditional returns in addition to the conditional JUMPS in its instruction set. ◇

(To be continued next month)



THE VMOS POWER FET

An up-and-coming rival to bipolar devices, VMOS offers advantages in circuit simplicity and improved performance

BY GARY McCLELLAN

VMOS power FETs are being designed into more and more electronic equipment, promising better performance, using less support circuitry, and permitting savings in cost. So far, they have replaced bipolar power transistors in some switching power supplies and audio amplifiers, with applications in power switching and power conversions soon to come.

Compared with its bipolar counterpart, a VMOS power FET has numerous advantages: its input impedance is higher, its bandwidth wider, and its inherent linearity greater. In addition, its temperature coefficient of gain is negative. That is, with a fixed level of drive at its gate, a VMOSFET conducts less and less current as it gets hotter.

Of course, VMOS devices offer a few tradeoffs to challenge the circuit designer. For one, the gate saturation voltage of the VMOSFET runs somewhat higher than that of an equivalent bipolar device. Second, the relatively high gate capacitance (500-800 pF) means that the input will tend to draw appreciable current at the higher audio frequencies and beyond.

Finally, there is the matter of cost. VMOS devices cost more, but, according to designers, the reductions in support circuitry that they allow can make them in the long run, a better bargain than bipolar.

Typical Applications.

Power Supplies. When the series-pass stage consists of several bipolar devices in parallel, at least two power resistors per transistor are required to prevent the devices from sharing the load current unequally should their temperatures differ. With the negative temperature coefficient, VMOS devices are free of this "current-hogging" tendency and require no power resistors. Another bonus of VMOS is that very high input impedance, makes the high drive currents that bipolar power transistors would require unnecessary. As a result of this, driver circuits that have lower power ratings and thus are less expensive to fabricate can be used.

Switching power supplies also benefit from VMOS. While many bipolar power transistors—especially the rugged ones—have a bandwidth of 2 or 3 MHz, VMOS devices can operate to 30 MHz and above. Because the VMOS devices

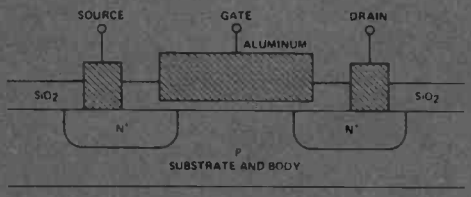


Fig. 1. Cross section of a conventional MOSFET.

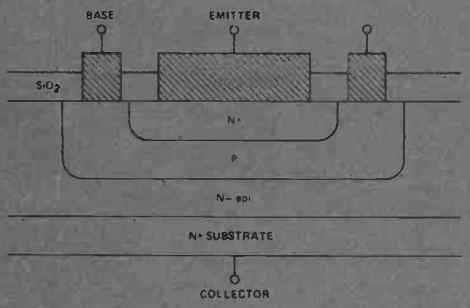


Fig. 2. A double-diffused epitaxial planar transistor.

switch faster, less energy is dissipated in them, and that improves efficiency. The higher switching frequencies made possible—up to 500 kHz as opposed to 100 kHz with bipolars—allow the use of smaller power transformers and output filter capacitors.

Audio Amplifiers are improved by VMOS technology and several commercial products using these devices are available. Here the VMOS devices replace the bipolar power transistors in the output stage. Because of the high-impedance VMOS inputs, less drive power is required by the output stage. That means that the driver stage can use lower-cost, lower-powered components.

Having a more linear operating characteristic, VMOS devices produce inherently less distortion. They are also free of the tendency of bipolar devices to "stick" to the power supply rails, and they come out of saturation faster with no extra drive current required. The result is a "cleaner" power amplifier. Another advantage of VMOS devices in audio amplifiers, is the freedom from "second breakdown," basically a situation in which momentary overvoltage or overcurrent will cause the device to heat up, draw more current, and then heat up some more, until it breaks down.

R-F Amplifier circuits such as those found in transmitters are likely places for VMOS technology. One of the first applications for the VMOS power FET was in the final amplifier stage of a radio transmitter. The ease with which the devices can be connected in parallel to obtain greater output power, the reduced drive power required, and the wide frequency range make VMOS a natural for transmitter (r-f) applications. At least one VMOS manufacturer claims the devices can tolerate infinite VSWR without destruction! (This corresponds to a situation where the user attempts to transmit without the antenna load connected.) Usually this subjects the output r-f stage to excessive power dissipation. Freedom from second breakdown makes VMOS devices better able to tolerate such abuse.

VMOS is also making inroads in double-balanced mixer circuits, normally a low-power receiver application. Because of their approximately square-law transfer characteristics, VMOS devices deliver more of the desired mixer products and fewer troublesome high-order products, providing more overload margin.

Power-switching applications for VMOS include control of displays, solenoids, and motors. Conventional designs use transistors in most low-power applications and change to SCRs and relays for high power. A good example of a VMOS power switching application lies in display control. At the present time, most display interfacing is done with inexpensive low-power transistors. If CMOS logic is used, however, it may be necessary to buffer the CMOS signals (which are low current) to the higher current requirements of the driver transistors. With VMOS, no buffering is required; in fact, one CMOS output can drive 100 or more VMOSFETs to the point of saturation!

VMOS can be used to advantage in controlling motors and solenoids, which pose difficulties because of the voltage transients when the current through an inductive load is interrupted. With conventional bipolar transistors, it is necessary to use very high-voltage devices or special networks to suppress the transients. Neither solution is cheap, and suppression networks reduce performance in high-frequency applications. Since VMOS devices are free from second breakdown, and can withstand back emf better, lower voltage FETs can be used and suppression networks simplified. In some low-power circuits, the traditional diode across the motor or solenoid can be removed.

For the area of power control in which SCRs and relays are presently used, VMOS shows promise. Even now, devices to handle high-voltages and high currents are under development. The future will tell whether VMOS will substitute for SCRs and relays, but 450-volt devices are already being advertised.

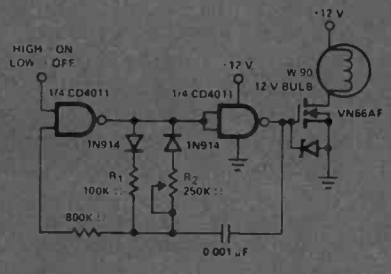


Fig. 5. A simple lamp dimmer circuit.

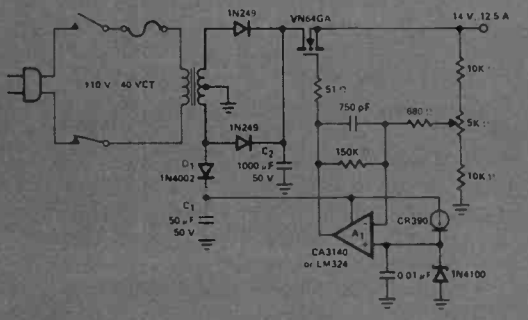


Fig. 6. An automatic battery charger.

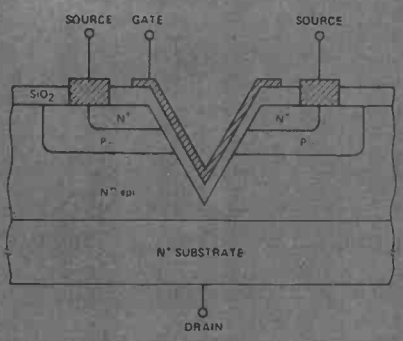


Fig. 3. Cross section of a VMOS channel.

Illustrations courtesy of Siliconix, Inc.

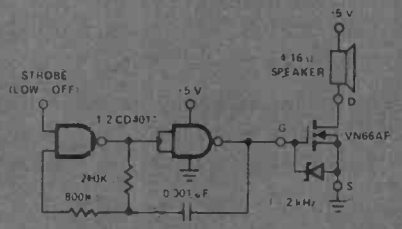


Fig. 4. Circuit for a 2-kHz audio alarm.

Anatomy of a VMOSFET. Although it would appear that a VMOS power FET would just be a conventional MOSFET on a larger scale, this is not the case. Such a device could be built, but it would be costly and inefficient. Figure 1 shows a cross section of a conventional MOSFET "die," stripped of all nonessentials. Several things prevent this FET from being used effectively for power handling, among them the fact that the current flow is horizontal through the substrate of the device. This is due to the horizontal positions of the drain and source connections, and the relatively great distance between their electrical connections. Both of these cause high resistance—and loss.

As a result of the characteristics of the semiconductor material, current densities are lower when current flows horizontally, and power dissipation is increased. A conventional bipolar power transistor die is shown in Fig. 2. Note that the emitter and collector are in a vertical plane. Because of this arrangement, current densities are higher, and more current can flow between these two points. Since the collector is also the substrate, the die can be thermally bonded to a heat sink for cooling. This is why TO-3 power transistors have the collector connected to the metal case.

The VMOS power FET is a variation on the vertical theme used by conventional power transistors, but it has some key differences. As shown in Fig. 3, four vertical layers are used, with a V-shaped channel etched in the material (which gives the VMOS its name) as the gate connection. A layer of silicon dioxide (SiO_2) insulates the conductive gate channel from the semiconductor materials, and gives the device its high-impedance characteristics. The source connection rests over the *n* and *p* materials, and provides the remaining power connection. These are the basics of the fabrication of the VMOS device. In practice, many "V" channels and source connections are paralleled on the die to produce the high current capability.

In use, the drain and gate are biased positive with respect to the source. The insulated gate produces an electric field, which allows the *n*-type material next to it to permit electrons to travel through the layers from the source to the drain. Increasing the field intensity of the gate (raising its voltage) increases its influence on the *n*-type material, causing a greater current flow. Conversely, reducing the gate field intensity reduces the source-to-drain current flow.

There are many advantages inherent in this type of construction. Since the substrate forms the drain connection, there is one less connection on the top of the die. As a result, the die can be made smaller. Also, since the drain connection is so large, saturation resistance can be made very low. This means the completed VMOS power FET can be inexpensive (small die) and handle high power (large drain surface). Another benefit is that each V groove creates two channels, one on each side of the groove, so current density can be doubled. In other words, the VMOS devices can have high sensitivity, with shorter length channels, than conventional MOSFETs. For example, the standard MOSFET needs at least a 5-micrometer channel. VMOS devices, on the other hand, require only about 1.5 micrometers for good results, and shorter V grooves mean less stray capacitance and improved high-frequency performance. The 2N6657 VMOS power FET, for example, switches 1 ampere on or off in 4 nanoseconds. That's 10 to 200 times faster than a bipolar power transistor!

Finally, the VMOS power FET has built-in, high-voltage capabilities. This is because of the *n*-epi (taxial) layer, which absorbs the depletion region from the *pn* junction above it, thus acting as a highly effective insulator when the device is turned off. Also, in VMOS construction, the SiO_2 layer under the V groove need withstand only 25% of the gate-drain voltage. (In a conventional MOSFET, the oxide must withstand the entire gate-drain voltage.) Although the point of the V groove can create high

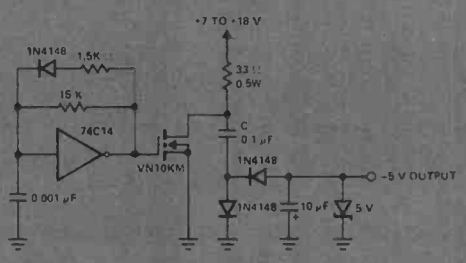


Fig. 7. A "flyback" dc-dc converter.

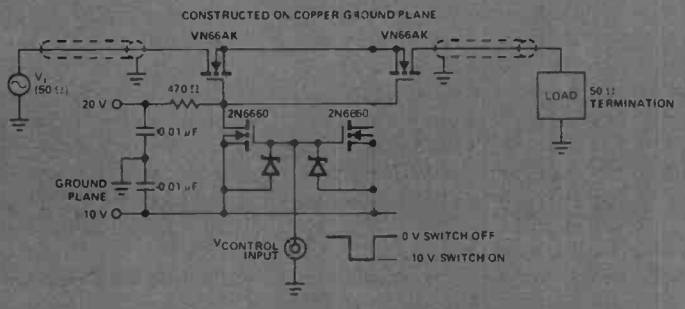


Fig. 8. An r-f switch using VMOS.

electrostatic fields which can break down the oxide layer, work is in progress to solve this problem. One solution is to flatten the point of the V. This should ultimately make available high-voltage devices on a large scale.

Some Simple Circuits. Now that you have a basic familiarity with VMOS devices, let's look at how they can be used in some simple circuits. VMOS devices are now fairly easy to obtain. The VN66AF used in many of these circuits is available nationally through Radio Shack stores. Basically, the circuits run the gamut from simple gadgets where the VMOS power FET simply replaces a conventional power transistor, to a high performance r-f switch where only VMOS will work properly. In all of the circuits, simplicity is apparent, particularly in the drivers for the VMOS devices. This is one of the benefits of high-impedance inputs.

Audio Alarm. A circuit that can be used as a burglar alarm, keyboard beeper, timer alert, or audio tone generator is shown in Fig. 4. The CMOS gate is wired as an oscillator, whose pitch is variable by changing the 200-kΩ resistor, or the 0.001-μF capacitor. The VMOS power FET is wired as a simple switch that drives the speaker directly. Note a zener diode connected across the gate and source of the VMOS device. This component is internal to the VMOS, and protects the input against overvoltage. A zener is built into most VMOS devices to make them less sensitive to static, so fewer handling precautions are necessary.

The circuit can be built on a small piece of perf board and cemented to the rear of the speaker. If desired, the supply voltage can be raised to 12 V for higher output power. If you want to tinker with the design, you can wire the two unused gates in the CD-4011 for another lower-frequency oscillator. Connect the output of this oscillator to the "strobe" input of the first oscillator. This produces a two-tone "boop-beep" sound similar to some police sirens.

Lamp Dimmer. The problem in dimming conventional incandescent lamps is that more power can be dissipated in the controller than in the lamp! The circuit of Fig. 5 solves this problem using a VMOS and pulse-width modulation. Control *R2* changes the duty cycle, or "on time," of the CMOS oscillator. As a result, the on time for the VMOS switch varies along with lamp intensity. Since the VMOS power FET isn't on continuously, it dissipates less power, reducing heat-sink requirements. This circuit can be constructed on perf board, and adapted to many different applications. For example, it should work well controlling low-power dc motors. Freedom from second breakdown, means less chance of damage from back emf or momentary high current. Of course, the maximum ratings of the VMOS device must be observed!

Automatic Battery Charger. The circuit shown in Fig. 6 provides up to 12.5 A at 14 V. As the battery charges and its voltage rises, the circuit automatically reduces the charging current. When the battery is fully charged, the charger cuts off. Thus, a lead-acid storage battery can be maintained fully charged at all times.

FOR MORE INFORMATION ON VMOS TECHNOLOGY

The following publications are available from Siliconix, Inc., 2201 Laurelwood Rd., Santa Clara, CA 95054:

Document number	Title
AN79-1	A 500 KHz Switching Inverter for 12 V Systems
AN79-3	Dynamic Input Characteristics of a VMOS Power Switch
AN79-4	Driving VMOS Power FETs
AN79-5	Using the VN64GA High Current, High Power VMOS Power FET
AN79-6	Using VMOS Transistors to Interface from IC Logic to High Power Loads
AN79-7	Applications of the VN10KM VMOS Power FET
AN80-1	A Key to the Advance of Switching Power Supplies
AN80-2	Meet the VMOS FET Model
AN80-3	Ultralinear Broadband Amplifier
AN80-4	Enjoy VHF Power Amplifier Design
AN80-5	An Alternative Power Amplifier Design

Basically, the battery charger is a full-wave rectifier consisting of a pair of 1N249 silicon diodes, filter capacitor *C2*, and the VMOS series-pass element. The VMOS device is driven by a simple op-amp error amplifier, that compares a portion of the output voltage, via the 5-kΩ potentiometer, with a constant-voltage reference source. The reference consists of a CR390, a 390-μA current source, and the 1N4100 zener diode. The power for the op amp and reference is derived from a separate source, which produces a slightly higher operating voltage than the main dc source. This allows the op amp to provide more voltage to the VMOS power FET, insuring it will deliver maximum output current. If desired, this project can be built as a battery charger or, with the filter capacitor increased in value, as an adjustable high-current power supply.

"Flyback" DC-DC Converter. With a +7-to-18-volt input, this circuit (Fig. 7) can produce regulated −5 volts. The current output is limited, but should be enough for an op amp or two. The circuit consists of a CMOS oscillator driving a VMOS switch. A full supply voltage square wave appears across the 33-ohm resistor forming the VMOS load, and the negative, or "flyback" transition, is rectified, filtered, and zener regulated to −5 volts. Since the oscillator operates at a high frequency, the filter capacitor can have a small value, yet do a good job. The circuit can be assembled in little space and work with battery-powered op-amp projects.

VMOS R-F Switch. The circuit of Fig. 8 can switch r-f signals in 50 nanoseconds, far faster than any relay (20 to 50 ms typical). Other advantages include 60-dB isolation with a 10-MHz, 20-volt peak-to-peak input, and 1-dB insertion loss. These are impressive features for such a simple circuit.

Basically, the VMOS power FETs are wired as a "T" switch. When the V-control input is 0 volt, the two 2N6660 FETs are biased on, because 10 volts appear between their source and gate. The left 2N6660 turns off both power VMOS devices by pulling their gates to −10 volts. At the same time, the sources of both VMOS devices are pulled low by the right 2N6660. Thus, both VMOS devices are turned off, and the junction between them is grounded to reduce leakage through the switch. Making the V-control input −10 volts turns off the two 2N6660s and the VMOS devices are allowed to turn on because of the 470-ohm pull-up resistor. The input r-f signal passes through the VMOS devices to the output. This simple circuit can be used for many applications where high r-f frequencies are used. A good example would be in a low-power transceiver, or to switch several receivers to one antenna. Build it on a piece of "ground plane" perf board or board covered on one side with copper sheet. This will insure maximum attenuation when the switch is "off."

From this and the other circuits shown above, it is easily seen that VMOS power FETs are not exotic, difficult-to-use devices. On the contrary, they not only offer performance advantages over bipolar devices in many applications, they are often considerably easier to use. ◇

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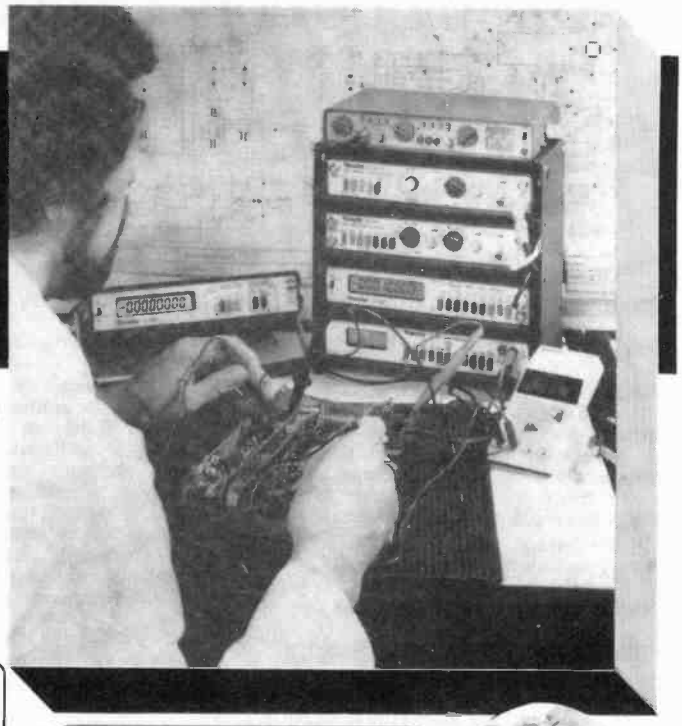

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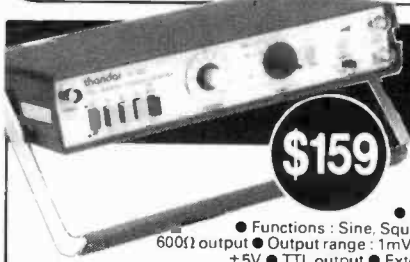

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SUCCESSFUL SOLDERING

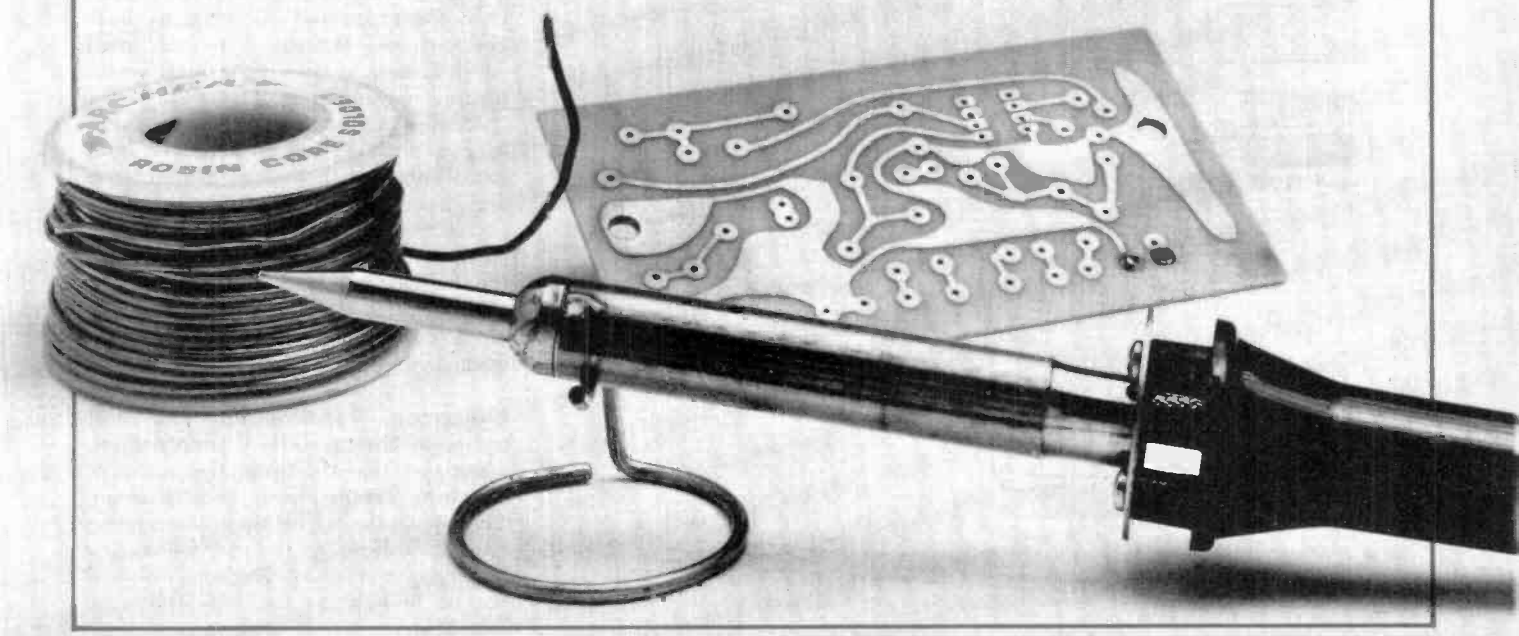
Helpful tips on materials, tools, and techniques

BY JOHN D. BORNEMAN

IN ELECTRONICS, the basic goal of soldering is to electrically and mechanically join two circuit components. For this connection to be reliable, the solder must adhere to or "wet" the mating surfaces of the components being joined. The wetting of solder to a base metal is similar to the action of water spilled on a smooth surface: if the surface is clean and free of dirt, wax and oils, the water will wet and spread evenly over it; if the surface is waxed, the water balls up.

Most manufacturers of electronic components do a good job of making their products of easily solderable material or providing a clean solderable coating. Copper, copper-clad steel, or nickel-steel are some of the common base metals used in the leads of resistors, capacitors, integrated circuits, etc., and they may be coated with silver, tin, tin-lead, or gold to improve solderability. Greases, oils, dirt, and oxides are the principal sources of contamination that prevent good solder wetting despite the original surface. Also, aging deteriorates the surface and inhibits solder wetting by the formation of oxide films.

Solder Alloys and Fluxes. Technically, soldering is the joining of two parts with a metal alloy having a melting point below 800°F. Various solder alloys include combinations of tin, lead, antimony, silver, indium, and bismuth; however, the most common combination is tin and lead. Tin-lead solders range from pure tin to pure lead and include all proportions in between. For plumbing, alloys of 10% tin and 90% lead (10/



90 solder) are commonly used. In electrical soldering, the alloy mix is usually 60% tin and 40% lead (60/40).

Characteristics of alloys of tin and lead are plotted against temperature in Fig. 1. This graph, referred to as a phase diagram, allows one to see that only a 63/37 alloy has a eutectic point—that is, a single melting point. All other alloys start melting at one temperature, move through a "pasty" or semisolid stage, and then become liquid at a higher temperature. Any physical movement of the components being soldered while the solder is in the "pasty" range will result in a "cold" joint. Such a joint appears grainy and dull, and is mechanically weaker, thus less reliable. Therefore, 63/37 or 60/40 solder is commonly used in electronics since they do not remain long in a "pasty" phase. However, a 50/50 alloy can be used if proper care is taken.

An often-ignored aspect of soldering is the *flux*. The word flux comes from the Latin root "fluere" meaning "to flow." Soldering flux, which is usually included in the solder as a central core, or separately in liquid or paste form, helps the solder alloy flow around the connection. Flux also cleans the component leads of oxides and films, and allows the solder to wet their surfaces.

Chemically, flux is either acid or rosin based. Always use rosin flux in electronic soldering since the acid may cause corrosion. "Activated" rosin or "RA" flux produces better cleaning and

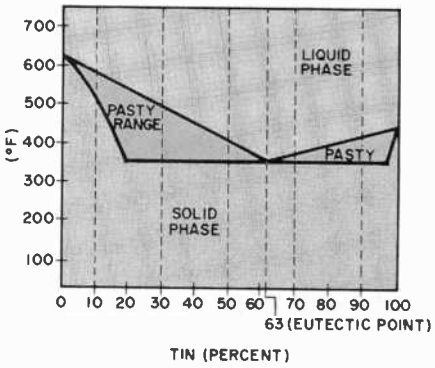


Fig. 1. Melting point, including pasty phase, of alloys of tin and copper.

flowing properties than the popular mildly activated fluxes (RMA), and they are noncorrosive.

Equipment. The tools required to solder electrical connections are: a good soldering iron and a supply of replaceable tips, long-nose pliers for holding parts or bending leads (or as a heat sink for temperature-sensitive components), and desoldering braid (or a suction desoldering tool).

There are basically two types of soldering instruments—the "gun" and the "iron," although most people use these descriptions interchangeably. In essence, a soldering "gun" is a pistol-shaped device consisting of a transformer forming the bulk of the "gun," with the secondary winding extending out to form the replaceable tip. Usually, soldering guns come with high wattages, in most cases too high for use with pc foil patterns. Such guns also generate a high magnetic field around the tip that can de-gauss any magnetically sensitive devices close to it. Using a gun may produce too high a heat on the foil pattern so that the cement that secures the copper foil pattern to the substrate is weakened and the foil separates from the printed circuit board.

The "iron" is often called a "pencil iron" because it resembles a thick pencil that is held in the fingers. These tools feature interchangeable (usually screw-on) tips having various shapes—each for its own purpose. Their wattages are usually low enough to be safely used on pc boards. The latest version of the pencil iron is the low-wattage self-contained rechargeable type that can be used remote from the ac line.

Soldering irons are specified primarily by wattage as shown in the table. Wattage represents the amount of heat capacity available at the iron tip. Irons of all wattages usually run at about the same tip temperature, but a lower-wattage iron will cool faster during soldering. The recommended wattages given in the table are to be used as general guidelines only. Slight variations may give perfectly good performance, depending on the particular soldering situation. A higher-wattage iron is more likely to damage heat-sensitive components. If static-sensitive components are to be soldered, i.e. many MOS devices, be sure the iron has a grounded plug. Soldering irons can produce static voltage spikes that will destroy many integrated circuit components, so a grounded tip is a wise safety measure.

Tips are usually selected by preference. Each type and shape has its place and purpose, but the commonly used pointed, conical type is the most versatile and convenient.

Desoldering equipment is always useful even for experienced solderers. Both braid and suction devices are effective and, again, operator preference is the best guide. If you elect to use a suction desoldering tool, pay close attention to the distance and velocity that the "piston" requires. It is very easy to get a black eye, or have glasses damaged, when using those devices.

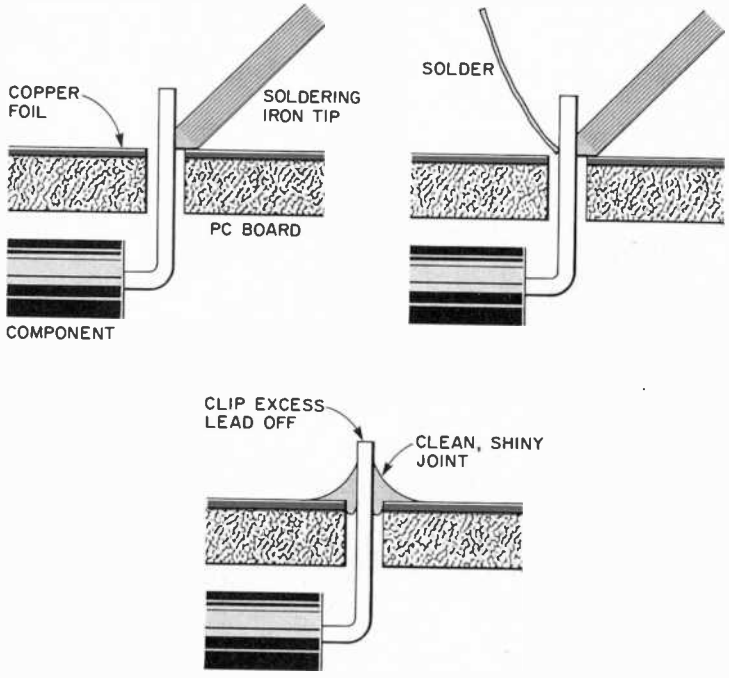


Fig. 2. Steps in soldering. Place heated iron to junction of parts to be soldered (top left) Bring flux-cored solder to the joint after it is hot enough to melt solder (top right) When a smooth-contoured fillet has formed, remove the solder and allow to cool without moving.

Soldering Techniques. The best technique can be outlined simply. First, make sure that the tip of the iron is at operating temperature, and is clean. Then touch the heated tip to the connection, preferrably on the part having the larger mass (Fig. 2). The solder should not be brought to the joint until the

IRON WATTAGES FOR DIFFERENT SOLDERING TASKS

Type of Soldering	Recommended Iron Wattage
Light duty: single joints, repair, touch-up, delicate parts such as ICs or fine wires. Mass of parts in connection is small.	25 to 30
Medium duty: multiple joints; many in succession. Mass of parts is intermediate (for example, 1/4-watt resistors or conventional disc capacitors).	60 to 100
Heavy duty: Mass is large, as in wires soldered to steel case or wires to screw heads for ground points.	over 100

metals being joined have become hot enough to melt it. How long this takes is quickly learned after a few trials. The flux-cored solder is then brought to the joint and placed at the junction of the two parts. When the solder has melted and flowed into a smooth-contoured fillet, remove the solder. Keep the tip on the joint for a few seconds, then remove it. Do not disturb the newly made connection until it has had time to solidify. A good solder joint will be shiny (Fig. 3). Disturbing the joint before it has solidified may produce a "cold" joint.

Problem Solving.

To Avoid Cold Joints. Even when you know that the parts should not be moved while the solder joint is cooling, it is sometimes difficult to find enough hands to hold a soldering iron, solder, circuit board, and the part being attached. In this case, a small vise or a surgeon's hemostat may be used to hold the board and parts. If you are using rosin flux in liquid or paste form, another method is possible. Using long-nose pliers, hold the part to the circuit board. Apply flux to the pieces being soldered and take up the soldering iron. Touch the iron to a length of solder, creating a ball on the tip. Touch the tip to the connection and hold it there until the fillet is formed. This will create a good joint and free your hands to hold the parts.

To Get Good Solder Wetting. Clean the parts well with isopropyl alcohol to remove greases and oils, and use a 10% solution of hydrochloric acid (HCl) to remove the oxides. Fine steel wool may be used on foil patterns to remove oxide films. These chemicals should be available from any drugstore, but remember to ask about any handling precautions before using them. Note that extra liquid flux can also help in soldering contaminated parts.

To Make Solder Flow. Be sure the soldering iron is providing enough heat, with the iron tip on tight and the proper wattage being used. Also be sure enough flux has reached the component leads

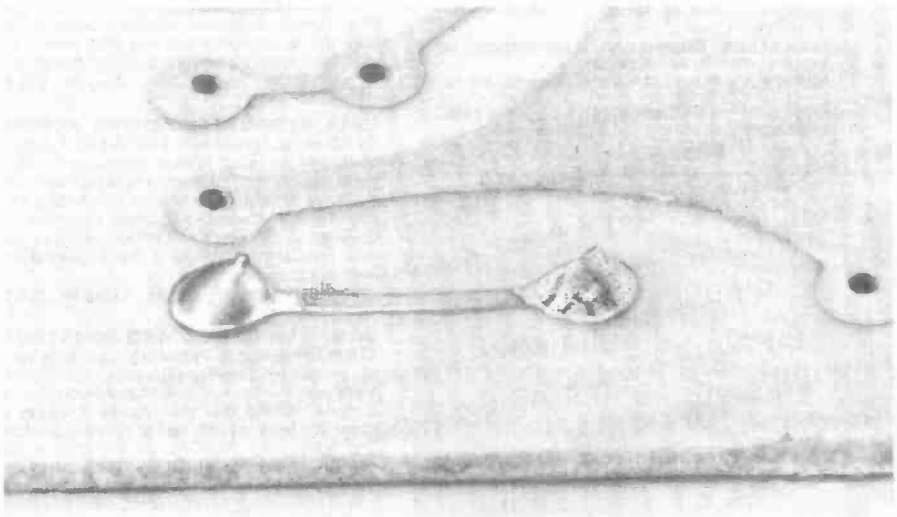


Fig. 3. Photo of two soldered joints. The one at left is shiny indicating a good joint. At right, is a "cold" solder joint.

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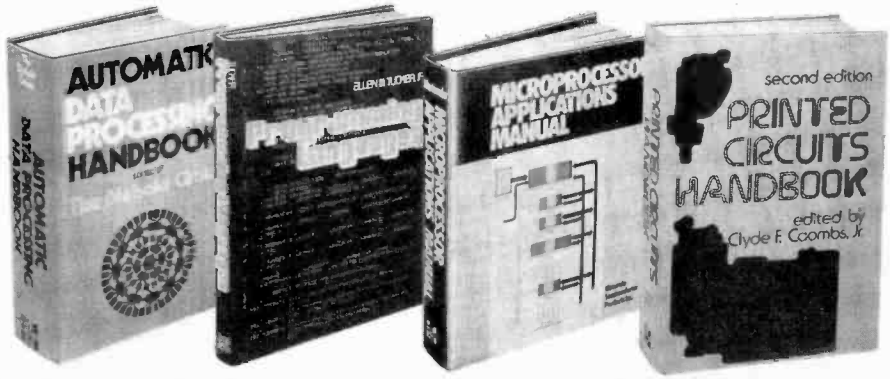

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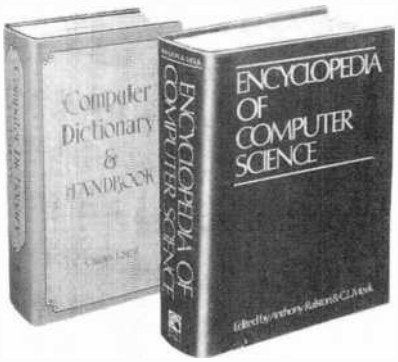

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soldering

and that it is not necessary to add extra liquid or past flux. Do not keep the iron on the joint or continue adding solder if a connection is not made after two trials. This will only damage the components or the circuit board.

To Solder ICs and Other Small Components. Use only a low-wattage iron and sharp tip to avoid excess heat. Also, use 0.031-inch diameter solder to help control the amount of solder deposited. Provide a heat sink by using long-nose pliers to grasp the lead between the component package and the portion to be soldered.

After completely soldering a pc board, an inspection of the soldered joints is suggested. A toenail clipper can be used to trim any lead ends so they don't protrude too far from the solder. To help in the inspection, a bright spotlight and low-power lens can be used to examine each joint. A sharp tool can clear away dross, solder bridges, or anything that looks suspicious between solder pads, and a toothbrush can be used to clean the solder joint. To make sure that all joints are checked, a drop of red nail polish can be placed on each after inspection. A minute spent checking a board can save an hour of troubleshooting later on.

Another problem can arise when a plastic capacitor appears to be "soldered" in place, but is not making an electrical connection. This often happens when a small "sleeve" of nonconducting plastic extends from the capacitor body slightly down each lead. The solder will hold the plastic to the pad, but an electrical connection may not result. Use long-nose pliers to break away the unwanted plastic.

Since your fingers may be dirty or oily, handle parts and circuit boards as little as possible. If there is any question of oily spots on a part, clean it using isopropyl alcohol or fine steel wool. If you use steel wool, use lint-free cloth to remove all vestiges of the wool from the parts or board.

To Summarize:

(1) Use clean new parts and circuit boards.

(2) Use 60/40 or 50/50 tin-lead alloy solder with an activated rosin core. Liquid or paste rosin flux may be used to improve wetting when necessary.

(3) Use the proper wattage soldering iron based on the amount of soldering to be done and the type of components being soldered.

(4) Use the proper soldering sequence—tip to parts, solder to parts—solder away from parts—tip away from parts.

(5) Use patience.

(6) Practice. ◇

PEAK UNLIMITER
AUDIO DYNAMIC RANGE PROCESSOR

Increases system gain when passing peaks that may have been limited during the original recording process

BY JOHN SUTTON

LIVE music can easily have a dynamic range exceeding that of current analog recording and playback systems. To "fit" onto an analog tape or disc, this dynamic range must be reduced. Generally, this is accomplished by manipulating the system gain as the signal passes through, making the loud passages softer and the soft passages louder. *Compression* is moderate application of this technique throughout the dynamic range. *Peak limiting* cuts gain radically if the signal exceeds a determined level.

Although this approach works, it sacrifices some of the realism in the reproduction of the program material. But not all of the 30 or so dB of dynamic range subtracted by the compression and limiting process is irretrievably lost. It can be restored by electrical processing complementary to what was done in recording. Most often, the exact nature of the original processing is unknown, making the complementary nature of the restorative action a hit-and-miss proposition. Expansion (the inverse of compression) that is not correct is often unsatisfactory, but the ear is more tolerant of errors in peak unlimiting.

The Peak Unlimiter described in this article "stretches out" what's left of the original peaks to enhance dynamic range. It is low in cost and easy to build and use.

Peak Unlimiting VS. Expansion. Peak unlimiting differs from expansion in that it need not change the system gain as radically to accomplish what it does. This means that attack and release times can generally be faster than in a linear expander without causing audible side effects such as "pumping and breathing." As shown in Figures 1A and 1B, linear expansion may use as much as 20 dB of gain change, while peak unlimiting uses 7.5 dB.

Another advantage of peak unlimiting is that it allows the processor to control each channel independently. Were such an arrangement used in a linear expander, the stereo image of the program material would suffer greatly. Common gain control avoids this, but causes another problem. The effect of synchronized gain change is quite noticeable in music that favors one channel, especially with low-frequency material. To the ear, this may result in an annoying "swishing"sound that we would like to avoid.

The Peak Unlimiter makes independent gain control work in its favor. Since we're interested in processing short-term peaks with a modest change in gain, attack and release times can be optimized. Audible signal degradation is thereby minimized.

About the Circuit. The Peak Unlimiter, shown schematically in Fig. 2, is designed around two quad BiFET operational amplifiers. The first, *IC1*, performs the actual signal processing, and the other, *IC2*, forms the heart of a gain-change indicator that is common to both audio channels. The signal-processing stages of both channels are identical, so further reference will be made only to the left channel.

Potentiometers *R1A* and *R2* couple a portion of the input signal to capacitor *C1*, which passes ac but blocks any dc level. The signal is applied to the noninverting inputs of *IC1A* and *IC1B* by means of *R4* and *R8*. Diode *D1* rectifies the output of *IC1A*, and capacitor *C2* filters the pulsating dc into a smooth level. This dc level is applied to the gate of FET *Q1* via *R9*

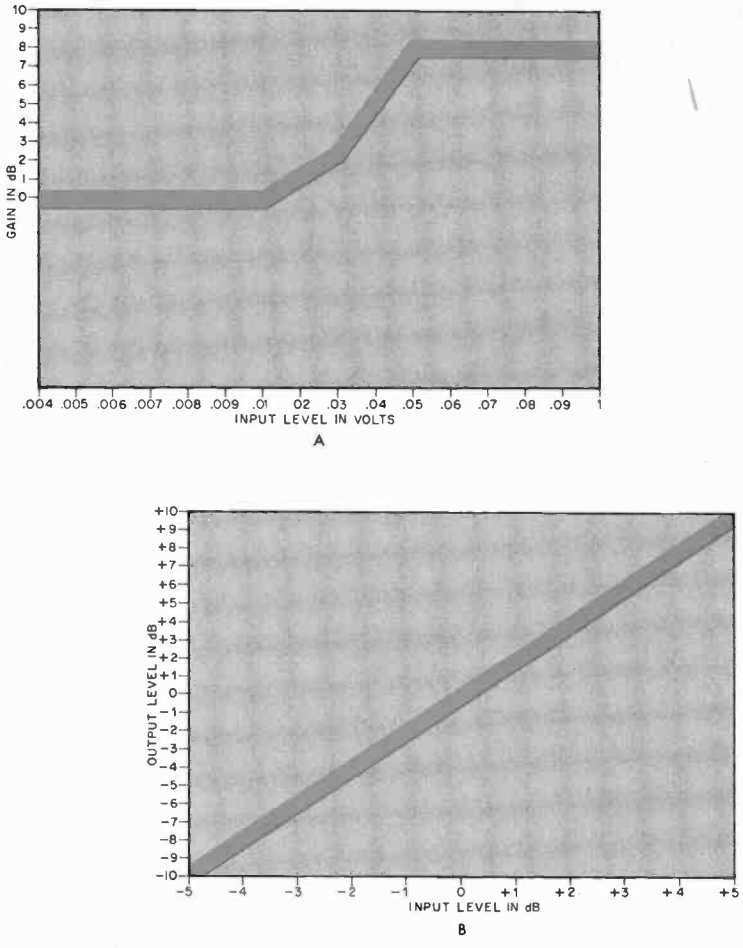


Fig. 1. Peak unlimiting (A) shows a 7.5-dB change, while linear expansion (B) shows a 20-dB variation.

when switch *S1* is in its open position. The time constant associated with this rectifier/filter network has been chosen for optimum project performance. Diode *D1*, a 1N82 germanium type, was carefully chosen for the required dynamic characteristics. Substitution of another diode type may degrade performance.

The drain of *Q1* is connected to the inverting input and feedback resistor of *IC1B*. Its source is grounded. The channel (drain-to-source) resistance of the FET depends on the dc level applied between its gate and source, which in turn depends on the amplitude of the input signal. A large input-signal amplitude results in a large gate-to-source control voltage and, hence, less channel resistance and greater gain. When *S1* is closed, the channel resistance of *Q1* and the gain of stage *IC1B* are constant. No peak unlimiting occurs when the switch is closed.

The output of *IC1B* is routed to jack *J3* by coupling capacitor *C3* and to the input of voltage follower *IC2A*. Diodes *D3* and *D4* rectify and feed the output of *IC2A* to the inverting and noninverting inputs of differential dc amplifier *IC2B*. Similarly, the output of *IC2C* (the voltage follower in the right-channel portion of the circuit) is rectified and applied to the inputs of *IC2B* by means of *D5* and *D6*. Tricolor emitter *LED1*, which consists of a red LED and a green LED connected back to back and housed in a single package is driven by the output of *IC2B* via current limiter *R23*.

The indicator circuit alerts the user to changes in gain. If the differential dc input voltage is negative, the red section of *LED1* becomes forward biased. In operation, faint red flickers indicate that gain changes of approximately 1.9 dB are taking place. If the differential dc input voltage is positive, the green emitter in *LED1* becomes forward biased. When this happens and the LED flashes green, a gain change of approximately 7.5 dB is taking place.

As is the case with *D1* (and *D2*), the diodes selected for use as *D3* (and D5) and *D4* (and *D6*) have been specified for their dynamic characteristics. Silicon diode *D4* has a higher conduction threshold than *D3*. This makes possible the desired visual indication of gain changes, because the red section of *LED1* will be firing at lower levels than the green section, which is forward biased only during relatively large changes in gain.

The power supply, shown schematically in Fig. 3, is of fairly conventional design. Transformer *T1* has a fuse-protected primary and a grounded secondary center tap. The outputs of full-wave bridge rectifier *D7* through *D10* are filtered by *C8* and *C10*. Regulators *IC3* and *IC4* generate stable +15- and −15-volt outputs for the rest of the circuit. Capacitors *C9* and *C11* improve the transient response of the IC regulators and ensure low effective power-supply impedances.

Construction. Printed-circuit assembly techniques are recommended in building the Peak Unlimiter. A full-size etching-and drilling-guide for a suitable pc board appears in Fig. 4, and the complementary component-placement guide appears in Fig. 5. Alternative construction techniques such as point-to-point or wrapped-wire assembly can be employed, but care should be taken to avoid ground loops and circuit instability. The use of IC sockets or Molex Soldercons is highly recommended. To ensure close tracking between channels, match *Q1* and *Q2* for their *actual* values of key parameters—I_{DSS}, V_{GSS}, and g_m.

Observe the polarities and pin basings of electrolytic and tantalum capacitors and of semiconductors. Note particularly that the pin basings of regulators *IC3* and *IC4* differ. The use of a radiation (hum) shield for *T1* is recommended. One can be fashioned by cutting a piece of sheet tin to fit and wrapping it around the body of the transformer. Trimmer potentiometers *R2* and *R11* are not mounted on the pc board: they can be soldered directly to the lugs of dual potentiometer *R1*. Use shielded cable for connections between the input jacks and the dual potentiometer, between the trimmer potentiometers and the circuit board, and between the pc board and the output jacks. Finally, house the project in a metal enclosure.

Initial Adjustment. Patch the Peak Unlimiter into your stereo system at some line-level point, such as a tape-monitor loop, or between the preamplifier outputs and the power-amplifier inputs. The only prelimina-

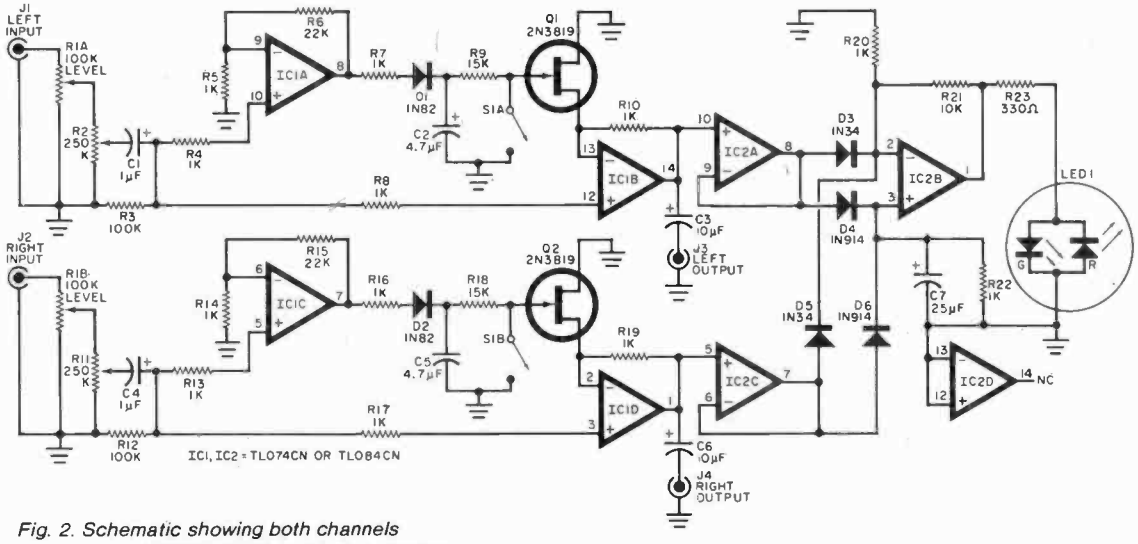


Fig. 2. Schematic showing both channels of the Peak Unlimiter circuit and LED indicator.

PARTS LIST

C1,C4—1-μF, 35-V tantalum capacitor
C2,C5—4.7-μF, 25-V, radial-lead aluminum electrolytic
C3,C6—10-μF, 16-V, axial-lead aluminum electrolytic
C7—25-μF, 25-V, axial-lead aluminum electrolytic
C8,C9,C10,C11—1000-μF, radial-lead aluminum electrolytic
D1,D2—1N82 germanium signal diode (see text)
D3,D5—1N34 germanium signal diode (see text)
D4,D6—1N914 silicon switching diode (see text)
D7,D8,D9,D10—1N4002 rectifier
F1—1/4-ampere fast-blow fuse
IC1,IC2—TL074CN or TL084CN quad Bi-FET operational amplifier
IC3—LM340T-15 +15-volt regulator
IC4—LM320T-15 −15-volt regulator
J1,J2,J3,J4—RCA phono jack
LED1—Tricolor light-emitting diode (Radio Shack 276-035 or equivalent)
Q1,Q2—2N3819 n-channel FET (see text)
The following, unless otherwise specified, are 1/4-watt, 5% tolerance, carbon-composition fixed resistors.
R1—100-kΩ, linear-taper dual potentiometer
R2,R11—250-kΩ, linear-taper trimmer potentiometer
R3,R12—100 kΩ
R4,R5, R7, R8, R10, R13, R14, R16, R17, R19, R20, R22—1 kΩ
R6,R15—22 kΩ
R9,R18—15 kΩ
R21—10 kΩ
R23—330 Ω
S1—Dpst miniature toggle switch
T1—35-V, 65-mA, center-tapped transformer (Triad F-227X or equivalent)
Misc.—Suitable enclosure, printed-circuit or perforated board, standoffs, IC sockets or Molex Soldercons, LED mounting collar, terminal strips, line cord, shielded cable, hookup wire, control knob, suitable hardware, solder, etc.
Note—The following is available from XEN, Box 2, Scranton, PA 18504: a complete kit of parts (not including enclosure), No. X-1980, for $59.00 post-paid in the United States. Also available separately are *Q1* and *Q2*, No. XMP-3819, for $5.00 a matched pair; etched and drilled printed-circuit board, No. X-1980-PCB, for $11.00; both postpaid in the U.S. Pennsylvania residents, add state sales tax. Allow four to six weeks for delivery. Add 2 weeks for personal check to clear.

ry adjustments that must be made are of trimmer potentiometers *R2* and *R11*. Close switch *S1* so that the peak unlimiting is defeated. Place the MODE switch of the preamplifier in its MONO position, rotate the control knob of the preamplifier's BALANCE potentiometer to its fully left position, and adjust the control knob of the project's front-panel LEVEL control (*R1*) so that the wipers of the dual potentiometer are at the midpoint of their travel. Adjust trimmer potentiometer *R2* so that the signal level at jack *J3* equals that at *J1*. This can be done aurally, by monitoring the loudspeaker output while alternately routing the drive signal through and around the Peak Unlimiter.

A more precise adjustment can be made if you have access to a signal generator and an oscilloscope. Connect the signal generator to a line-level input of the preamplifier and the probe of the oscilloscope to *J1*. Adjust the generator's output-level control for a 1-volt p-p signal at *J1*. The output frequency of the generator is not critical, but should be approximately 1000 Hz. Then shift the scope probe to *J3* and adjust *R2* for a 1-volt p-p output level.

Next, connect a pair of stereo headphones using clip leads to the "hot" sides of output jacks *J3* and *J4*. Do not make any connection to the common (shell) lead of the headphones. With the stereo preamplifier still providing a monaural drive signal, adjust *R11* for an output null. If an oscilloscope is being used, connect its probe(s) to the project outputs and set the scope to read differential voltage. Then adjust *R11* for an output null. Note that both channels of the project must be driven by the same signal to make valid adjustments of the trimmer potentiometers.

Now disconnect the clip leads or scope probe(s) and install the cover.

(Continued overleaf)

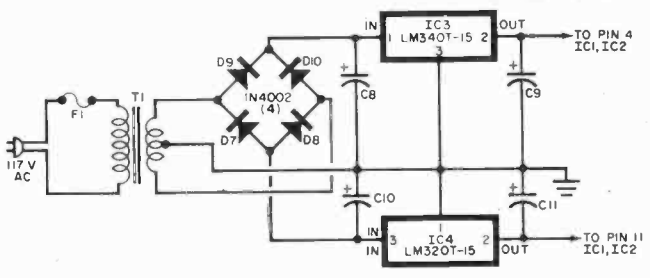


Fig. 3. Power supply provides regulated bipolar 15 volts for op-amp power.

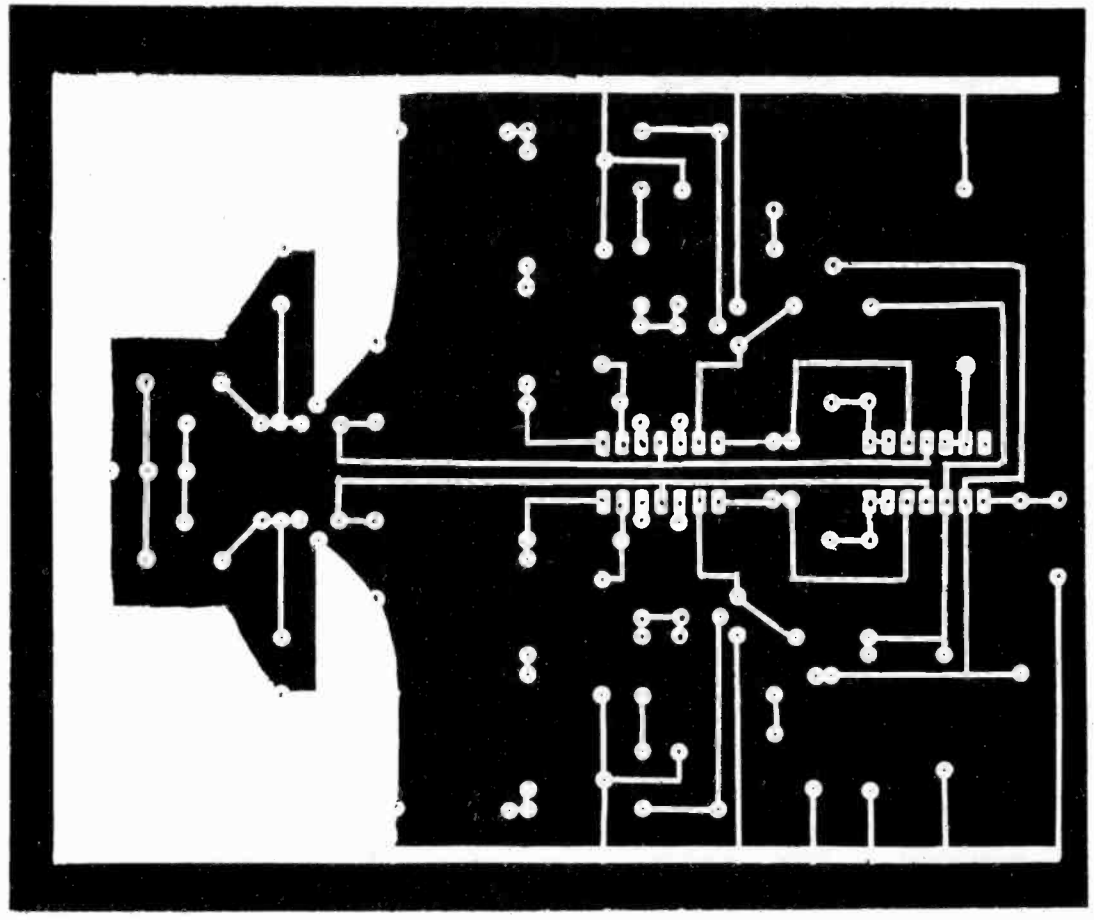


Fig. 4. Etching and drilling guide for pc board.

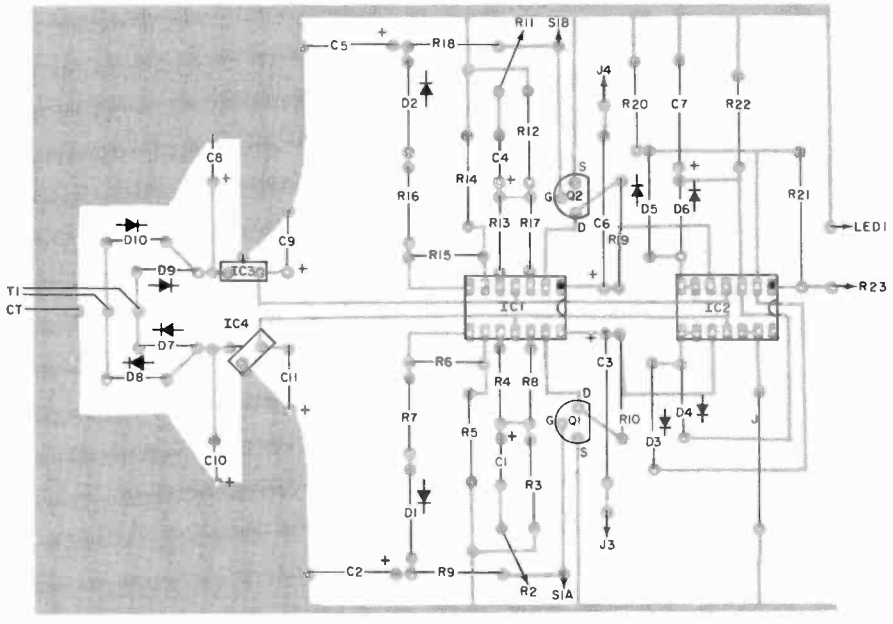


Fig. 5. Component-placement guide for pc board.

Using the Peak Unlimiter. Route audio signals through the project, and monitor the loudspeaker outputs and indicator *LED1*. The author recommends that LEVEL control R1 be adjusted so that, with *S1* in its open position, *LED1* glows red most of the time (except in the absence of input signals) and flashes green on the loudest signal peaks. This recommendation is somewhat arbitrary, however, and your ears should be the final judge. Opening and closing *S1* will allow you to make quick comparision between the processed and unprocessed signal. You might find that the nature of the program material dictates which setting gives the most pleasing results.

An apparent improvement in the program material's signal-to-noise ratio will be realized because of a masking effect introduced by the Peak Unlimiter. Keep in mind that signal peaks are accentuated by several dB, so some caution should be observed, at least at first. If the audio system does not have sufficient headroom, amplifier clipping and damage to the loudspeakers may occur. ◇

AN ALARM FOR TOXIC GASES

Detects oxygen-hungry gases such as carbon monoxide and methane. . . . sounds a warning before dangerous concentrations are reached

BY CASS LEWART

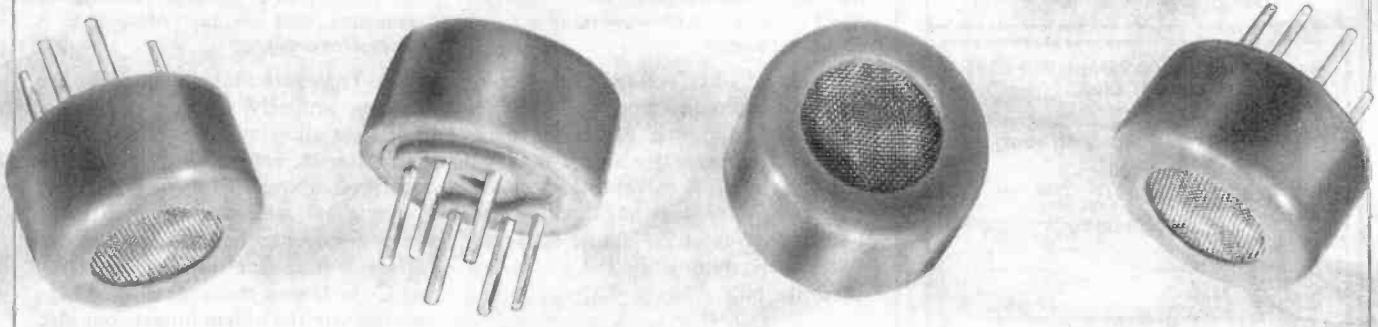
WHEN a lethal fire starts, flame and smoke are not the only killers. Colorless, odorless carbon monoxide gas (CO) has been known to kill or incapacitate people—often far from the fire itself. One factor that makes CO such a stealthy, insidious assassin is its ability to elude conventional smoke detectors. These devices are similarly insensitive to dangerous hydrocarbon gases like methane (CH_4), a toxic compound that is the chief component of natural gas.

The Gas Alarm described here has been designed to sound its warning *before* dangerous levels of poisonous gases accumulate. The Gas Alarm should be considered complementary to, and not a replacement for conventional smoke detectors, as it will *not* respond to ionized gases generated by fire unless the fire is smoldering in an enclosed area lacking oxygen. This project has the advantage of being self-powered, thus providing portable protection both at home and in hotels or motels when you travel.

The alarm is based on an inexpensive semiconductor sensor whose electrical resistance changes when its active surface is exposed to gases such as carbon monoxide, methane, butane, and alcohol vapors that have a strong affinity for oxygen. (These are known as *reducing gases*.) The sensor element is enclosed in a small capsule and protected by a stainless steel mesh, while a low-power heater activates the sensor element and purifies it after exposure to gas.

Circuit Operation. As shown in Fig. 1, transformer *T1*, fullwave rectifier *RECT1*, resistor *R2*, and filter capacitor *C1* make up the line-powered power supply for 5-volt regulator *IC1*. Resistor *R1*, in conjunction with rectifier *D1*, maintains the charge on the rechargeable cells in *B1*, while diode *D2* allows *B1* to power the circuit in stand-by mode when the line power is interrupted. Under these conditions, *D1* is reverse biased and battery power flows through forward-biased diode *D2* to power the circuit. The regulated output from *IC1* maintains a fixed heater voltage for gas sensor *TGS1* to provide uniform sensitivity. The combination of *R3* and *LED1* forms a power-on indicator.

When gas is present at *TGS1*, the



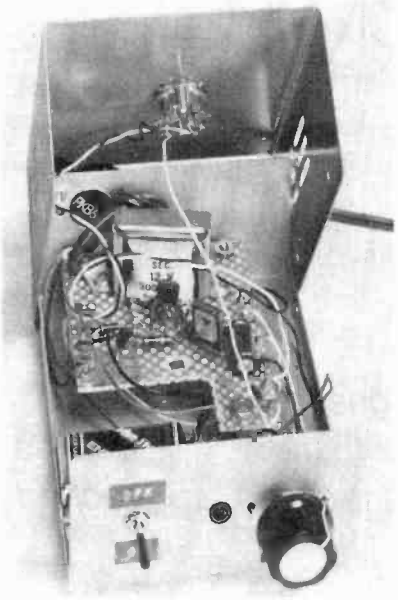


Photo of the author's prototype.

resistance of its sensor element drops, raising the voltage applied across calibration potentiometer *R4*. The rotor of *R4* is connected to the gate of *SCR1*, and when voltage at that point reaches approximately 0.3 V, *SCR1* turns on, supplying power to alarm *A1*. The piezoelectric alarm specified for *A1* interrupts current flow periodically, so *SCR1* does not latch permanently on. Switch *S1* allows for faster battery charging while the gas sensor is turned off.

Construction. The project will easily fit in a 6" x 4" x 2½" metal cabinet, and all components except the alarm and gas sensor can be mounted on perf board or multi-lug terminal strips using point-to-point wiring. Mount the socket for sensor on top of the cabinet for maximum exposure to surrounding air, and mount the alarm on the side or back of the cabinet for best audio output. The six rechargeable cells forming *B1* can be mounted in readily available battery holders.

Adjustment. (1) Plug the Gas Alarm into a 117-volt ac outlet; (2) rotate *CAL* control *R4* fully CCW for minimum resistance between the SCR gate and ground; (3) apply power and allow the sensor to stabilize for 1-2 minutes, then rotate the *CAL* control clockwise till the alarm sounds; (4) rotate *CAL* control CCW till the alarm stops. The alarm is now ready for operation. Test the system by rubbing a drop of alcohol between your fingers, near the sensor. When the alarm sounds, repeat steps two through four.

The rechargeable batteries are trickle charged when the alarm is plugged into an ac outlet, and will be fully charged after approximately 24 hours. To ensure that the batteries are working properly, unplug the alarm and, after allowing it to stabilize with the batteries, repeat the alcohol test described above. The fully charged AA-size batteries should operate the sensor for over an hour during a power failure. For longer standby operation use C- or D-size rechargeables. These will operate the alarm longer, but also require longer charging time. When the alarm is not in use, open *S1* to protect batteries from discharging through *IC1*. ◇

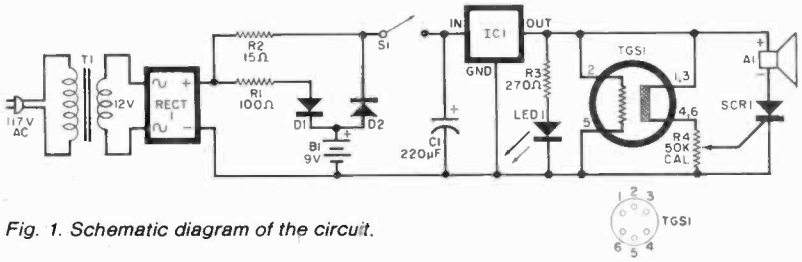


Fig. 1. Schematic diagram of the circuit.

PARTS LIST

A1—Piezoelectric buzzer (Radio Shack 273-060 or similar)
B1—Battery (six rechargeable 1.5-V cells)
C1—220-μF, 16-V electrolytic
D1, D2—200-V, 1-A silicon diode
IC1—5-V regulator (Radio Shack 276-1770 or similar)
LED1—Red LED (optional)
R1—100-Ω, ½-W resistor
R2—15-Ω 1-W resistor
R3—270-Ω, ½-W resistor (optional)
R4—50-k Ω linear potentiometer
RECT1—50-V, 1-A full-wave rectifier
S1—Spst switch
SCR1—200-V, 6-A SCR (Radio Shack 276-1067 or similar)
TGS1—Gas sensor (See note)
T1—12-V, 1-A transformer (Radio Shack 273-1505 or similar)
Misc.—6" x 4" x 2½" enclosure with cover, perf board or terminal strips, etc.
Note—The following is available from C & R Electronics, Box 217, Holmdel, NJ 07733: Pretested gas sensor, with socket, $10.95 plus $1 postage/handling. NJ residents, add 5% tax. Allow 2 to 3 weeks for delivery.

SINGLE-LED ANALOG METER

Complete LED changes "color" with input voltage

BY DAVID LEITHAUSER

THERE are many ways that an electronic measuring circuit can display information. Numerical data can be displayed on LED or LCD readouts, analog meters, or similar devices, while on/off indications can be made via a low-cost discrete LED or lamp. Another possibility is to show a changing variable as a series of color variations, taking advantage of a new low-cost, multicolor LED.

This new device consists of a pair of LEDs, one emitting red light and the other green, oppositely polarized and enclosed in a common plastic housing with two electrical leads. Applying current in one direction causes only the forward-biased LED to glow, while the reverse-biased LED remains dark. If the current polarity is rapidly alternated, then the composite LED will glow yellow or greenish red, depending on the duty cycles of the currents in the two directions. This is the operating principle behind the Single LED Analog Meter. The schematic diagram of the circuit for the meter is shown in Fig. 1.

Circuit Operation. Op amp *IC1A* generates a ramp waveform at point A that drives amplifier *IC1B* via *R4* (*R5* acting as the gain-determining feedback resistor) with the amplified ramp voltage applied to the noninverting input (+) of comparator *IC1C*. The input voltage (referenced to ground) applied to the inverting (−) input is compared with the instantaneous ramp voltage applied to the noninverting input (also referenced to ground). If the input voltage is higher than the ramp voltage, the output of *IC1C* is near ground, and when the input voltage is lower than the instantaneous ramp voltage, the output of *ICIC* is near the level of the positive supply voltage.

The output of *IC1C* is connected to the inverting input of *IC1D* with the dual-color LED connected like a feedback element in conjunction with current-limiting resistor *R7*. When the output of *IC1C* is positive, the output of *IC1D* is at ground. Thus, current will flow from the output of *IC1C*, through *R7*, and the forward-biased LED to the virtual ground of *IC1D*. This causes that LED to glow. Since the other LED in the package is reverse-biased, it remains dark. When the output of *IC1C* goes to ground, the output of *IC1D* goes high, and current flows the opposite way, causing the now forward-biased LED to glow while the other goes dark.

Thus, contingent on the level of the input signal, the single LED can assume either of two distinct colors, or a combination of the two colors when the input voltage is centered on the ramp voltage.

The builder can decide which of the two colors within the LED can represent the high or low inputs, and ar-

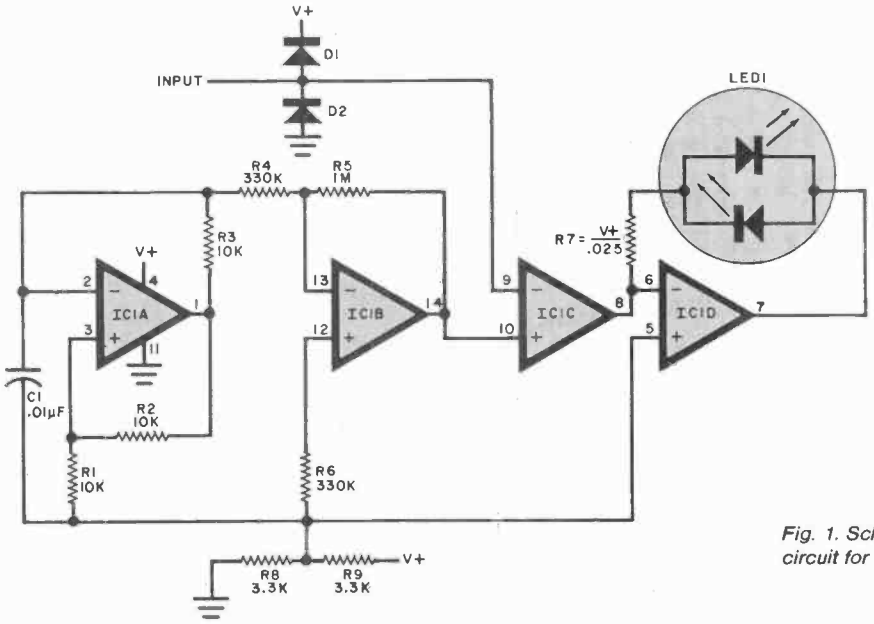


Fig. 1. Schematic diagram of the complete circuit for the LED Analog Meter.

PARTS LIST

C1—0.01-µF disc ceramic capacitor
D1, D2—PTC205, 1-V diode (see text)
IC1—Quad op amp (Radio Shack 276-1714 or similar, see text)
LED1—Two-color LED (Radio Shack 276-035)
R1, R2, R3—10-kΩ, ½-W resistor
R4, R6—330-kΩ, ½-W resistor
R5—1-MΩ, ½-W resistor
R7—See text
R8, R9—3.3-kΩ, ½-W resistor

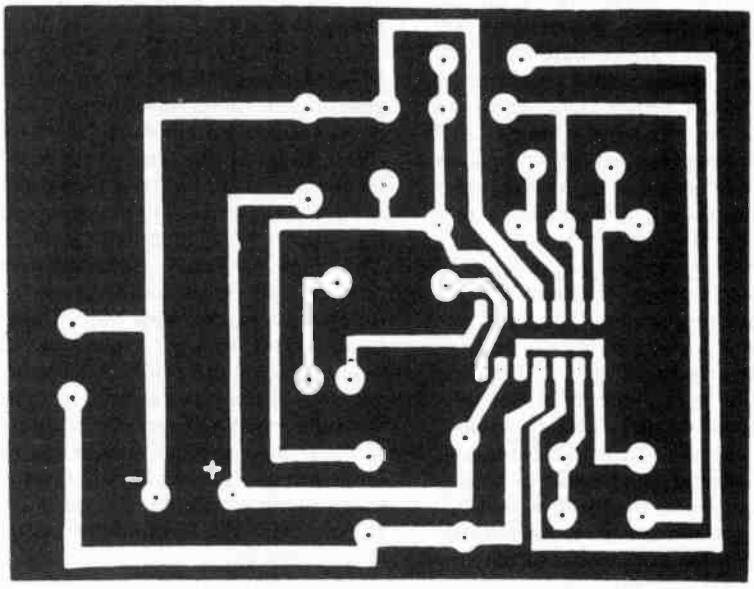
Note: A pc board (RW-205) is available for $5.25, plus $1.25 postage and handling from Danocinths Inc., Box 261, Westland, MI 48185. Michigan residents please add 4% sales tax.

range the LED polarity accordingly. (It is suggested that red be used for higher values.) Protection diodes *D1* and *D2* are included to ensure that the input voltage level does not go above the power supply positive voltage or below −1V with respect to ground. If desired, one or more conventional 1N914 or similar silicon diodes can be used in place of the 1-volt diodes specified. Each silicon diode drop is about 0.6 volt, so two in series can provide a limit of about 1.2 volts. Since a single-ended power supply is used, the network of *R8* and *R9* is used to bias the noninverting inputs of the three operational amplifiers

Construction. The circuit can be assembled on a small pc board such as that shown in Fig. 2. Observe the polarity of input protective diodes. A socket may be used for the IC. The polarity of *LED1* is optional.

The value of current-limiting resistor *R7* is determined by dividing the power supply operating voltage by 0.025. For example, with a 9-volt supply, *R7* is 9/0.025 or 360 ohms (the nearest standard value can be used). Operating power can be any value between 5 and 35 volts dc. If desired, discrete op amps may be used for the four stages.

Applications. The Single LED Analog Meter can be used any place an approximate measurement is to be made. For example, a thermistor can be used to convert temperature to a voltage level that is applied to the input. The LED is then arranged so that a rise in temperature causes the red portion to glow, while lower temperatures keep the green LED lit. The thermistor can be thermally coupled to the output stages of an audio power amplifier to keep an eye on heat-sink temperature. Or, it can be used for an automotive temperature gauge. The circuit can be used to monitor a high voltage if a suitable voltage divider is used, or monitor a very low voltage if a dc amplifier is used at the input. ◇



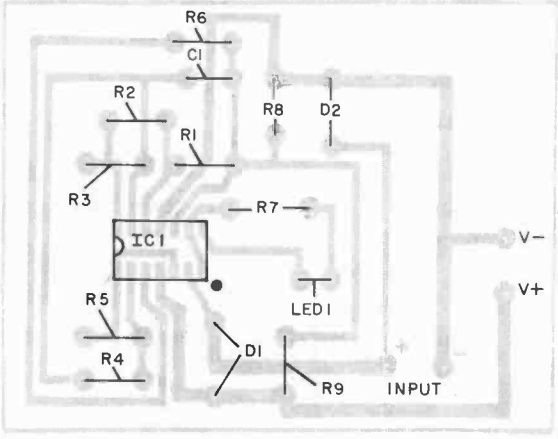


Fig. 2. Full-size etching and drilling guide (above) and component-placement guide (left) for the project's printed-circuit board.

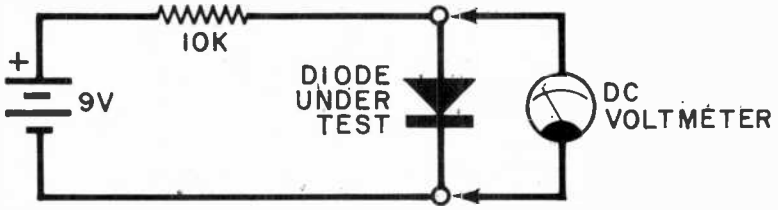
HOBBY SCENE

By John McVeigh, Technical Editor

Checking Diodes

Q. ***I recently acquired a selection of diodes, and I want to build the AD*ZAP Commercial Killer that was presented in the February 1981 issue. The AD*ZAP receiver employs 1N270 germanium diodes. I know that at least one of my diodes is a 1N270, but I don't know which. Can you tell me how I can find out?—Matt Berent, Baton Rouge, LA***

A. The simple circuit shown will enable you to distinguish a germanium from a silicon diode. Connect the device to be tested to the circuit as shown so that the diode will be forward-biased. If you have a lot of diodes to test, build a little test jig that employs binding posts or Fahnestock clips. This will simplify connecting the diodes to the circuit. When the device to be checked is in place, connect the probes of a dc voltmeter across the diode as shown. If the diode is made of germanium, the meter will indicate a voltage drop of approximately 200 mV across the device. If the device under test is made of silicon, the measured voltage will be approximately 600 mV.



Diode action can be verified by reversing the way the diode is connected to the circuit. If the voltage reading is 9 volts, the diode is behaving as an open circuit—as it should under reverse-bias conditions. Note that the circuit will only indicate whether a diode is made of silicon or germanium and whether its junction displays diode action (a simple good/bad test). However, in the AD*ZAP receiver circuit, the exact germanium diode is not critical. Satisfactory performance should be obtained with any of the common germanium signal diodes (1N34, 1N58, 1N270, etc.).

RFI

Q. ***In the past, I have built such projects as special-effects units for electronic musical instruments, and have had trouble with interfering radio-frequency signals. Can you give me some tips on how to cut down on this ever-present menace?—Dennis Halsey***

A. Radio-frequency interference (RFI) to audio devices is the result of signal rectification. A signal lead or some other conductor acts as an antenna and presents r-f to a semiconductor or some other device which rectifies the signal. (Even a poor solder joint can act as a rectifier.) Once the r-f signal has been rectified, any audio-frequency variations in its envelope can be amplified along with the desired audio signal. To cure RFI, the offending r-f signal must be prevented from reaching the point at which rectification takes place.

There are several tactics that can be employed to achieve this result. The sensitive audio circuit should be housed in a metallic enclosure. Signal cables should have effective shields (many audio cables are woefully deficient in this respect). Cable shields should be committed to ground at at least one end, but beware of ground loops in high-gain circuits. Keep signal-carrying cables as short as possible.

Inside the project enclosure, use short lead lengths, some of which might have to be shielded. Power-supply buses should be heavily bypassed and should be decoupled with resistors or r-f chokes. Chokes or ferrite beads at high-gain inputs will block the passage of r-f, and bypass capacitors of suitable values will shunt r-f to ground. Capacitor values should be chosen so that their reactances are low at radio frequencies but high at audio frequencies and so that they do not disturb the desired response of the circuit in which they are installed.

An article that appeared in the May 1977 issue of *Stereo Review* describes RFI prevention in audio equipment in some detail. Reprints of the article are available for $2.00 each (minimum order $6.00) from Stereo Review Reprints, Box 278, Pratt Station, Brooklyn, NY 11205. ◇

SIMPLE DISPLAY AND OPERATING PROGRAM

BY JACK DOLLHAUSEN

THE simple display and operating system described in this article allows any 1802 user to input machine-language programs, and as a bonus, provide a display readout with any Elf using an 1861 video chip.

The program requires 1K bytes of RAM; ½K for display buffer storage, and ½K for program and subroutines that do not alter themselves. The I/O commands are compatible with an expanded Elf using an 1861 TV chip. An EF3 flag is required, and this can be supplied by grounding that input through a toggle switch.

The Program. Load the program shown in the Listing starting at M0000. Flip the RUN switch on and enter any two-byte address. The video display will be a column of eight 4-digit addresses with their corresponding data bytes. Set EF3 to logic 0, insert 00 via the INPUT toggle switches and note that when the INPUT switch is turned on, the display scrolls upward through memory. Entering 01 on the switches will produce a down scroll, and 02 will single-step up for each operation of the INPUT switch. To jump the display anywhere in memory, enter 03 and the two-byte address.

Note that the input address is displayed at the bottom of the CRT screen. This is the "active" position, and all operations are performed from this point.

Address an empty memory location (keep in mind that M0200-M03FF is display buffer storage), and make EF3 = 1. Now with each operation of the INPUT switch, the byte on the toggle switches will be sequentially input into memory. A pointer reminds you that memory is being changed. When finished, return EF3 to logic 0.

To execute a program from any point in memory, set the display to the beginning address of the program to be run and enter 04. The 1861 is disabled by an 04 command, and the machine is running outside the operating program. To return, flip the RUN switch off/on and enter an address. The program you are

```
INITIALIZATION:
     0000  F8 01  B1  B2  B3  B8
     0006  F8 C9  A1  F8  EA  A2
     000C  F8 81  A3

     000F  F8 02  B6  F8  00  A6
     0015  F8 00  56
     0018  16 96  FB  04                    clear display buffer
     001C  3A 15

     001E  F8 00  B4  F8  25  A4
     0024  D4                               R4 is "main" pgm. ctr.

MAIN PROGRAM:
     0025  E2 69                            TV on
     0027  37 27  3F  29                    ENTER high byte
     002B  6C BE                            memory location displayed
     002D  37 2D  3F  2F                    ENTER low byte
     0031  6C AE                            in RE
     0033  37 33
     0035  8E FF  07  AE  33  3F
     003B  9E FF  01  BE                    RE has top of display
     003F  F8 02  B6  F8  00  A6            R6 is display buffer pointer
     0045  16                               display loop:
     0046  9E 7A  D3  9E  7B  D3            R3 is pgm. ctr. for digit
     004C  8E 7A  D3  8E  7B  D3            configuration subroutine
     0052  16
     0053  0E 7A  D3  4E  7B  D3            one display line
     0059  86 FB  C0  3A  45                loop for eight lines
     005E  F8 8B  A3  F8  10  D3            display filled

     0064  3F 64  3E  77                    ENTER opcode or EF=3
     0068  F8 8B  A3  F8  8D  A6            EF3=1, put flag and change
     006E  F8 11  D3  2E  6C  5E            byte
     0074  1E 30  33                        inc display and loop for more

     0077  F8 8B  A3  F8  8D  A6
     007D  F8 12  D3
     0080  6C FB  00  3A  87                opcode 00
     0085  30 35                            shift display up

     0087  6C FB  01  3A  90                opcode 01
     008C  2E 2E  30  35                    shift display down

     0090  6C FB  02  3A  97                opcode 02
     0095  30 33                            single step display

     0097  6C FB  03  3A  9E                opcode 03
     009C  30 27                            change display address

     009E  6C FB  04  3A  B3                opcode 04 (TV off)
     00A3  61                               run program at :
     00A4  2E 9E  B0  8E  A0                ENTER high address
     00A9  37 A9
     00AB  D0                               ENTER low address
     00AC  00 00  00  00
     00B0  00 00  00                        R0 is pgm. ctr.

     00B3  6C FB  05  3A  64                opcode 05 (TV off)
     00B8  F8 01  BA  F8  EB  AA            move block of memory
```

FOR THE EXPANDED ELF

Permits easy machine-language input to an 1802-based system

```
00BE  61 22 EA 37 C1
00C3  3F C3 37 C5          ENTER beginning add. of data
00C7  6C B9                to be moved (high byte)
00C9  3F C9 37 CB          ENTER (low byte)
00CD  6C A9
00CF  3F CF 37 D1          ENTER last add. of data to
00D3  6C 1A                be moved (high byte)
00D5  3F D5 37 D7          ENTER (low byte)
00D9  6C 2E
00DB  49 5E 1E 89 F3 3A DB
00E2  2A 99 F3 1A 3A DB
00E8  49 5E 30 25          return for display

TABLE: DIGIT CONFIGURATION
0100  35 2B 2F 39 27 31 41 51
0108  43 45 56 49 3D 4D 20 24
0110  5B 60 66 65 00 00 00 00
0118  00 00 00 00 00 00 00 00
0120  F0 80 C0 80 F0 80 C0 80
0128  80 A0 F0 20 60 20 20 70
0130  10 F0 80 F0 10 F0 90 90
0138  90 F0 10 70 10 F0 80 80
0140  80 F0 80 F0 90 F0 90 F0
0148  10 F0 50 70 50 F0 50 50
0150  50 F0 10 20 40 40 F0 90
0158  F0 90 90 2F 25 25 A5 EF
0160  F8 7C 3E 7C F8 00 00 00
0168  00 00 AA 00 00 00 00 00
0170  00 00 00 00 00 00 00 00
0178  00 00 00 00 00 00 00 00

SUBROUTINE: DIGIT MAKER
0180  D4
0181  39 87                 Q state identifies hi/lodigit
0183  FE FE FE FE
0187  F6 F6 F6 F6
018B  A8 08 A8             enter here for single digit
018E  F8 05 A7             R5 counts 5 lines per digit
0191  48 56
0193  86 FC 08 A6 3B 9D
0199  96 FC 01 B6
019D  27 87 3A 91
01A1  86 FF 27 A6 33 AB
01A7  96 FF 01 B6
01AB  86 FE FE FE FE
01B0  32 B6 FB 80 3A C0
01B6  86 FC 30 A6 3B C0
01BC  96 FC 01 B6
01C0  96 FB 04 3A 80

SUBROUTINE: TV INTERRUPT
01C7  72 70
01C9  C4 22 78 22 52
01CE  F8 02 B0 F8 00 A0
01D4  C4 C4 E2 80
01D8  E2 20 A0 E2
01DC  3C D7
01DE  80 E2 20 A0 2F
01E3  34 DE 30 C7
```

creating may "eat" the operating program space, so keep the operating program on cassette.

To move a block of memory, address the first memory position to be changed and enter 05. Note that the display blanks. Enter the two-byte beginning address of the data to be moved, and then the two-byte ending address. The display will return when the transfer is complete. Enter a two-byte address to get back in the operating program.

The program uses two subroutines. The TV interrupt routine (M01C7) is a standard 512-byte display for the 1861 chip. The digit maker routine (M0180) provides functions useful in any display requiring hex digits, and has two entry points. If entered at M0181, it will display a digit corresponding to the high or low half byte present in the D register. The main program sets buffer pointer R6 to the position of the upper left corner of the digit in the display, and sets the Q line to specify whether the high or the low digit is to be displayed. Before a D3 is executed, R6, D, and Q must be set and the subroutine leaves R6 pointing to the next digit position in the display. The main program uses the subroutine at M003F-FD to create the display. The routine may also be entered at M018B to produce a symbol or digit of your own design. Following the operations for the pointer at M0068-71 will reveal how this works, and space is provided in the configuration table at M0170-7F.

This program does not alter itself and could be put into ROM. There are, however, three bytes of storage at M01E8-EA which would need to be moved. Putting them at the bottom of the display buffer M03xx will add a line of dancing dots and dashes to the display. Registers R2 and RA point to this storage.

The ability to scan memory and to move stacks makes machine language easier to edit and debug. Keep your loop addresses and X designators straight and you can say almost anything to the 1802 . . . in its own language. ◇

SOLID-STATE DEVELOPMENTS

By Forrest M. Mims

The Billion Transistor Chip?

YOU have probably read about ENIAC, the pioneering electronic digital computer built during World War II. This enormous machine, which filled a room the size of a small house, used 18,000 vacuum tubes, 70,000 resistors, 10,000 capacitors and 7,500 relays and switches. ENIAC weighed 30 tons and consumed 140,000 watts of power.

ENIAC was first operated in November 1945, about the time the average reader of POPULAR ELECTRONICS was born! The Army's Ballistic Research Lab. used the machine from 1946 until it was disassembled in October 1955.

Remarkable advances have been made in computer technology since the power-hungry ENIAC first began making the lights flicker around the University of Pennsylvania, but the basic operating principles of digital computers have not changed much. They still process instructions and data in much the same way they did back in the early 1950's. However, the components and peripherals of today's computers have changed dramatically.

Consider those 18,000 tubes in the old ENIAC: they were the reason ENIAC consumed so much power. There was

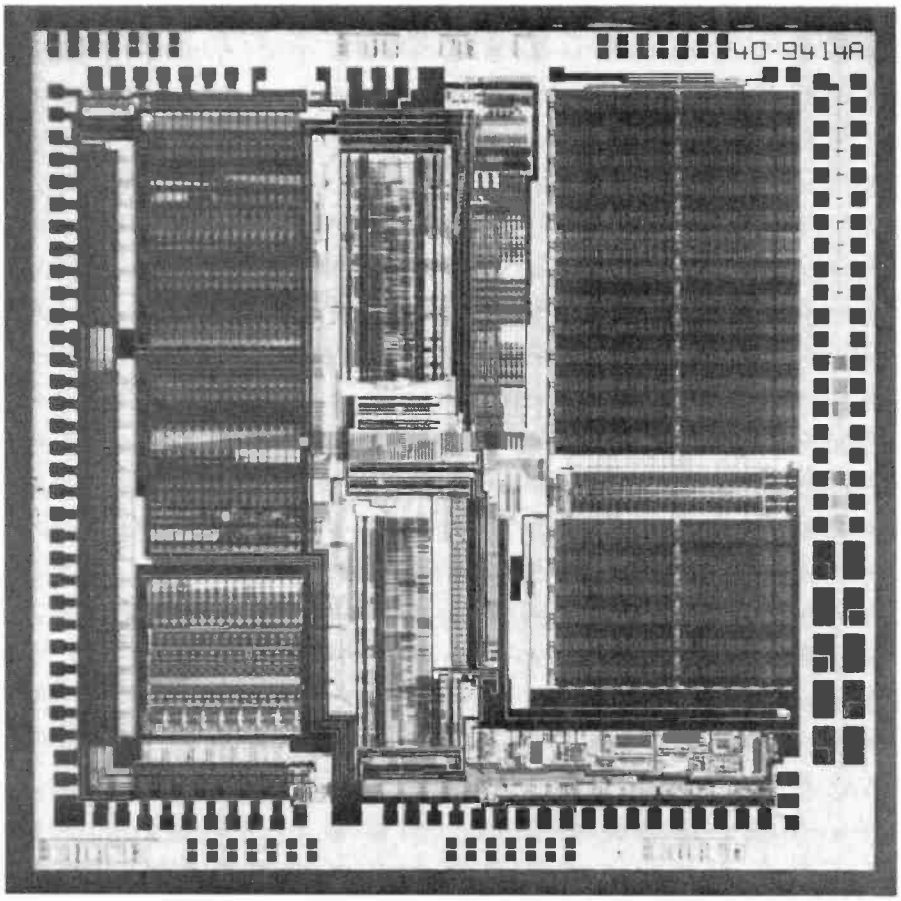


Fig. 1. Photomicrograph of Hewlett-Packard's new CPU containing 450,000 transistors on a single chip.

even a prediction by one skeptic that the mean time between tube failures would be so brief the computer would operate in short spurts between lengthy delays to find and replace burned-out tubes.

Solid-state switching circuits long ago reduced the power appetite of computers to manageable levels. And, they continue to make possible an amazing degree of miniaturization. Incredible as they are, today's crop of single-chip microcomputers are but a hint of what's to come in the future.

A 450,000-Transistor Microcomputer. One of the latest marvels of miniaturization is the silicon chip whose photomicrograph appears as Fig. 1. This chip, which measures only one-quarter inch on a side, contains 450,000 transistors and functions as the central processing unit of what may be the most powerful 32-bit microcomputer yet developed.

Scientists at Hewlett-Packard's Desktop Computer Division (3404 East Harmony Road, Fort Collins, CO 80525) developed the new CPU chip along with a series of compatible VLSI (very large scale integration) devices containing up to 600,000 transistors per chip. The latter devices include an I/O processor, memory controller, 128K-byte RAM and 528k-byte ROM. Interconnecting these chips provides a complete 32-bit microcomputer.

As significant as the number of transistors per chip is the achievement of interconnections only 1.5 micrometers wide and 1 micrometer apart. To place these tiny dimensions in perspective, a micrometer is twice the wavelength of green light.

The ultranarrow interconnection paths cause current densities too high for the conductors used in ordinary integrated circuits. Therefore, the Hewlett-Packard scientists used tungsten metallization on their chip.

Other VLSI Developments. Hewlett-Packard's new microcomputer was announced at the International Solid-State Circuits Conference (ISSCC) earlier this year. While it is a remarkable achievement, it may soon be eclipsed by technologies which offer similar component densities, consuming less power.

That's because Hewlett-Packard selected the familiar nMOS process for the new chips. Consequently the CPU chip consumes a hefty seven watts. Other companies in Japan and the United States are thinking in terms of CMOS processes which permit much higher component densities than conventional CMOS while preserving low power-consumption advantage of CMOS.

Bell Laboratories, a relative newcomer in microprocessor technology, has recently developed a 32-bit CMOS microprocessor which incorporates 100,000 transistors on a single chip. While this chip has a fourth the components of the Hewlett-Packard CPU, it consumes only 500 milliwatts.

Another big advantage to CMOS is that differential amplifiers are easily made. This simplifies the inclusion of such on-chip functions as analog-to-digital and digital-to-analog conversion.

What Next? In the mid-1960's, Dr. Gordon Moore of Intel predicted that the number of components integrated onto a single chip would double each year. Figure 2 confirms this prediction and shows that chips containing *millions* of transistors may possibly be on the horizon.

"Moore's law," as it came to be known, cannot hold forever since it would eventually require devices smaller than their constituent atoms. But look at what is already happening in the big push to make advanced CMOS chips.

Honeywell has just announced a method of forming CMOS chips of submicrometer geometry. The firm predicts its new process will permit 250,000 components to be integrated onto a single chip.

Much to the chagrin of the U.S. companies that pioneered integrated circuitry, Japanese firms are making major strides in the development of high-density CMOS. Nippon, for example, makes a CMOS version of the popular 8048 microcomputer. Toshiba and Hitachi

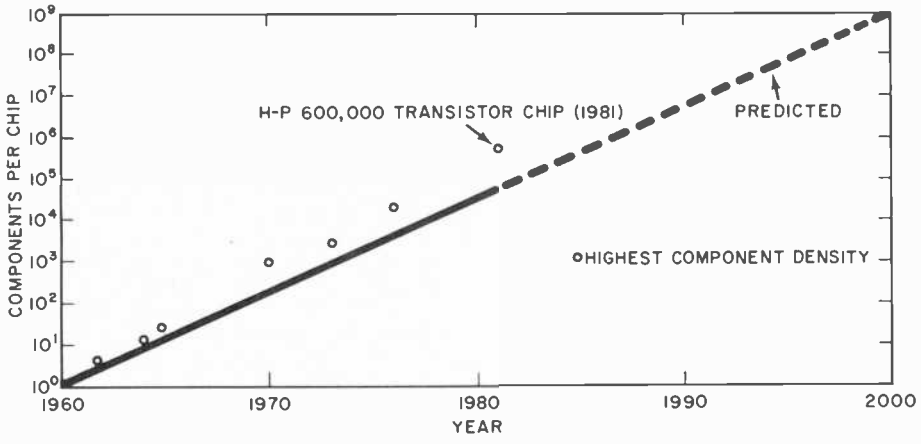


Fig. 2. Maximum number of components per chip from 1960 to the present and projected to the year 2000.

have both developed 4K CMOS memories with ultrafast 18-nanosecond access times. Advanced Japanese research on these and related topics was much in evidence at the ISSCC.

The new generation of high-density ICs will be known as *ultra-large-scale integration* (ULSI). Some of the probable specifications of futuristic ULSI chips were outlined for the ISSCC in a talk by James D. Meindl of Stanford University.

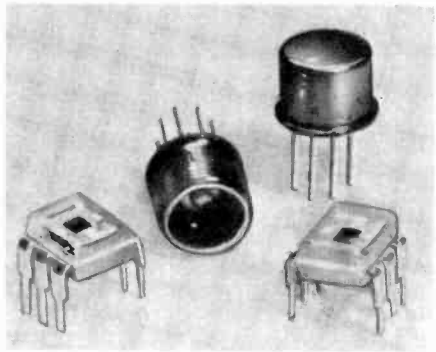
Dr. Meindl predicted we will have chips with from ten million to a billion transistors by the year 2000! According to his calculations, the size of components can be reduced to 0.25 micrometer. Assuming problems in interconnecting vast numbers of such ultrasmall components can be solved, corresponding increases in chip size provide a good potential for at least 10,000,000 and possibly 100,000,000 transistors per chip. As yet unperfected design techniques and undiscovered technologies may permit billion-transistor chips.

Applications for ULSI. The development of practical ULSI will substantially improve the outlook for such extraordinarily difficult tasks as speech recognition and signature analysis. In the latter category might be chips which will enable precise aircraft or missile identification by detailed processing of radar returns.

Another important application for ULSI will be solid-state memories having the same capacity as some of today's disk memories. Of course, access times will be much faster and physical size much smaller.

Still another major application for ULSI will be entire systems on a single chip. For example, a large mainframe computer might be scaled down to a single ULSI chip. The chip might include all interfacing circuits, several hundred-thousand bits of RAM, several CPUs, onboard analog-to-digital conversion, and other major functions.

These are exciting days indeed for solid-state electronics. I'll keep a close watch on ULSI events and keep you abreast of important developments. In the meantime, if you happen to work for a laboratory or company involved in developing LSI and ULSI chips, please ask your public relations department to put my name on their mailing list.



Integrated photodetectors with on-chip interfacing made by AEG-Telefunken.

New Photodetector ICs. AEG-Telefunken's Semiconductor Division has announced two highly sensitive integrated photodetectors with on-chip interfacing. The U123P consists of a photodetector, preamplifier, and operational amplifier monolithically integrated on a single chip. It exhibits a 15-dB signal-to-noise ratio when its detector is illuminated by a signal having a power level of only 150 nanowatts.

The U123P requires a single-ended power supply delivering from 4 to 12 volts. Its op-amp output stage provides an open-loop gain of 94 dB. The output of the preamplifier and the input of the op amp are brought out to separate pins to increase the chip's versatility.

AEG-Telefunken's second photodetector IC is designated the U102P. It is similar to the U123P, except that the op-amp output stage has been replaced with a Schmitt trigger. The U102P is supplied in a hermetic 8-lead metal can. For additional information, write AEG-Telefunken Corporation, Route 22, Orr Drive, Somerville, NJ 08876. ◇

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EXPERIMENTER'S CORNER

Experimenting with an Air Pressure Switch

By Forrest M. Mims

RECENTLY, I learned that an ultrasensitive air pressure switch is available from Edmund Scientific (101 East Gloucester Pike, Barrington, NJ 08007). I immediately ordered one and have been impressed with its capabilities.

The switch, a Honeywell Model PSF 100A, is actuated (closed) by an air pressure of only 0.02 pounds per square inch (psi). This is equivalent to the pressure of about 0.5 inch of water or a gentle puff of air from a distance of a few inches.

You might be able to purchase the PSF 100A directly from Honeywell. Otherwise, you can buy one from Edmund (Cat. No. 41,623) for $7.00, plus $1.30 for postage and handling.

The PSF 100A has two differential control ports—one for low—and the other for high-pressure operation. If one port is at atmospheric pressure (*i.e.*, open), the other will trigger the switch on pressure (high port) or vacuum (low port). If both ports are connected to external gas sources, the switch will close when the pressure difference between the two sources exceeds 0.02 psi.

Fairchild assigns a life of 1,000,000 on-off operations to the PSF 100A. Contact resistance of closed switch is 0.5 ohm.

The major drawback of the switch is its current rating of only 10 milliamperes dc. This means that, in many applications, external buffering is required. We will look at several buffering methods, as well as some practical applications for the PSF 100A shortly. First, let's review some of the applications listed in the Edmund data sheet:

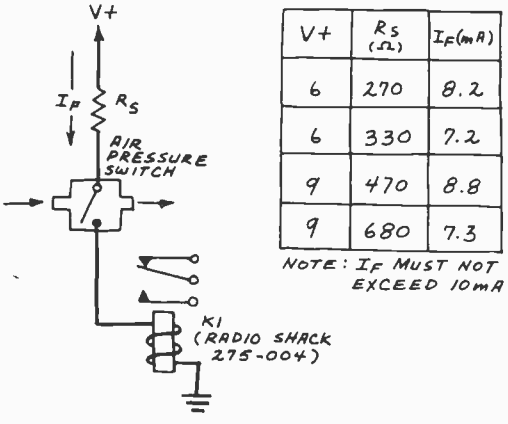
1. Replacement of vane-type flow switches.
2. High-wind detector.
3. Proximity sensor.
4. Counting sensor.
5. Clean-air system pressure-drop detector.
6. Edge sensor.
7. Fan or cooling system failure sensor.
8. Fixed-point temperature detector (in a closed system dependent upon the contraction and expansion of a fixed volume of gas).
9. Respiration rate sensor.
10. Venturi tube sensor.
11. Pressurization sensor for inflatable structures.

These applications in turn suggest others. For example, the high-wind detector idea could be used as a fixed-point airspeed indicator for a model rocket, aircraft, bicycle, or automobile. In each case, the input ports of the sensor require constriction to permit the switch to operate at higher air pressures. Or a higher threshold sensor switch can be used. Honeywell's PSF 100A-3, for example, has a switching threshold of 0.1 psi.

Buffer Circuits for a Pressure Sensor. As long as the current to be switched is less than 10 mA, the PSF 100A needs no buffering. This means the switch can directly actuate LEDs and some solid-state warning devices and alerters. For many applications, however, the rated current capacity of the PSF 100A is insufficient.

Figure 1 shows how to connect a low-current, inexpensive relay to the PSF 100A to increase its switching capability from 10 mA to a full ampere (at 125 volts). Since the relay coil current can safely exceed the 10-mA maximum rating of the PSF 100A's contacts, it is necessary to limit the current flow with an external resistor (R_S). Figure 1 gives the values of R_S for power supplies of both 6 and 9 volts which will allow the relay to pull in without exceeding the 10-mA rating.

I arrived at these values by actual measurements, and you may wish to verify my results. Though the relay coil is specified to have a resistance of 500 ohms, the unit I used actually measured 480 ohms. At 6 volts, this relay pulled in at 5.5 mA and dropped out when the current fell below 4.5 mA. Therefore, the currents given in Fig. 1 provide ample margin for proper operation of the relay.



V+	R_S (Ω)	I_F(mA)
6	270	8.2
6	330	7.2
9	470	8.8
9	680	7.3

NOTE: I_F MUST NOT EXCEED 10mA

Fig. 1. Using a relay to increase current capacity.

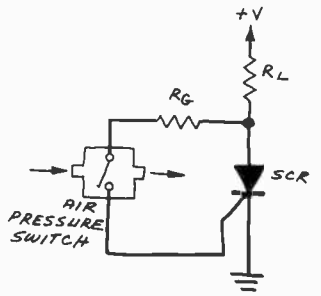


Fig. 2. An air pressure switch can be used to trigger an SCR as shown here.

Figure 2 shows how the PSF 100A can be used to trigger an SCR. The pressure switch is simply inserted in the SCR's gate circuit. Resistor R_G should provide ample SCR gate current while limiting the current through the switch.

Incidentally, remember that a triggered, dc-powered SCR stays on even after the gate signal is removed. Only when the forward current falls below what is termed the minimum required *holding current* does the SCR turn off. This occurs, of course, when the load is temporarily disconnected. It also occurs on the negative transition of an ac voltage.

Optoisolating the PSF 100A will electrically isolate the

sensor from the circuit being controlled. Figure 3 shows how the PSF 100A is connected to the LED portion of a LED-phototransistor optoisolator (also called an optocoupler).

Current-limiting resistor R_S must be selected to limit the current through the LED, and therefore the PSF 100A, to less than 10 mA. The appropriate series resistance can be found with the simple formula: $R_S = (V_F - V_{LED})/I_F$, where V_F is the forward voltage, V_{LED} is the LED forward voltage, and I_F is the desired current in amperes.

GaAs LEDs having a forward voltage from 1.2 to about 1.8 volts are used in most optoisolators. Inserting a typical V_{LED} of 1.5 volts and a desired I_F of 5 mA into our formula gives the following values of R_S for a range of forward voltages:

V_F	R_S
3	300
4	500
5	700
6	900
7	1,100
8	1,300
9	1,500
10	1,700
11	1,900
12	2,100

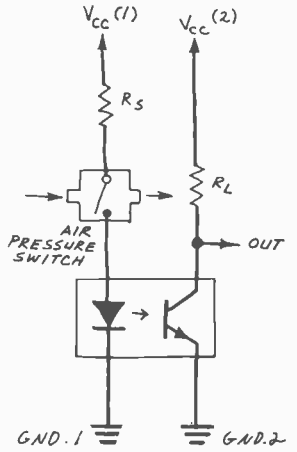


Fig. 3. The air pressure switch can be isolated from the controlled circuit by an opotoisolator.

Application Circuits. Having explored the operation of the PSF 100A and seen how its contacts can be buffered, we can now use the switch in practical applications. I've designed three circuits with biomedical applications in mind. Remember that these circuits are merely representative of the ways the PSF 100A can be applied. You can use the same techniques for applications of your own.

Puff/Sip Multi-Channel Controller. Several years ago I read about an electric wheelchair that could be controlled by puffing or sipping on one or more tubes connected to air pressure switches. The same method was used to turn on lights and appliances.

Figure 4 shows one way to implement a "puff/sip" controller. The circuit provides up to five channels of on-off control. More channels can be added by expanding the basic circuit.

The CMOS decade counter (*IC2*) is a 4017 with self-contained 1-of-10 output decoding. In operation, a clock formed by two NAND gates in *IC1* repeatedly cycles *IC2* through each of its ten outputs. The five control channels, only one of which is shown in Fig. 4, are provided by adjacent pairs of decoded outputs from *IC2*.

Channel 1 is controlled by pins 3 and 2 of *IC2*. At the beginning of a count cycle, pin 3—the lowest order decoded output from *IC2*—goes high while all other outputs remain low. This turns on Channel 1's ON LED, notifying the operator that the device or appliance controlled by Channel 1 can

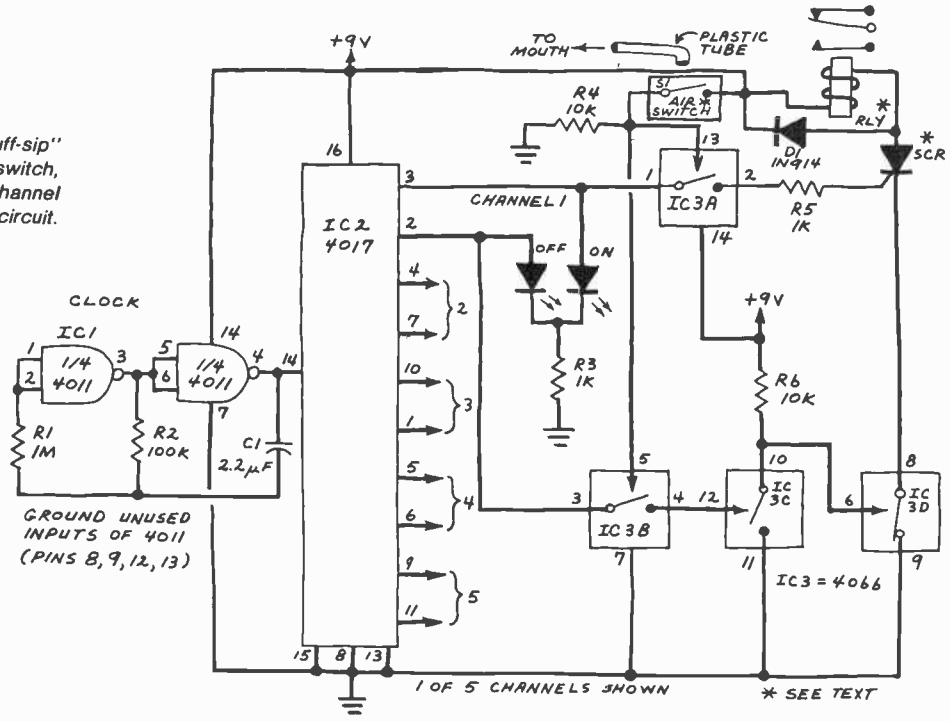


Fig. 4. A "puff-sip" single-switch, multi-channel controller circuit.

be turned on by puffing or sipping on the plastic tube connected to the circuit's single PSF 100A air switch. Depending upon the value of *C1*, the operator has up to a second to operate the air switch. If more time is required, the value of *C1* can be increased at the expense of slowing down the control cycle.

Whether or not the air switch is closed when Channel 1's ON LED is glowing, the clock eventually advances *IC2* to

decoded output two (pin 2). This turns on Channel 1's OFF LED and notifies the operator that the device or appliance controlled by Channel 1 can be turned off by puffing or sipping on the air switch's tube. Again, whether or not the switch is closed, *IC2* continues to advance through the decoded outputs as the clock supplies pulses. If the switch is *not* closed, the controlled device or appliance remains either on or off.

The four transmission gates in a single 4066 analog switch (*IC3*) provide the necessary control logic for a single channel. If the air switch is closed when Channel 1's ON LED is glowing, *IC3A* closes, firing the SCR and pulling in the relay.

If the air switch is closed when Channel 1's OFF LED is glowing, *IC3B* closes. This, in turn, closes *IC3C*. Switch *IC3D* is normally in the closed state due to the voltage drop across *R6*, but when *IC3C* closes, the control pin (6) of *IC3D* goes to ground. This opens the current path through the SCR, turning off the SCR and allowing the relay to drop out.

When *IC2* advances to the next decoded output, *IC3B* and *IC3C* open and *IC3D* is again closed by the drop across *R6*. The SCR can then be triggered by a puff or sip the next time Channel 1's ON LED is glowing.

I used a low-current relay (Radio Shack 275-004) in the prototype of the circuit. The SCR can be any low-voltage, economy-grade unit.

Follow the circuit used for Channel 1 to add additional control channels. The PSF 100A in Fig. 4 should be connected to pins 5 and 13 of each additional channel's 4066. This permits one switch to control all channels. Connect the mouth tube to the switch's HIGH port for puff operation or the LOW port for sip operation.

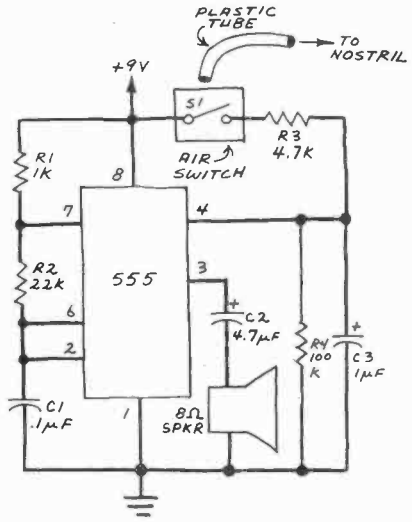


Fig. 5. Respiration indicator provides audible signal.

Caution: Do not exceed the relay's contact ratings. Avoid shock hazards by powering the circuit with a 9-volt battery and carefully insulating connections to the relay's contacts.

Respiration Indicator. The circuit in Fig. 5 provides a brief tone burst each time a person or animal being monitored inhales or exhales. The circuit is a straightforward 555 astable oscillator whose frequency is controlled by *C1*.

When the PSF 100A air pressure switch, *S1*, is open, the 555's reset input (pin 4) is held low by *R4* and the oscillator is disabled. When *S1* is closed, pin 4 of the 555 is made high via *R3* and the oscillator is enabled. Simultaneously, *C3* is charged through *R3* to the battery voltage. When *S1* is opened, pin 4 is held high by the charge on *C3* until it discharges through *R4*. The oscillator is then disabled.

The tone frequency of this circuit can be increased (or decreased) by reducing (or increasing) the value of *C1*. The length of the tone burst can be extended by increasing the value of *C3*, or the extended tone burst can be eliminated entirely by removing *C3*. The circuit will continue to provide a tone for each respiration cycle.

I tested the circuit by taping a length of flexible aquarium

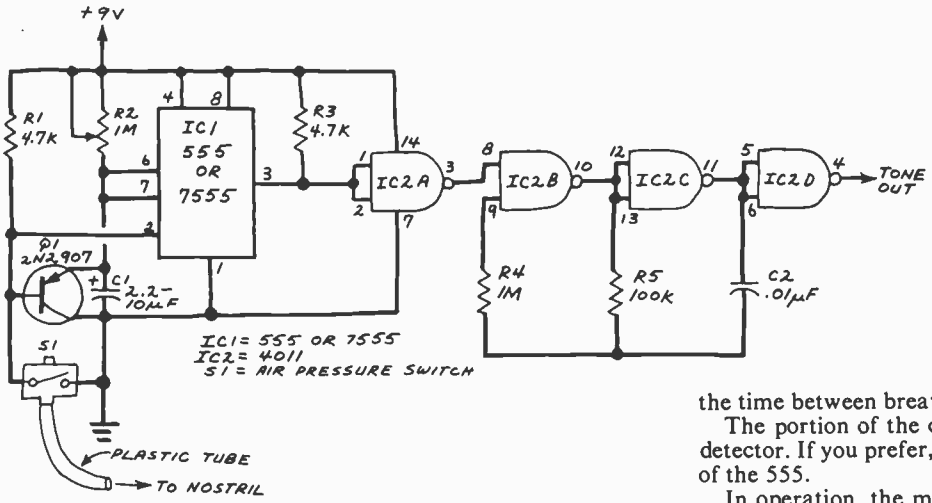


Fig. 6. This circuit monitors respiration and emits a warning tone when time between breaths exceeds a predetermined interval.

tubing under one nostril. When the remaining end of the tubing was attached to the PSF 100A's LOW port, the circuit beeped each time I *inhaled*. When the tube was connected to the HIGH port, the circuit beeped when I *exhaled*. Try both operating modes if you build the circuit.

This circuit provides a simple way for recording the breathing rates of animals for study and evaluation. It can also be used with human subjects such as athletes. It should be used with seriously ill patients only under medical supervision. In any case, power the circuit with a 9-volt battery or an isolated line-operated supply to avoid electrical shock.

Respiration Failure Alarm. When used under proper medical supervision, the circuit in Fig. 6 can save a life. It continuously monitors respiration and emits a warning tone when the time between breaths exceeds a predetermined interval.

The portion of the circuit involving *IC1* is a missing pulse detector. If you prefer, you can use a 7555, the CMOS version of the 555.

In operation, the missing pulse detector is reset each time *S1*, a PSF 100A air switch, is closed. Resistor *R2* controls the maximum time allowed between reset pulses. If the circuit is not reset before the allowed time expires, pin 3 of the 555 goes low. This actuates an astable oscillator made from *IC2B* and *IC2C*. If the 555 is subsequently reset, the oscillator will be disabled. Otherwise the oscillator will provide a continuous warning tone. The frequency of the warning tone can be changed by changing the value of *C2*.

You can test this circuit by using a length of aquarium tubing as described in the previous section. Be sure to power the circuit with a 9-volt battery or isolated line supply to avoid the possibility of electrical shock. Like any biomedical electronic device, the respiration failure alarm should be used with seriously ill patients only under medical supervision.

Reader's Comments. The April 1981 installment of this column attracted a number of interesting letters. As you may recall, that column concerned electronic aids for the handicapped. Frank Cuta, an electrical engineer at Battelle Northwest Laboratories, wrote that while he appreciated the column, "... the tone of the article tends to appeal to the nonhandicapped person ... It would do a heap of good if you would mention in your next article on this subject that you expect the information to be used by technically inclined handicapped persons as well. It promotes a positive image of handicapped people and their capabilities."

Mr. Cuta, who happens to be blind, is right. I hope his suggestion will encourage both disabled and nondisabled readers to build the projects which appear in this column.

The former chief engineer at a radio station wrote to describe his experiences with a blind operator who was able to operate sophisticated equipment with the help of various LED indicators and a light probe. He also "... used his light probe to 'see' the moon for the first time in his life ... Here's hoping that articles such as Mr. Mims's will stimulate some thoughts on interfacing the world to people who might otherwise sit around all their lives. ..."

This reader had a suggestion of his own: "I've noticed that many elevators now have the floor selector buttons labelled in Braille. The problem is that even though the blind person can select the proper floor, he cannot know for sure which floor the elevator has stopped at. What a place for an annunciator. It could say something as simple as 'third floor' or as elaborate as 'fifth floor: ladies hosiery, lamps, tables and lights.' "

This is an excellent suggestion. I'll be glad to pass along other ideas in future columns. If you wish to make a suggestion, please give permission for its use. Also, clearly print (or type) your name and address. Names will be omitted upon request. ◇

DX LISTENING

By Glenn Hauser

Strikes Disrupt International Broadcasting

Radio Canada International was forced off the air in May by labor disputes. Though unable to originate newscasts in any language, *RCI* was able to continue broadcasting English-language news programs coming from Toronto, which had already been scheduled. *RCI* did not carry any additional newscasts from Toronto, but played fill music instead.

Kol Israel was also hit by labor difficulties in May. It was forced to substitute fill music for regularly scheduled programs, except the news, which continued as usual. ("Usual" meaning that the news on the 0000, 0100, and 0200 GMT broadcasts was tape-delayed from 2230.)

Radio Andorra faced an even more serious situation at the end of March when its 20-year license expired. The station had been dominated by Spanish and French interests, resulting in little programming which served Andorra itself. The Andorrans wanted it to be a station of their own; it went off the air pending resolution of the conflict.

Radio New Zealand has been struggling to keep its shortwave service going, despite the drawbacks of two antiquated 7½-kW transmitters. Several times over the past few years, it has submitted plans to get new higher-powered transmitters, only to have them turned down by the N.Z. government. The latest proposal is for a site adjoining a naval transmitting facility, with four 50-kW transmitters. If this is also turned down, *Radio New Zealand* threatens to give up shortwave altogether. Not having a big signal means that stronger stations do not respect its frequencies. In late May, the *Voice of America* went on 17860 in the 0000-0400 GMT period; an unidentified utility frequently overcomes 15485; *HCJB* and *Radio Peking* block 11945 after 1130 GMT; and *RNZ*'s old 49-meter channel of 6105 can no longer be used because of television-interference complaints near the transmitter site.

Not all the news is bad. The *Voice of Germany*, *Radio Deutsche Welle*, is reportedly expanding its North American service in English to 50-minute programs in September, after several years during which *DW* considered its North American English-speaking audience worthy of no more than 20 or 30 minute programs. The man to thank is *DW*'s new director, Klaus Schütz, though his predecessor, Conrad Ahlers—who died unexpectedly in December—started the move.

New Orleans' new shortwave station, *WRNO*, should be on the air by September if its transmitter and antennas were delivered as planned in late June. Unlike all other U.S. shortwave broadcasting stations, which are either governmental or missionary, *WRNO* will be a commercial rocker. It registered this tentative schedule for September and October: 1830-2100 GMT on 15175; 2100-2300 on 11890; 2300-0200 on 11965; 0200-0700 on 6155. Meanwhile, *Radio Portugal* has started using 6155 for its broadcasts to North America; and the *Austrian Radio* will no doubt object to 6155, which it also uses toward the end of *WRNO*'s projected schedule.

Two Pacific Islands which had been difficult-to-impossible to hear in North America burst upon the scene this year. *Radio Kiribati* fired up a single-sideband unit on 16433 kHz, to feed its programs to another island under the same administration, Christmas Island (the one in the Pacific). They picked up an audience in North America, too, in the 0600-0900 time period; the first half of the program is in English (including BBC transcriptions), the second in Gilbertese (or Kiribati).

Radio Cook Islands had at least been on shortwave, usually 5045 kHz, but still faced a considerable challenge until it moved to 11760 kHz, also at 0600 past 0900. During the summer, this frequency happened to be clear after Havana signed off, but this fluke cannot be expected to continue, nor can *Radio Cook Islands* be depended upon to stay on this frequency.

Those still seeking a Pacific DX listening challenge should try for this one: "3RPH," Radio for the Print Handicapped, in Melbourne, Australia, on the unusual frequency of 1705 kHz. Such stations in the U.S. operate on FM subcarriers, but Australia has taken a different route since its FM broadcasting

system is not fully developed. This is a volunteer-operated station with 500 watts, active initially in the local evenings (and heard at 1130 GMT by Arthur Cushen in New Zealand), but planning to expand to 24-hour transmission. Similar stations on nearby frequencies are expected soon in Brisbane, Sydney and Hobart. Now is the time to try for them in North America because, in a few years, this frequency range will be smothered by an expanding domestic AM band.

Two Caribbean islands have new mediumwave stations operated by American interests. The *Voice of America*'s English service to the Americas is now available on AM radios, thanks to a 50-kilowatt transmitter on 1580 kHz from Antigua. It could be heard in the U.S. itself before its directional antenna was finished, in the 0000-0400 GMT period. And on Anguilla, Quality Media Corp. has gone on the air with "The Caribbean Beacon" on 690 and 1610 kHz. It's a gospel station, mostly in English, but with Spanish reported at 0300-0330 by Maxfield Greenwood in Maine.

Anti-Castro Cubans in Florida must now feel freer to put clandestine radio stations on the air, since a U.S. attorney refused to prosecute one such operator, much to the chagrin of the FCC. Currently the most reliable and professional anti-Castro station is *Radio Cuba Libre*, which says it is run by the Cuban Christian Democratic Movement. Half-hour broadcasts start at 11 p.m. (ET) on 6989 kHz (announced as 6990), on Thursdays and Sundays.

Ironically, in June, the Senate approved a regulation proposed by Sen. Jesse Helms (R, NC), requiring the *Voice of America* to identify *its* broadcasts to Cuba as "Radio Cuba Libre." But since "Cita Con Cuba" was dropped several years ago, *VOA* broadcasts in Spanish have been for Latin America in general. This includes those on 1180 kHz from Florida, for which the main target is Cuba.

Radio Quince de Septiembre, the clandestine station opposing the Sandinist government in Nicaragua, operated freely and clearly at 0400 GMT each night on 5565 kHz until the Sandinists apparently decided to jam it in late May. After that, the station and the jammer began playing cat-and-mouse, jumping from one frequency to another in that area, such as 5555 and 5570. Of course, this also disrupts aeronautical communications allocated for this band.

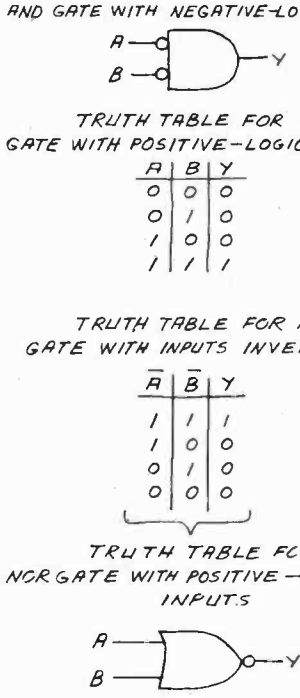
Rádio Nacional, Brasília, provides a pleasant respite from rhetoric and noise, especially on its "Sunday Special" programs at 0200-0300 (GMT Mondays) on 17830 and 15290. Talk and music-oriented specials alternate: scheduled for Aug. 9, Carmen Miranda; Aug. 16, Brazilian Coffee and Its History; Aug. 23, Brazilian Country Music; Aug. 30, History of the Brazilian Republic.

For more background information on broadcasting around the world, tune in Austrian Shortwave Panorama, GMT Mondays at 0434, on 12015 kHz. ◇

TIPS & TECHNIQUES

Negative Logic Gates

An experimeter who is accustomed to reading schematics containing positive-logic gate symbols might be confused when a gate symbol with negative-logic inputs turns up. Here's a simple way to



decipher those gates. Draw a truth table for the gate, ignoring the inverted inputs, as shown here (see figure). Then invert inputs on the truth table. Determine which type of gate fits this truth table. The truth table with the inverted inputs is that for a NOR gate with positive-logic inputs, which is the actual gate used in such a circuit.—*John Fobel, Ontario, CA.*

Low-Cost Holders for Soldering Irons

Small clay flower pots (about 4 in. diameter) make good, inexpensive holders for soldering irons. The pot is simply inverted and the iron tip inserted into the drainage hole. Because of its wide base, the holder is very stable; and, since the material is a poor heat conductor, it can be put on a finished table or desk top without causing damage to the finish. Needless to say, the flower pot costs only a fraction of an ordinary soldering-iron holder.—*F. Penicka, Mississauga, Ontario, Canada*

ELECTRONICS LIBRARY

TRS-80 BASIC

by Albrecht, Inman & Zamora

This book has been written so that even a beginner can teach himself how to read, write, and program in BASIC on the TRS-80 microcomputer. The "programmed-instruction" format first introduces a topic and follows it with one or more questions, answers for which immediately follow the questions. Review questions at the end of each chapter allow the reader to gauge his progress. Games, graphics, learning tools, and home management applications are given to illustrate programming techniques. Since the book's main thrust is the BASIC language itself, procedures for setting up the TRS-80 and use of a cassette recorder in the system are in separate appendices.

Published by John Wiley & Sons, Inc., 605 Third Ave., New York, NY 10016. Soft cover. 351 pages. $8.95.

How to Repair CB Radios

by Lawrence E. Schultz

If any of you bodacious CBers are having trouble getting your ears on, here is a straightforward guide to CB troubleshooting and repair. In addition to examples of commercially available equipment, hints are given on how to build your own equipment and accessories. Written from a service technician's point of view, the manual provides a description of the circuitry in both 23- and 40-channel CB radios. Also covered are power supplies, distribution systems, antennas, transmission lines, and single-sideband radios.

Published by McGraw-Hill Book Co., Gregg Div., New York, NY. Soft Cover. 192 pages. $9.95.

Video/Computers

by Charles J. Sippl & Fred Dahl

Almost every American household contains video and audio terminals—the television set and telephone. These terminals can be interfaced with a number of devices, most importantly, the microcomputer (or computer terminal) and the VCR. If you're interested in imaginative ways to combine this technology, this book may be a good source of ideas. Simple sketches show how things work, and configuration diagrams help you develop your own construction projects. Hardware is listed by manufacturer, with an overview of basic specifications.

Published by Prentice-Hall, Inc., Englewood Cliffs, NJ 07632. Hard cover. 246 pages. $15.95.

Interrelated Integrated Electronics Circuits

by R.M. Mendelson

Here's a book for the project builder. It contains details for building a diversity of interesting electronic projects, including power supplies, amplifiers, passive circuits, test and measurement instruments, and electronic games. All told, there are 25 projects. Among the items you can build are an audio mixer, SSB detector, resistance boxes, portable DMM, battery-powered frequency counter, electronic dice, and a digital roulette "wheel." Each project is fully described, accompanied by circuit description, schematic diagram, parts list, component-layout diagram, hints on construction, and photo of the finished project. Etching-and-drilling guides for each project are contained in the appendix at the back of the book.

Published by Hayden Book Co., Inc., 50 Essex St., Rochelle Park, NJ 07662. Soft cover. 128 pages. $6.95.

NEW LITERATURE

Heathkit Catalog

The new 104-page catalog from Heath includes; in addition to the company's standard kits for amateur radio, stereo, and test equipment, new kits for a 2-meter amplifier, a deluxe antenna tuner, a cordless digital wall clock, and a speedometer/trip log for boats. An educational section includes self-study courses in computer programming, microprocessors, optoelectronics, and hobby electronics. **Address:** Heath Co., Dept. 350-800, Benton Harbor, MI 49022.

PC Drafting Manual and Catalog

Catalog No. 107 from Bishop Graphics describes, in 200 pages, the company's line of pressure-sensitive aids for printed-circuit design and other drafting products. Among methods illustrated are the use of overlay drafting to achieve the accuracy of computer-aided techniques while maintaining the flexibility of manual layout. Also featured are 20,000 printed-circuit drafting aids to create precision pc artwork masters. **Address:** Bishop Graphics, Inc. 5388 Sterling Center Dr., Westlake Village, CA 91359.

Solid-State Replacement Guide

The 1981 RCA SK line of solid-state replacements are listed in a new guide covering 1,300 devices which replace 170,000 domestic and foreign types. Included are transistors, rectifiers, thyristors, integrated circuits, triplers, etc. The 408-page Guide (SPG-202Z) is $2.25 from RCA distributors or RCA Distributor and Special Products, Box 597, Woodbury, NJ 08096.

US GPO Catalog

The US Government Printing Office has assembled a brochure describing 23 titles of publications on the subjects of radio and electronics. Ranging in price from $1.90 to $7.70, the publications cover subjects as diverse as "Basic Electronics" to "Repair of FM Transmitters and Receivers" and "Cathode-Ray Tubes and Their Associated Circuits." The catalog, "Radio and Electronics," can be obtained free from the Superintendent of Documents, Washington, DC 20402.

Miniature Tool Catalog

Catalog C-8010 describes the Moody line of miniature screwdrivers, sockets, hex key wrenches, drills, and taps available in sets and kits. Tools are interchangeable in a solid-locking, chuck-type, knurled handle and are intended for work on models and electronics. **Address:** Moody Tools Inc., 42-60 Crompton Ave., E. Greenwich, RI 02818.

Guide to Loudspeakers

Dahlquist Inc. has published an 8-page brochure called "Hearing and Believing," which describes, in nontechnical language, the theory and proper use of loudspeakers. It discusses such topics as "Spectral Balance," "Imaging," "Dynamic Range," "Driver Blending," and "Practical Hints." **Address:** Dahlquist Inc., 601 Old Willets Path, Hauppauge, NY 11787.

Variable Resistive Devices

"A Guide to Understanding and Specifying Variable Resistive Devices" gives, in 22 pages, performance parameter charts of trimmers and control and pre-

cision potentiometers to help the user choose the best device for his application. A series of schematic diagrams shows how each component is applied in particular circuits. **Address:** Variable Resistive Components Institute, 3451 Church St., Evanston, IL 60203.

CB Antenna Catalog

Featured in a new catalog of CB and scanner antennas from Avanti are two glass-mounted, ½-wave units designed for easy mounting on the window or any other smooth surface. Other models include the Moonraker and various base station antennas, plus rotators. **Address:** Avanti Communications, 340 Stewart Ave., Addison, IL 60101.

Mount-Anywhere Sound Cabinets

A 4-page brochure describes two models of the Advantage sound cabinets, featuring Jensen Triax speakers and Advantage Bass Resonator PortHoles. The cabinets are designed to be mounted in any type of vehicle or at home and can also be removed for use out-of-doors. **Address:** Advantage Sound Systems, Inc., Box 970, Jonesboro, AR 72401

Video Production Catalog

A 20-page publication "Video Update" provides information about video production, editing, and use of several new devices in the video field. For example, the Special Effects Keyer adds color titles and graphics to color videotapes during editing. Two devices enable video producers to use an Apple computer as color graphics generator. Request on letterhead, including $1.50 for postage and handling from: Adwar Video, 100 Fifth Ave., New York, NY 10036.

Assembly Tool Catalog

The Contact East 1981 Catalog offers a guide to over 10,000 products in the areas of hand tools, soldering and desoldering equipment, multimeters, oscilloscopes, anti-static material, test probes, and field service tools. **Address:** Contact East, Inc., Box 160, 7 Cypress Dr., Burlington, MA 01803.

Car Stereo Installation

A 46-page booklet entitled "How to Install a Car Stereo," from Pioneer Electronics, includes sections on wiring, noise problems, speaker mounting, antennas, and power sources. Helpful drawings give installation and dimensional details. Available at Pioneer dealers and from: Pioneer Electronics of America, 1925 E. Dominquez St., Long Beach, CA 90810 with a SASE.

Electronic Instrument Rental

A new 64-page catalog lists over 1,500 electronic test instruments available for monthly rental. Included are oscilloscopes, recorders, logic analyzers, microprocessor test systems, power meters, X-Y plotters, etc. Also computer peripherals such as line printers, ERTs and modems. Delivery is available from eight inventory centers. **Address:** Continental Resources, Inc., 175 Middlesex Turnpike, Bedford, MA 01730.

FCC Regulations on EMI

"The FCC and You" is the title of a booklet published by Sierracin/Power Systems to describe the new FCC regulations governing EMI emissions as they apply to computer devices. Directed primarily toward the computer manufacturer, the rules are of interest to users in that they include topics such as devices affected, what the restrictions are, rule enforcement and penalties, EMI emission levels, etc. **Address:** Sierracin/Power Systems, 20500 Plummer St., Chatsworth, CA 91311.

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.)

Jackson model 112 capacitor tester. Need operating manual, schematic and parts list. Tom Hirsch 846 N. Oliver, Wichita, KS 67208.

Ampeg model B-25 amplifier. Need schematic diagram and any other available information. William McGuire, 162 Brookhaven Ave., Cincinnati, OH 45215.

Knight model 290 FM stereo tuner. Need schematic and service data. R.L. Willard, 111-10th St., New Orleans, LA 70124.

General Electric model FE53JC radio. Need manual and schematic. James Zacher, 121 Hilton Pl., Elgin, IL 60120.

Hallicrafters SX-122 receiver. Need operations manual, schematic and any other available information. Ronald S. Rubin, 1722 Canterbury Circle, Casselberry, FL 32707.

Clarion model 30600 "Privateer" CB. Need schematic and service manual. Joe Chew, Box 2469, Campus Station, Socorro, NM 87801.

Allied star roamer. Need assembly instructions. Tom Pridmore, Box 2095, Melbourne, FL 32901.

Admiral model 394-11B, serial #A308695 radio. Need schematic and dial face. Robert E. Hopkins, 123 W. Marseille Dr., St. Louis, MO 63129.

Precision Apparatus Co., Inc., model E200C signal generator. Need schematic, parts list, and manual. Bill Pechter, 134 Juniper Dr., Freehold, NJ 07728.

Hallicrafter S-85 receiver. Need operating manual and schematic. S.M. VanZant, 166 S. Madera Ave., #63, Kerman, CA 93630.

Kintel model 202BR dc microvoltmeter, serial #2276. Need schematic or manual. Dan Amen, Route 1, Pawnee, OK 74058.

DSI Instruments model #5500 frequency counter. Need schematic. R. Craig Bracken, Rt. Box 64A, Davenport, WA 99122.

Waico Electronics Co., model WA75 transmitter. Need schematic and operating manual. Curtis E. Frazier, 92 West Main St., Rockville, CN 06066.

Sears & Roebuck model 280-626-730 CB/FM radio. Need schematic diagram. Frederick J. Darling, Jr., Box 549, Ayer, MA 01432.

Philco BC221-E frequency meter. Need high band coil, part #22. William J. O'Meara, 807 E. Seminary Ave., Towson, MD 21204.

Hallicrafters model S-40A receiver. Need operation manual, schematic, and service manual. C.H. Nelson, 4712 School, Yorba Linda, CA 92686.

Precision model 10-54 Test Master. Need schematic, operation manual and parts list. B. Robinson, 75-E Nelson Pt. Road, Indian Head, MD 20640.

Tektronix model 511D oscilloscope. Need manual. James A. McCoy, 2734 E. 6th St., Casper, WY 82601.

Realistic DX150 Allied Star Roamer. Need schematic diagram, alignment instructions, and assembly instructions. Tom Pridmore, Box 2095, Melbourne, FL 32901.

Electronics International model 8007 receiver. Need schematic, Andy Anderson, 2250 Cable Ave., Beaumont, TX 77703.

operation assist

Precision model 954-G tube tester, serial # 13610. Need current roll chart. Karl Hund, Box 81, Beaverton, MI 48612.

Hickok 110A VTVM. Need manual. Bill Springer, 923 Nelda, Houston, TX 77088.

Tektronix model 533 and RM43 scopes. Need manuals and schematics. A.G. Lowrance, 316 Polk St., Waterloo, IA 50703.

National Semiconductor chip MM58106 digital clock and TV display. Need circuit diagram and information on proper hookup to TV. J. A. Caggianelli, Ashdown Rd., Ballston Lake, NY 12019.

Typagraph Corp., model DPM-30 printer. Need service manual. I. Carah, Box 11583, Zephyr Cove, NV 89448.

Tektronix type 512 oscilloscope. Need operating manual and schematic. Al Shor, Box 493, Cardiff, CA 92007.

Monitor Radio model MR-33, serial #7233 receiver. Need schematic, parts list or any available data. Henry J. Hacker, 27 Clarendon Ave., Pikesville, MD 21208.

Galvin BC-611 transceivers. Need any data available. M. Dunn, 45 Livingston Rd., #501, West Hill, Ontario, Canada M1E 1K8.

Ogawa model RS-1 receiver and **Harmony** model 530 bass amplifier. Need schematics. George Nishimoto, 504 Hoopuni St., Hilo, HI 96720.

Concord Electronics Corp., model R-1100 tape deck. Need service information and power transformer. Mike Smith, Box 15337, Sarasota, FL 33579.

Olson TE-188 r-f signal generator. Need schematic. Hugh Siuda, 512 W. Rand Dr., McHenry, IL 60050.

Allied Radio Corp., Knight model 2-JZ018. Need operating manual and schematic. Mike Dale, 1198 Lock 4 Rd., Gallatin, TN 37066.

Telequipment type S51A serviscope. Need schematic and operation manual. Jack Allen, Woodside Lane, Riverton, NJ 08077.

Ford Industries, Inc., model 1400 phone answering device. Need schematic. Van S. Vangor, Box 346C, Island Falls, Maine 04747.

Dumont type 279 oscillograph. Need schematic and manual. Everett Thompson, R.F.D. #61, La Grange, ME 04453.

Hammurland HZ100 receiver. Need schematic and alignment data. R. McKinnan, Box 1241, San Juan, TX 78589.

Allied model 2515 receiver. Need manual and schematic. Ed Bolin, 7650 Ovaldale St., Charleston, SC 29405.

Hallicrafters model SX-99 receiver. Need operation manual, schematic and service manual. Ross W. Smith, 1816 Abelia Rd., Fallston, MD 21047.

Stromberg-Carlson model AWP8 multi-band receiver. Need owner's manual and operating instructions. Steven A. Davis, Rt. #4, Box 295A, Angola, IN 46703.

RCA Radiola model 44 antique radio. Need tube #45. T. Wright, 4933 Yakima, Pocatello, ID 83204.

Radio City Products Co., Inc., model 664 meter. Need schematic and operating manual. J. Welden Dupre, W5SNK #7 HMS Court, Houma, LA 70360.

Dynakit model 70 stereo. Need owner's manual. W.M. Brenneman, 1000 W. Aaron Dr., #I-1, State College, PA 16801.

Hallicrafters model S-94 civic patrol receiver. Need schematic and service manual. Allen T. Purdy, 17 Dunwoodie St., Yonkers, NY 10704.

Hallicrafters SX-100 receiver. Need service data, schematic and alignment procedures. Charles F. Gould, 333 South Fifth Street, Darby, PA 19020.

Itron model 680 frequency counter. Need schematic. W.W. Bell, 1813 Nortonia Rd., Richmond, VA 23229.

DSI Instruments Inc., model 5612 frequency counter. Need schematic, or any information on AM56 Audio Multiplier option for this counter. Gerard Johnson, P.O. Drawer 191, Morgan City, LA 70380.

Video Brain model 101A. Need manual, schematic or any information available. Gary Wojcik, 3916½ N. Kedvale, Chicago, IL 60641.

Phone Mate 9000 answering machine. Need IC chip placement and schematic diagram. J. Ward, Box 5685, Virginia Beach, VA 23455.

Hallicrafters SX 130 receiver. Need schematic and maintenance manual. Mike Kaufman, K6VCI, 107 Suffield Ave., San Anselmo, CA 94960.

Robosonics Industries model 100 record-a-phone. Need service data and schematic. Stan Kern, 3 Cinnamon Circle, Apt. 3C, Randallstown, MD 21133.

Sterling model 70-0175 receiver and **Bogen** series BT-97 intercom system. Schematic and operation manuals needed. M. Maynard, 6109 E. Gold Dust Ave., Scotts, AZ 85253.

Tektronix model 555 oscilloscope. Need calibration instructions and schematic for power supply. Roy Kunst, 80 Willow Ave., Hackensack, NJ 07601.

Beston model CTR800 tape recorder radio. Need tape head H7310 and schematic. W.A. Williams, 6020 Lloyd, St. Louis, MO 63110.

Allied Electronics Knight space scanner. Need schematic and operating manual. Douglas Cummings, 1360 N. Celia Way, Layton, UT 84041.

PROJECT OF THE MONTH

By Forrest M. Mims

Precision CMOS Clock Generator

SEQUENTIAL digital logic circuits require one or more clock pulse generators. Microprocessors often include built-in clock generators. Other sequential circuits may use clocks made from 555 timers, a pair of cross-coupled inverters, or a trio of inverters connected as a ring oscillator.

Intersil makes a general-purpose timer chip which, for a CMOS device, has extraordinary specifications. The chip is the ICM7209, available from some electronics mail order suppliers for about $4.00.

The ICM7209 is guaranteed to oscillate at frequencies up to 10 MHz, and it can directly drive as many as five TTL gates. With a 5-volt power supply, the chip typically consumes 11 milliamperes and will operate with a minimum of three external components—two capacitors and a quartz crystal (Fig.1).

The power dissipation of the ICM7209 is directly related to its oscillation frequency. Since the oscillator portion of the chip consumes much less power than its output buffers, power dissipation can be dramatically reduced when the chip is disabled by making pin 3 low. The oscillator portion will continue to operate, but the output buffers will be disabled, thus reducing their current drain.

The crystal can be any quartz crystal having a frequency of oscillation from 10 kHz to 10 MHz, and the circuit can be powered by a supply of 3 to 6 volts. For best results, the crystal should have a load capacitance of 10 pF rather than the usual 30 pF. When *C1* and *C2* are 18 pF, this provides a typical frequency stability of one part per million (ppm) per one volt change in supply voltage.

Note that the ICM7209 includes two output pins. The divide-by-eight output (pin 6) can be used to obtain many combinations.

While Fig. 1 shows the disable input (pin 3) connected to a switch, disable/enable controls can be easily provided by external logic. Pin 3 can also be connected to either the oscillator IN or OUT pins for some interesting results. For example, when pin 3 is connected to pin 2, each of the divide-by-eight pulses appearing at pin 6 are further divided into four separate pulses. This provides a burst output mode not mentioned in the ICM 7209's data sheet.

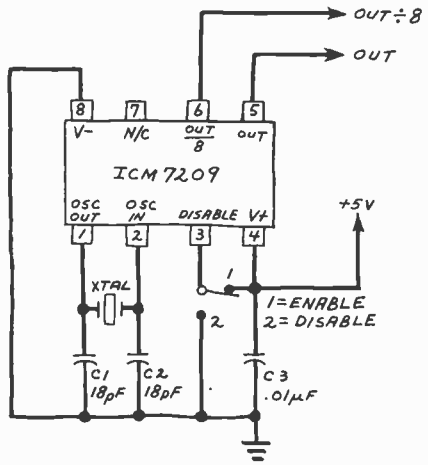


Fig. 1. A clock pulse generator using the ICM7209 chip with just three external components.

Figure 2 illustrates this chip's operation at its maximum guaranteed frequency of 10 MHz. Intersil claims typical rise and fall times of 10 nanoseconds (25 nanoseconds maximum) as measured from the 0.5-to-2.4-volt output points. These represent TTL logic levels.

As you see in Fig. 2, the circuit in Fig. 1 has a risetime better than 8 nanoseconds and a falltime faster than 7.5 nanoseconds. The pulse width is 50 nanoseconds FWHM (full width, half maximum). Figure 2 was taken directly from the screen of a 100-MHz oscilloscope. I assembled the oscillator on a standard plastic, solderless breadboard with short, point-to-point connection wires.

The ICM7209 provides an excellent solution to the need for a precision clock generator. Though the circuit shown in Fig. 1 isn't tunable, the oscillation frequency can be quickly altered by changing the quartz crystal used. ◇

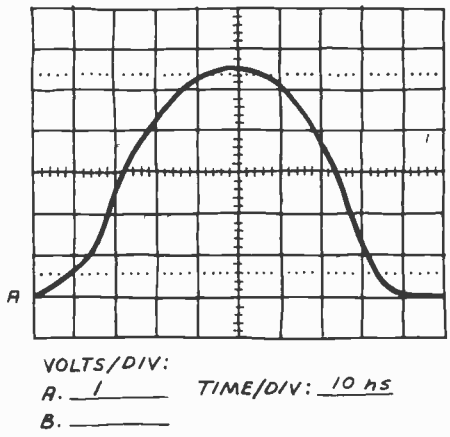


Fig. 2. Output waveform from an ICM7209 with a 10-MHz crystal.

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1N914	100v	10mA	.05
1N4005	600v	1A	.08
1N4007	1000v	1A	.15
1N4148	75v	10ma	.05
1N4733	5.1v	1 W Zener	.25
1N4749	24v	"	.25
1N753A	6.2v	500 mW Zener	.25
1N758A	10v	"	.25
1N759A	12v	"	.25
1N5243	13v	"	.25
1N5244B	14v	"	.25
1N5245B	15v	"	.25
1N5349	12v	3W Zener	.25

SOCKETS/BRIDGES

QTY				
8-pin	pcb .20	ww	.40	
14-pin	pcb .25	ww	.60	
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20-pin	pcb .45	ww	1.05	
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Molex pins .01		To-3 Sockets	.35	
2 Amp Bridge		200-prv	1.25	
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2N2222A	NPN	.35
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C MOS

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4001	.35	4020	1.25	4042	.95	4082	.60
4002	.35	4021	.60	4043	.90	4093	.90
4006	.95	4022	1.25	4044	1.20	4098	2.25
4007	.30	4023	.45	4046	1.50	4507	1.15
4008	.55	4024	.95	4047	1.50	4511	.90
4009	.75	4025	.45	4048	2.50	4512	1.25
4010	.75	4026	2.95	4049	.65	4515	2.50
4011	.45	4027	.85	4050	.65	4518	1.50
4012	.25	4028	.95	4052	.75	4519	.85
4013	.65	4029	1.00	4053	1.50	4522	1.50
4014	.95	4030	.95	4060	2.25	4526	1.50
4015	.95	4033	2.50	4066	1.25	4528	1.50
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				4072	.50	74C151	2.50

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8251	7.50
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— TTL —

QTY		QTY		QTY		QTY	
7400	.25	7493	.60	74H10	.35	74LS74	.65
7401	.35	7494	.75	74H11	.45	74LS75	.95
7402	.35	7495	.60	74H15	.45	74LS76	.75
7403	.30	7496	.55	74H20	.45	74L86	.75
7404	.35	74100	1.75	74H21	.35	74LS90	.95
7405	.35	74107	.55	74H22	.40	74LS93	.70
7406	.35	74111	3.00	74H30	.40	74LS107	.90
7407	.65	74121	.55	74H40	.45	74LS109	1.00
7408	.50	74122	.70	74H50	.40	74LS123	1.20
7409	.35	74123	.70	74H51	.40	74LS138	1.00
7410	.35	74125	.75	74H52	.40	74LS151	1.00
7411	.35	74126	.75	74H53	.45	74LS153	1.15
7412	.35	74132	.75	74H55	.45	74LS154	2.50
7413	.45	74141	.90	74H72	.45	74LS157	1.15
7414	.65	74145	1.35	74H74	1.50	74LS160	1.00
7416	.35	74150	1.15	74H101	.95	74LS161	1.50
7417	.40	74151	.95	74H103	.55	74LS164	.90
7420	.45	74153	.95	74L00	.60	74LS193	1.00
7426	.35	74154	1.40	74L02	.60	74LS195	2.00
7427	.40	74156	.70	74L03	.35	74LS196	2.50
7430	.40	74157	1.50	74L04	.39	74LS244	1.50
7432	.65	74158	1.50	74L10	.30	74LS245	1.50
7437	.45	74161	1.50	74L20	.75	74LS253	.95
7438	.50	74163	1.50	74L30	.55	74LS298	1.50
7440	.40	74164	1.50	74L47	1.95	74LS367	1.50
7441	.65	74165	1.10	74L51	.65	74LS368	.95
7442	.65	74166	1.10	74L55	.85	74LS373	.95
7443	.75	74175	.75	74L72	.65	74S00	.50
7444	.75	74176	1.15	74L73	.70	74S02	.60
7445	.75	74177	1.10	74L74	1.95	74S03	.45
7446	.75	74180	1.10	74L75	1.05	74S04	.60
7447	1.50	74181	2.25	74L85	3.00	74S05	.65
7448	1.50	74182	.75	74L93	2.95	74S08	.80
7450	.35	74190	1.25	74L123	2.95	74S10	.65
7451	.50	74191	1.25	74LS00	.30	74S11	.60
7453	.25	74192	1.50	74LS01	.30	74S20	.60
7454	.35	74193	1.50	74LS02	.30	74S22	.75
7460	.40	74194	.95	74LS03	.30	74S40	.70
7470	.35	74195	.95	74LS04	.40	74S50	.70
7472	.40	74196	1.75	74LS05	.30	74S51	.75
7473	.40	74197	.95	74LS08	.40	74S64	.35
7474	.45	74198	1.50	74LS09	.60	74S74	.75
7475	.45	74221	1.50	74LS10	.40	74S86	.75
7476	.45	74298	1.50	74LS11	.40	74S112	.90
7480	.60	74367	1.15	74LS20	.40	74S114	.85
7481	.95	75107A	.95	74LS21	.50	74S133	.85
7482	.95	75451	.85	74LS22	.45	74S140	.95
7483	.75	75452	.85	74LS27	.40	74S151	.95
7485	.75	75491	1.50	74LS32	.60	74S153	1.50
7486	.55	75492	1.50	74LS37	.60	74S157	1.50
7489	1.95	74H00	.40	74LS38	.65	74S158	1.50
7490	.75	74H01	.40	74LS40	.70	74S194	1.75
7491	.60	74H04	.90	74LS42	.75	74S196	2.00
7492	.50	74H05	.55	74LS47	.95	74S257(8123)	1.95
		74H08	.90	74LS51	.95	74S287	3.95
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LM301	.95	LM320T15	1.65	78L12	.75
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LM320H24	.89	LM340K12	1.50	LM747	1.25
LM320K5	1.65	LM340K15	1.50	LM1307	1.75
LM320K12	1.65	LM340K18	1.50	LM1458	.65
				LM3900	.95
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SN7413N	.40	SN7491N	.59	SN74174N	.99
SN7414N	.69	SN7492N	.45	SN74175N	.89
SN7416N	.29	SN7493N	.45	SN74176N	.79
SN7417N	.29	SN7494N	.69	SN74177N	.79
SN7420N	.25	SN7495N	.69	SN74179N	1.49
SN7421N	.29	SN7496N	.69	SN74180N	.79
SN7422N	.45	SN7497N	3.00	SN74181N	2.25
SN7423N	.29	SN74100N	1.49	SN74182N	.79
SN7425N	.29	SN74104N	.89	SN74184N	2.49
SN7426N	.29	SN74105N	.89	SN74185N	2.49
SN7427N	.25	SN74107N	.35	SN74190N	1.25
SN7428N	.49	SN74109N	.39	SN74191N	1.25
SN7430N	.25	SN74116N	1.95	SN74192N	.89
SN7432N	.29	SN74121N	.39	SN74193N	.89
SN7437N	.25	SN74122N	.55	SN74194N	.89
SN7438N	.40	SN74123N	.59	SN74195N	.69
SN7439N	.25	SN74125N	.49	SN74196N	.89
SN7440N	.20	SN74126N	.49	SN74197N	.89
SN7441N	.89	SN74132N	.75	SN74198N	1.49
SN7442N	.59	SN74136N	.75	SN74199N	1.49
SN7443N	1.10	SN74141N	.99	SN74221N	1.25
SN7444N	1.10	SN74142N	3.25	SN74251N	.99
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SN7446N	.79	SN74144N	3.49	SN74279N	.79
SN7447N	.69	SN74145N	.79	SN74283N	1.49
SN7448N	.79	SN74147N	1.95	SN74284N	3.95
SN7450N	.20	SN74148N	1.29	SN74285N	3.95
SN7451N	.20	SN74150N	1.25	SN74365N	.69
SN7453N	.20	SN74151N	.69	SN74366N	.69
SN7454N	.20	SN74152N	.69	SN74367N	.69
SN7459A	.25	SN74153N	.79	SN74368N	.69
SN7460N	.20	SN74154N	1.25	SN74390N	1.49
SN7470N	.29	SN74155N	.79	SN74393N	1.49

74LS

74LS00	.29	74LS92	.75	74LS192	1.15
74LS01	.29	74LS93	.75	74LS193	1.15
74LS02	.29	74LS95	.99	74LS194	1.15
74LS03	.29	74LS96	1.15	74LS195	1.15
74LS04	.35	74LS107	.45	74LS197	1.19
74LS05	.35	74LS109	.45	74LS221	1.19
74LS08	.35	74LS112	.45	74LS240	1.49
74LS09	.35	74LS113	.49	74LS241	1.49
74LS10	.35	74LS114	.49	74LS242	1.49
74LS11	.39	74LS122	.89	74LS243	1.49
74LS12	.35	74LS123	1.25	74LS244	1.49
74LS13	.59	74LS125	.59	74LS245	2.95
74LS14	.99	74LS126	.59	74LS247	1.19
74LS15	.35	74LS132	.99	74LS248	1.19
74LS20	.35	74LS133	.89	74LS249	1.19
74LS21	.35	74LS136	.49	74LS251	.99
74LS22	.35	74LS138	.89	74LS253	.99
74LS26	.35	74LS139	.89	74LS257	.89
74LS27	.35	74LS151	.89	74LS258	.69
74LS28	.35	74LS153	.89	74LS260	.69
74LS30	.35	74LS154	1.75	74LS266	.69
74LS32	.35	74LS155	.89	74LS273	1.95
74LS33	.59	74LS156	.89	74LS279	.89
74LS37	.45	74LS157	.89	74LS283	.89
74LS38	.39	74LS158	.89	74LS290	.99
74LS40	.35	74LS160	1.15	74LS293	.99
74LS42	.89	74LS161	1.15	74LS298	1.25
74LS47	.89	74LS162	1.15	74LS352	1.29
74LS48	1.15	74LS163	1.15	74LS353	1.29
74LS49	1.15	74LS164	1.15	74LS365	.69
74LS51	.35	74LS165	1.15	74LS366	.69
74LS54	.35	74LS168	1.19	74LS367	.69
74LS55	.35	74LS169	1.19	74LS368	.69
74LS73	.45	74LS170	1.95	74LS373	1.95
74LS74	.45	74LS173	.99	74LS374	1.95
74LS75	.59	74LS174	.99	74LS375	.89
74LS76	.45	74LS175	.99	74LS386	.69
74LS78	.49	74LS181	2.95	74LS393	2.49
74LS83	.89	74LS190	1.25	74LS399	2.49
74LS85	1.25	74LS191	1.25	74LS670	2.49
74LS86	.49			81LS95	1.95
74LS90	.69			81LS97	1.95

74S

74S00	.45	74S124	3.95	74S243	3.25
74S02	.45	74S133	.55	74S244	3.25
74S03	.45	74S134	.69	74S251	1.45
74S04	.55	74S135	1.19	74S253	1.45
74S05	.55	74S136	1.75	74S257	1.35
74S08	.50	74S138	1.35	74S258	1.35
74S09	.50	74S139	1.35	74S260	.79
74S10	.45	74S140	.79	74S280	2.95
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74S20	.45	74S157	1.35	74S373	3.49
74S22	.45	74S158	1.35	74S374	3.49
74S30	.45	74S160	2.95	74S387	2.95
74S32	.55	74S174	1.59	74S471	19.95
74S38	1.25	74S175	1.59	74S472	10.95
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74S51	.45	74S194	1.95	74S474	12.95
74S64	.50	74S195	1.95	74S475	12.95
74S65	.50	74S196	1.95	74S570	5.95
74S74	.75	74S240	2.95	74S571	5.95
74S86	.79	74S241	2.95	74S572	9.95
74S112	.79	74S242	3.25	74S573	9.95
74S113	.79			74S940	3.15
74S114	.79			74S941	3.15

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CA3010H	.99	CA3060N	3.25	CA3089N	3.75
CA3013H	2.15	CA3080H	1.25	CA3096N	3.95
CA3023H	3.25	CA3081N	2.00	CA3130H	1.39
CA3035H	2.49	CA3082N	2.00	CA3140H	1.25
CA3039H	1.35	CA3083N	1.60	CA3160H	1.25
CA3046N	1.30	CA3086N	.85	CA3401N	.59
CA3059N	3.25			CA3600N	3.50

CD–CMOS

CD4000	.39	CD4041	1.49	CD 4098	2.49
CD4001	.39	CD4042	.99	CD4506	.75
CD4002	.39	CD4043	.89	CD4507	.99
CD4006	1.19	CD4044	.89	CD4508	3.95
CD4007	.25	CD4046	1.79	CD4510	1.39
CD4009	.49	CD4047	2.50	CD4511	1.29
CD4010	.49	CD4048	1.35	CD4512	1.49
CD4011	.39	CD4049	.49	CD4514	3.95
CD4012	.25	CD4050	.69	CD4515	2.95
CD4013	.49	CD4051	1.19	CD4516	1.49
CD4014	1.39	CD4052	1.19	CD4518	1.79
CD4015	1.19	CD4053	1.19	CD4519	.89
CD4016	.59	CD4056	2.95	CD4520	1.29
CD4017	1.19	CD4059	9.95	CD4526	1.79
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CD4019	.49	CD4066	.79	CD4529	1.95
CD4020	1.19	CD4068	.39	CD4543	2.79
CD4021	1.39	CD4069	.45	CD4562	11.95
CD4022	1.19	CD4070	.55	CD4566	2.79
CD4023	.29	CD4071	.49	CD4583	2.49
CD4024	.79	CD4072	.49	CD4584	.75
CD4025	.23	CD4073	.39	CD4723	1.95
CD4026	2.95	CD4075	.39	CD4724	1.95
CD4027	.69	CD4076	1.39	MC14409	14.95
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CD4029	1.49	CD4081	.39	MC14411	14.95
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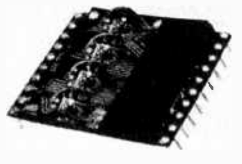
CD4034	3.49	CD4093	.99	MC14419	4.95
CD4035	.99			MC14433	13.95
CD4040	1.49			MC14538	2.49
				MC14541	1.95

4-Digit 16 Segment Alphanumeric Intelligent Display with Memory, Recorder, Driver



End-stackable, 4-character package. High contrast, 160mil high, magnified monolithic characters. 64-Character ASCII format. Built-in memory, decoder, multiplexer and drivers. Direct access to each digit independently and asynchronously. Five volt logic, TTL compatible. Five volt power supply only. Independent cursor function. Size: 1"L x 1-3/16"H x .225"D.

DL-1416 Alphanumeric Display **$19.95 ea.**

10-Segment Bargraph Displays (with On-Board Driver IC-Chip)

Size: 2"L x 7/8"H x 3/16"D

Bar or dot display mode externally selectable by user. Packages are end-stackable for expanded displays. Can be cascaded to 10 arrays (100 bargraph elements). LED current programmable from 2mA to 30mA. Stable internal voltage reference for full scale analog inputs from 1.2 to 12V. Each LED output of driver IC with external access. Size 2"x7/8"x3/16".

NSM3914	Linear Function (10 bars red)	$6.95
NSM39146	Linear Function (6 bars green/4 red)	6.95
NSM3915	Logarithmic Function (10 bars red)	5.95
NSM39168	Logarithmic Func. (6 grn./2 yell./2 rd.)	6.95
NSM3916	VU-Meter Function (10 bars red)	5.95
NSM39168	VU-Meter Func. (6 grn./2 yell./2 rd.)	6.95

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XC556R	.200"	red	5/$1	MV50	.085"	red	6/$1
XC556G	.200"	green	4/$1	XC209R	.125"	red	5/$1
XC556Y	.200"	yellow	4/$1	XC209G	.125"	green	4/$1
XC556C	.200"	clear	4/$1	XC209Y	.125"	yellow	4/$1
XC22R	.200"	red	5/$1	XC526R	.185"	red	5/$1
XC22G	.200"	green	4/$1	XC526G	.185"	green	4/$1
XC22Y	.200"	yellow	4/$1	XC526Y	.185"	yellow	4/$1
MV10B	.170"	red	4/$1	XC526C	.185"	clear	4/$1

.200(TI-A) Red/Green

Diffused Bi-Color LED

Part No.	1-99	100+
XC5491	.79	.69

XC556 RED LED, METAL MTG. HDW. 2-4" LEADS.

RL-2 . . $.39 ea. or 3/$1.00

DISPLAY LEDS

C.A. — Common Anode
D.D. — Double Digit
C.C. — Common Cathode
RHD — Right Hand Decimal

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MAN 1	C.A.—red	.270	2.95	DLG507	C.A.—green	.500	1.25
MAN 2	5x7 D.M.—red	.300	4.95	DL704	C.C.—red	.300	1.25
MAN 3	C.C.—red	.125	.25	DL707	C.A.—red	.300	1.25
MAN 52	C.A.—green	.300	.99	DL728	C.C.—red	.500	1.49
MAN 54	C.C.—green	.300	.99	DL741	C.A.—red	.600	1.25
MAN 71	C.A.—red	.300	.75	DL747	C.A.—red	.600	1.49
MAN 72	C.A.—red	.300	.75	DL750	C.C.—red	.600	1.49
MAN 74	C.C.—red	.300	1.25	DLO847	C.A.—orange	.800	1.49
MAN 82	C.A.—yellow	.300	.49	DLO850	C.C.—orange	.800	1.49
MAN 84	C.C.—yellow	.300	.99	DL33B	C.C.—red	.110	.35
MAN 3620	C.A.—orange	.300	.49	FND358	C.C. ± 1	.357	.99
MAN 3630	C.A.—orange ± 1	.300	.99	FND357	C.C.	.357	.75
MAN 3640	C.C.—orange	.300	.99	FND500	C.C. (FND503)	.500	.99
MAN 4610	C.A.—orange	.400	.99	FND507	C.A. (FND510)	.500	.99
MAN 6610	C.A.—orange—DD	.560	.99	HDSP-3401	C.A.—red	.800	1.50
MAN 6630	C.A.—orange ± 1	.560	.99	HDSP-3403	C.C.—red	.800	1.50
MAN 6640	C.C.—orange—DD	.560	.99	HDSP-3406	C.C. red ±1	.800	1.50
MAN 6650	C.C.—orange ± 1	.560	.99	5082-7751	C.A.,R.H.D.—red	.430	1.25
MAN 6660	C.A.—orange	.560	.99	5082-7760	C.C.,R.H.D.—red	.430	1.25
MAN 6710	C.A.—red—DD	.560	.99	5082-7300	4x7 Numeric (RHD)	.600	22.00
MAN 6740	C.C.—red—DD	.560	.99	5082-7302	4x7 Numeric (LHD)	.600	22.00
MAN 6750	C.C.—red ± 1	.560	.99	5082-7340	4x7 Hxdcl. (0-9/A-F)	.600	22.50
DLO304	C.C.—orange	.300	1.25	4N28	Photo Xsistor Opto-Isol.		.69
DLO307	C.A.—orange	.300	1.25	LIT-1	Photo Xsistor Opto-Isol.		.69
DLG500	C.C.—green	.500	1.25	MOC3010	Optically Isol. Triac Driver		1.25

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- G.F. PSF Plastic Body
- For testing IC's

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216-3340	16 pin	6.49	224-3344	24 pin	9.75
218-3341	18 pin	7.95	228-3345	28 pin	11.95
220-3342	20 pin	8.95	240-3346	40 pin	12.95

RECEPTACLES

- Nickel Boron Plating
- G.F. PSF Plastic Body
- Wire Wrap Contacts

Part No.	Pins	Price	Part No.	Pins	Price
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216-3593	16 pin	9.95	224-3597	24 pin	12.75
218-3594	18 pin	10.95	228-3598	28 pin	13.95
220-3595	20 pin	11.95	240-3599	40 pin	15.95

LOW PROFILE (TIN) SOCKETS

	1-24	25-49	50-100
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14 pin LP	.20	.19	.18
16 pin LP	.22	.21	.20
18 pin LP	.29	.28	.27
20 pin LP	.34	.32	.30
22 pin LP	.37	.36	.35
24 pin LP	.38	.37	.36
28 pin LP	.45	.44	.43
36 pin LP	.60	.59	.58
40 pin LP	.63	.62	.61

SOLDERTAIL STANDARD (TIN)

	1-24	25-49	50-100
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16 pin ST	.30	.27	.25
18 pin ST	.35	.32	.30
24 pin ST	.49	.45	.42
28 pin ST	.99	.90	.81
36 pin ST	1.39	1.26	1.15
40 pin ST	1.59	1.45	1.30

SOLDERTAIL (GOLD) STANDARD

	1-24	25-49	50-100
8 pin SG	.39	.35	.31
14 pin SG	.49	.45	.41
16 pin SG	.54	.49	.44
18 pin SG	.59	.53	.48
24 pin SG	.79	.75	.69
28 pin SG	1.10	1.00	.90
36 pin SG	1.65	1.40	1.26
40 pin SG	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-24	25-49	50-100
8 pin WW	.59	.54	.49
10 pin WW	.69	.63	.58
14 pin WW	.79	.73	.67
16 pin WW	.85	.77	.70
18 pin WW	.99	.90	.81
20 pin WW	1.19	1.08	.99
22 pin WW	1.49	1.35	1.23
24 pin WW	1.39	1.26	1.14
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ASST. 5	5 ea.	22K 27K 33K 39K 47K 56K 68K 82K 100K 120K	50 pcs.	$1.95
ASST. 6	5 ea.	150K 180K 220K 270K 330K 390K 470K 560K 680K 820K	50 pcs	$1.95
ASST. 7	5 ea.	1M 1.2M 1.5M 1.8M 2.2M 2.7M 3.3M 3.9M 4.7M 5.6M	50 pcs	$1.95
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7107CPL	3½ Digit A/D (LED Drive)		15.95
7107EV/Kit*	IC, Circuit Board, Display		29.95
7116CPL	3½ Digit A/D LCD Dis. HLD.		18.95
7117CPL	3½ Digit A/D LED Dis. HLD.		17.95
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7205IPG	CMOS LED Stopwatch/Timer		12.95
7205EV/Kit*	Stopwatch Chip, XTL		19.95
7206CJPE	Tone Generator		5.15
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7208IPI	Seven Decade Counter		17.95
7209IPA	Clock Generator		3.95
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7612BCPA	CMOS Op Amp Ext. Cmvr.	5MV	2.95
7621BCPA	CMOS Dual Op Amp Comp.	5MV	3.95
7631CCPE	CMOS Tri Op Amp Comp.	10MV	5.35
7641CCPD	CMOS Quad Op Amp Comp.	10MV	7.50
7642CCPD	CMOS Quad Op Amp Comp.	10MV	7.30
7660CPA	Voltage Converter		2.95
8038CCPD	Waveform Generator		4.95
8048CCPE	Monolithic Logarithmic Amp		21.60
8069CCQ	50ppm Band—GAP Volt Ref. Diode		2.50
8211CPA	Volt Ref/Indicator		2.95
8212CPA	Volt Ref/Indicator		2.95

74C

74C00	.39	74C95	1.59	74C221	1.95
74C02	.39	74C107	1.89	74C240	2.25
74C04	.39	74C151	2.95	74C244	2.25
74C08	.39	74C154	3.95	74C373	2.49
74C10	.39	74C157	2.25	74C374	2.59
74C14	.75	74C160	1.69	74C901	.69
74C20	.39	74C161	1.60	74C903	.69
74C30	.39	74C162	1.49	74C911	10.95
74C42	1.39	74C163	1.69	74C912	10.95
74C48	1.95	74C164	1.59	74C915	1.69
74C73	.79	74C173	1.39	74C917	10.95
74C74	.79	74C174	1.39	74C922	5.49
74C85	1.95	74C175	1.19	74C923	5.75
74C86	.99	74C192	1.69	74C925	7.50
74C89	6.95	74C193	1.69	74C926	7.50
74C90	1.29	74C195	1.59	80C95	.79
74C93	1.29			80C97	.79

LINEAR

LH0002CN	6.85	LM340T-5	1.25	LM702H	.79
LM10CLH	4.50	LM340T-12	1.25	LM703CN	.89
LM11CLH	4.75	LM340T-15	1.25	LM709N	.29
LH0070-OH	4.95	LM341P-5	.75	LM710N	.79
TL071CP	.79	LM341P-12	.75	LM711N	.79
TL072CP	1.39	LM341P-15	.75	LM723N	.69
TL074CN	2.49	LM342P-5	.69	LM733N	1.00
LH0082CD	35.80	LM342P-12	.69	LM739N	1.19
TL082CP	1.19	LM342P-15	.69	LM741CN	.35
TL084CN	2.19	LM348N	1.25	MC1741SCG	3.00
LH0094CD	36.80	LM350K	5.75	LM747N	.79
LM300H	.99	LF351N	.60	LM748N	.59
LM301CN	.35	LF353N	1.00	LM1014N	2.75
LM302H	1.95	LF355N	1.10	LM1310N	1.95
LM304H	1.95	LF356N	1.10	LM1458CN	.59
LM305H	.99	LM358N	1.00	LM1488N	1.25
LM307CN	.45	LM359N	1.79	LM1489N	1.25
LM308CN	1.00	LM370N	4.49	LM1496N	1.95
LM309H	1.95	LM373N	3.25	LM1556V	1.75
LM309K	1.25	LM377N	2.95	LM1800N	2.95
LM310CN	1.75	LM380N	1.25	LM1871N	5.49
LM311/CN	.90	LM381N	1.95	LM1872N	5.49
LM312H	2.49	LM382N	1.79	LM1877N-9	3.25
LM317MP	1.15	LM384N	1.95	LM1889N	3.20
LM317T	1.75	LM386N-3	1.29	LM1896N	1.75
LM317K	3.95	LM387N	1.45	LM2002T	1.49
LM318CN	1.95	LM389N	1.35	LM2877P	2.05
LM319N	1.95	LM392N	.69	LM2878P	2.25
LM320K-5	1.35	LF398N	4.00	LM2896P-1	2.25
LM320K-12	1.35	LM399H	5.00	LM3189N	2.95
LM320K-15	1.35	TL494CN	4.49	LM3900N	.69
LM320T-5	1.25	TL496CP	1.75	LM3905CN	1.25
LM320T-12	1.25	NE510A	6.00	LM3909N	1.15
LM320T-15	1.25	NE529A	4.95	LM3914N	3.95
LM323K	5.95	NE531H	3.95	LM3915N	3.95
LM324N	.99	NE536H	6.00	LM3916N	3.95
LM329DZ	.65	NE540H	6.00	RC4136N	1.25
LM331N	3.95	NE544N	4.95	RC4151NB	3.95
LM334Z	1.30	NE560A	1.30	RC4194TK	6.95
LM335Z	1.40	NE555V	.39	RC4195TK	5.49
LM336Z	1.75	LM556N	.99	LM4500A	3.25
LM337T	1.95	NE564N	3.95	ICL8038B	4.95
LM337MP	1.15	LM565N	1.25	LM13080N	1.29
LM338K	6.95	LM566CN	1.95	LM13600N	1.49
LM339N	.99	LM567V	1.25	75138N	1.95
LM340K-5	1.35	NE570N	4.95	75450N	.89
LM340K-12	1.35			75451CN	.39
LM340K-15	1.35			75492	.89

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

Value	1-9	10-99	100+	Value	1-9	10-99	100+
10 pf	.08	.06	.05	.001µF	.08	.06	.05
22 pf	.08	.06	.05	.0047µF	.08	.06	.05
47 pf	.08	.06	.05	.01µF	.08	.06	.05
100 pf	.08	.06	.05	.022µF	.09	.07	.06
220 pf	.08	.06	.05	.047µF	.09	.07	.06
470 pf	.08	.06	.05	.1µF	.15	.12	.10

100 VOLT MYLAR FILM CAPACITORS

.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022mf	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	.22mf	.33	.27	.22

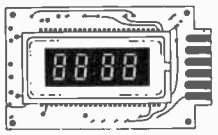
+20% DIPPED TANTALUMS (Solid) CAPACITORS

.1/35V	.39	.34	.29	1.5/35V	.41	.37	.29
.15/35V	.39	.34	.29	2.2/35V	.51	.45	.34
.22/35V	.39	.34	.29	3.3/25V	.53	.47	.37
.33/35V	.39	.34	.29	4.7/25V	.63	.56	.45
.47/35V	.39	.34	.29	6.8/25V	.79	.69	.55
.68/35V	.39	.34	.29	15/25V	1.39	1.25	.95
1.0/35V	.39	.34	.29	22/6V	.79	.69	.55

MINI. ALUMINUM ELECTROLYTIC CAPACITORS

Axial	1-99	100-499	500+	Radial	1-99	100-499	500+
.47/50V	.16	.14	.10	.47/25V	.15	.13	.12
1.0/50V	.19	.16	.12	.47/50V	.16	.14	.13
3.3/50V	.17	.15	.11	1.0/16V	.15	.13	.12
4.7/25V	.18	.15	.11	1.0/25V	.16	.14	.13
10/25V	.18	.15	.11	1.0/50V	.17	.15	.14
10/50V	.19	.16	.12	4.7/16V	.15	.13	.12
22/25V	.19	.16	.12	4.7/25V	.16	.14	.13
22/50V	.24	.20	.18	4.7/50V	.17	.15	.14
47/25V	.25	.21	.19	10/16V	.15	.13	.12
47/50V	.29	.25	.23	10/25V	.16	.14	.13
100/25V	.28	.24	.22	10/50V	.17	.15	.14
100/50V	.41	.37	.34	47/50V	.25	.21	.19
220/25V	.39	.34	.33	100/16V	.21	.17	.14
220/50V	.49	.45	.41	100/25V	.25	.23	.21
470/25V	.54	.49	.45	100/50V	.37	.34	.31
1000/16V	.79	.69	.61	220/16V	.25	.21	.19
2200/16V	.89	.79	.69	470/25V	.35	.31	.27

National Semiconductor Clock Modules



12VDC AUTOMOTIVE/ INSTRUMENT CLOCK

APPLICATIONS:
- In-dash autoclocks
- After-market auto/ RV clocks
- Aircraft-marine clks.
- 12VDC oper. instru.
- Portable/battery powered instrumnts.

Features: Bright 0.3" green display. Internal crystal time-base. ± 0.5 sec./day accur. Auto. display brightness control logic. Display color filterable to blue, blue-green, green & yellow. Complete – just add switches and lens.

MA1003 Module (3.05"L x 1.75"H x .98"D) . **$16.95**

CLOCK MODULES

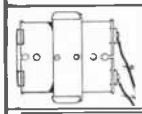
MA1023 .7" Red Digital LED Clock Module	8.95
MA1026 .7" Dig. LED Alarm Clock/Thermometer	18.95
MA5036 .3" Red Digital LED Clock/Timer	6.95
MA1002 .5" Red Digital LED Clock & Xformer	9.95
MA1010 .8" Red Digital LED Clock	7.95
MA1032 CBA .5" Red Digital LCD Clock	17.95
MA1043 .7" Green Digital LED Clock	8.95

TRANSFORMERS

102-P20 Xformer for MA1023, 1043 & 5036 Mods.	3.49
102-P22 Xformer for MA1026 Clock Modules	3.49
102-P24 Xformer for MA1010 Clock Modules	3.49

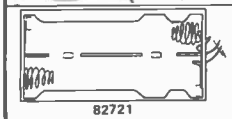
8 OHM SPEAKER

2¼" – 8 Ohm – .25 watt
A0201
$1.25 ea. 2/$1.95 ea. 10/$7.95 ea.



BATTERY HOLDER

- Holds 2 ea. C cells
- Aluminum Case
- 5" leads — H-801-159
- $ .45 each — 10/$3.95



82721

BATTERY HOLDER

- Holds 4 ea. C cells
- Plastic case
- 9" leads
- $ .49 ea. 10/$4.25

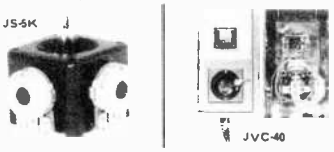
EPROM Erasing Lamp

- Erases 2708, 2716, 1702A, 5203Q, 5204Q, etc.
- Erases up to 4 chips within 20 minutes.
- Maintains constant exposure distance of one inch.
- Special conductive foam liner eliminates static build-up.
- Built-in safety lock to prevent UV exposure.
- Compact – only 7-5/8" x 2-7/8" x 2"
- Complete with holding tray for 4 chips.

UVS-11EL Replacement Bulb $16.95

UVS-11E $79.95

JOYSTICKS



JS-5K	5K Linear Taper Pots	$5.25
JS-100K	100K Linear Taper Pots	$4.95
JVC-40	40K (2) Video Controller in case	$4.95

6-Digit Clock Kit

- Bright .300 ht. comm. cathode display
- Uses MM5314 clock chip
- Switches for hours, minutes and hold modes
- Hrs. easily viewable to 20 ft.
- Simulated walnut case
- 115 VAC operation
- 12 or 24 hr. operation
- Incl. all components, case & wall transformer
- Size: 6¾" x 3-1/8" x 1¾"

JE701 . . . . . $19.95

NEW! JE215 Adjustable Dual Power Supply

General Description: The JE215 is a Dual Power Supply with independent adjustable positive and negative output voltages. A separate adjustment for each of the supplies provides the user unlimited applications for IC current voltage requirements. The supply can also be used as a general all-purpose variable power supply.

FEATURES
- Adjustable regulated power supplies, pos. and neg. 1.2VDC to 15VDC.
- Power Output (each supply). 5VDC @ 500mA, 10VDC @ 750mA, 12VDC @ 500mA, and 15VDC @ 175mA.
- Two, 3-terminal adj. IC regulators with thermal overload protection.
- Heat-sink regulator cooling
- LED "on" indicator
- Printed Board Construction
- 120VAC input
- Size: 3-1/2"w x 5-1/16"L x 2"H

JE215 Adj. Dual Power Supply Kit (as shown) . . $24.95

(Picture not shown but similar in construction to above)
JE200 Reg. Power Supply Kit (5VDC, 1 amp) . . $14.95
JE205 Adapter Brd. (to JE200) ±5, ±9 & ±12V. $12.95
JE210 Var. Pwr. Sply. Kit, 5-15VDC, to 1.5amp. $19.95

MICROPROCESSOR COMPONENTS

8080A/8080A SUPPORT DEVICES

INS8080A	CPU	4.95
DP8212	8-Bit Input/Output	3.25
DP8214	Priority Interrupt Control	5.95
DP8216	Bi-Directional Bus Driver	3.49
DP8224	Clock Generator/Driver	3.95
DP8226	Bus Driver	3.49
DP8228	System Controller/Bus Driver	4.95
DP8238	System Controller	5.95
INS8243	I/O Expander for 48 Series	9.95
INS8250	Asynchronous Comm. Element	16.95
DP8251	Prog. Comm. I/O (USART)	7.95
DP8253	Prog. Interval Timer	14.95
DP8255	Prog. Peripheral I/O (PPI)	9.95
DP8257	Prog. DMA Control	19.95
DP8259	Prog. Interrupt Control	14.95
DP8275	Prog. CRT Controller	39.95
DP8279	Prog. Keyboard/Display Interface	19.95
DP8303	System Timing Element	6.95
DP8304	8-Bit Bi-Directional Receiver	3.95
DP8307	8-Bit Bi-Directional Receiver	3.95
DP8308	8-Bit Bi-Directional Receiver	3.95
DP8310	Octal Latched Peripheral Driver	5.25
DP8311	Octal Latched Peripheral Driver	5.25

6800/6800 SUPPORT DEVICES

MC6800	MPU	7.95
MC6802CP	MPU with Clock and RAM	14.95
MC6810API	128x8 Static RAM	4.95
MC6821	Peripheral Inter. Adapt (MC6820)	7.49
MC6828	Priority Interrupt Controller	18.95
MC6830L8	1024x8-Bit ROM (MC68A30-8)	14.95
MC6850	Asynchronous Comm. Adapter	6.95
MC6852	Synchronous Serial Data Adapter	6.95
MC6860	0-600bps Digital MODEM	10.95
MC6862	2400bps Modulator	12.95
MC6880A	Quad 3-State Bus Trans. (MC8T26)	2.25

MICROPROCESSOR CHIPS

Z80 (780C)	CPU (MK3880N) (2MHz)	13.95
Z80A (780-1)	CPU (MK3880N-4) (4MHz)	15.95
COP1802	CPU	19.95
2650	MPU	16.95
IDA2901A/DC	CPU 4-Bit Slice (Com. Temp. Grade)	19.95
MCS6502	MPU w/Clock (65K Bytes Memory)	11.95
INS8035N-6	MPU– 8-Bit (6MHz)	9.95
INS8039N-6	CPU Spl. Chip 8-Bit (128 bytes RAM)	19.95
INS8040N-6	CPU (256 Bytes RAM)	24.95
INS8070N	CPU 16 Bytes RAM	24.95
INS8073N	CPU w/Basic Micro Interpreter	29.95
P8085	CPU	19.95
TMS9900JL	MPU– 16-Bit	49.95

SHIFT REGISTERS

MM500H	Dual 25-Bit Dynamic	.50
MM503H	Dual 50-Bit Dynamic	.50
MM506H	Dual 100-Bit Stc.	.50
MM510H	Dual 64-Bit Accumulator	.50
MM1402N	256-Bit Dynamic	2.95
MM5013N	1024-Bit Dynamic/Accumulator	1.95
MM5016H	500/512-Bit Dynamic	1.95
MM5034N	Octal 80-Bit	9.95
MM5035N	Octal 80-Bit	9.95
2504V(1404A)	1024-Bit Dynamic	1.95
2518N	Hex 32-Bit Static	3.95
2522V	Dual 132-Bit Static	2.95
2524V	512-Bit Dynamic	.99
2525V	1024-Bit Dynamic	2.95
2528V	Dual 256-Bit Static	3.95
2529V	Dual 240-Bit Static	3.95
3328N	Quad 80-Bit Static	2.95
3341PC	Fifo (Dual 80)	6.95

DATA ACQUISITION

AF100-1CN	Universal Active Filter 2.5%	5.95
AF121-1CJ	Touch Tone Low Band Filter	19.95
AF122-1CJ	Touch Tone High Band Filter	19.95
LM308AH	Super Gain Op Amp	1.15
LM334Z	Constant Current Source	1.30
LM335Z	Temperature Transducer	1.40
LF356N	JFET Input Op Amp	1.10
LF398N	Sample & Hold Amplifiers	3.95
LM399H	Temp. Comp. Prec. Ref. (.5ppm/°C)	4.95
ADC0804LCN	8-Bit A/D Converter (1 LSB)	4.95
OAC0808LCN	8-Bit D/A Converter (0.78% Lin.)	2.25

DATA ACQUISITION (CONTINUED)

ADC0809CCN	8-Bit A/D Converter (8-Ch. Multi.)	5.25
ADC0812CCN	8-Bit A/D Converter (16-Ch. Multi.)	10.95
DAC1008LCN	10-Bit D/A Conv. Micro. Comp. (0.05%)	13.95
DAC1008LCN	10-Bit D/A Conv. Micro. Comp. (0.20%)	8.95
DAC1020LCN	10-Bit D/A Converter (0.05% Lin.)	8.49
DAC1021LCN	10-Bit D/A Converter (0.20% Lin.)	5.95
DAC1222LCN	12-Bit D/A Converter (0.20% Lin.)	9.95
CD4051N	8-Channel Multiplexer	3.19
AY-5-1013	30K BAUD UART	6.95

RAM'S

1101	256x1 Static	1.49
1103	1024x1 Dynamic	.99
2101 (8101)	256x4 Static	3.95
2102	1024x1 Static	1.75
2112L02	1024x1 Static	1.95
2111 (8111)	256x4 Static	3.95
2117	256x4 Static MOS	4.95
2114	1024x4 Static 450ns	3.25
2114L	1024x4 Static 450ns Low Power	3.49
2114-2	1024x4 Static 200ns	3.95
2114L-2	1024x4 Static 200ns Low Power	4.95
745200	256x1 Static	6.95
4116N-4 (1103-4116)	16K Dynamic 250ns (MM5290N-4)	3.49
4164	64K Dynamic 250ns	19.95
MM2107	4096x1 Fast 70ns	7.95
5101	256x4 Static	7.95
MM5261	1024x1 Dynamic Fully Decoded	.99
MM5262	2Kx1 Dynamic	.99
MM5280/2107	4096x1 Dynamic	4.95
MM5290N-2 (4116)	16K Dynamic 150ns (UPD416C-2)	4.95
MM5298J-3A	8K Dyn. 200ns (lower ½ of MM5290)	1.95
82S25	64 Bit RAM (16x4)	2.49
UPD414/MK4027	4K Dynamic 16-pin	4.95
TMS4044-45NL	4K Static	9.95
TMS4045	1024x4 Static	9.95

PROMS/EPROMS

1702A	2K UV Erasable PROM	6.95
2708	8K EPROM	4.95
TMS2716	16K EPROM (-5V, +5V, +12V)	19.95
2716(Intel/2516) TI	16K EPROM (Single +5V)	8.95
2732/Intel TI	32K EPROM	17.95
2758	8K EPROM (450ns) (Single +5V)	7.49
2764Q	64K EPROM	99.95
5203	2048 PROM	14.95
82S23(74S188)	32x8 PROM (Open Collector)	3.95
82S115	4096 Bipolar PROM	14.95
82S123(74S288)	32x8 Tri-State Bipolar PROM	3.95
82S185	8K PROM	19.95

— Over 30 More PROMS Listed in Our Catalog —

ROM'S

2513(2140)	Character Generator (Upper Case) 9.95
2513(3021)	Character Generator (Lower Case) 9.95

NMOS READ ONLY MEMORIES

MCM6778P	128x8x7 ASCII Shifted w/Greek	13.50
MCM6740P	128x8x7 Math Symbol & Pictures	13.50
MCM6750P	128x8x7 Alpha, Control Char. Gen.	13.50

MICROPROCESSOR MANUALS

M-Z80	User Manual	7.50
M-COP1802	User Manual	7.50
M-2650	User Manual	5.00

SPECIAL FUNCTION

DS8835CN	Dual MOS Clock Driver (SMZ)	3.50
DS8836CN	Dual MOS Clock Driver (SMZ)	1.95
INS1771N-1	Floppy Disc Controller	24.95
INS2651N	Communication Chip	19.95
MM5837N	Microprocessor Real Time Clock	8.95
MM5813N	Microprocessor Compatible Clock	11.95
COP402N	Microcontroller with 64-Digit RAM and Direct LED Drive	6.95
COP402M-N	Microcontroller with 64-Digit RAM & Direct LED Drive w/N Buss Int.	7.49
COP478N	32-Seg. VAC Fluor. Driver (20-pin pkg.)	3.25

TELEPHONE/KEYBOARD CHIPS

AY-5-9100	Push Button Telephone Dialer	14.95
AY-5-9200	Repertory Dialer	14.95
AY-5-9500	CMOS Clock Generator	4.95
AY-5-2376	Keyboard Encoder (88 keys)	11.95
HD0165-5	Keyboard Encoder (16 keys)	7.95
74C922	Keyboard Encoder (16 keys)	5.49
74C923	Keyboard Encoder (20 keys)	5.75
MM5309N	Push Button Pulse Dialer	7.95
MM5749N	98/144-Key Serial Keyboard Encoder	8.95

ELECTRONIC TOY MOTORS

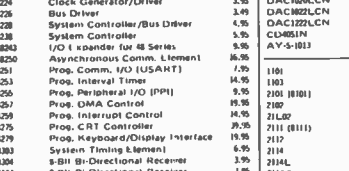
Typical Power Source	Operating Voltage Range	TYPICAL CHARACTERISTICS								SMALL TORQUE
		NO LOAD		AT MAXIMUM EFFICIENCY						
		Voltage	Speed RPM	Current AMP	Speed RPM	Current AMP	Torque OZ IN	Output W	Eff %	OZ IN
DRY CELL	1.5 6.0	3.0	9,200	0.20	6,750	0.90	0.260	1.30	57.0	0.97

.937 O.D. X 1.201 Length

MABUCHI RE280 $.99 each . . .10/$7.50 . . .100/$50.00

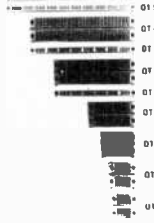
GLOBAL SPECIALTIES

EXPERIMENTOR SOCKETS



Model	Length	Width	Center Channel	5 Tie Point Terminals	Bus Strips	Price
EXP48	6.0"	1.0"	n/a	n/a	4(160)	$ 4.75
EXP300	6.0"	2.1"	.3"	94(470)	2(80)	$12.00
EXP325	1.8"	2.1"	.3"	22(110)	2(20)	$ 3.50
EXP350	3.6"	2.1"	.3"	46(230)	2(40)	$ 6.75
EXP600	6.0"	2.4"	.6"	94(470)	2(80)	$14.75
EXP650	3.6"	2.4"	.6"	46(230)	2(40)	$ 8.75

Quick Test Sockets & Bus Strips



	Length	Hole to-hole	Terminals	Unit Price $
QT-595	6.5"	6.2"	110	$12.50
QT-590	6.5"	6.2"	70	$ 2.99
QT-475	5.2"	5.0"	94	$10.24
QT-470	5.2"	5.0"	46	$ 2.59
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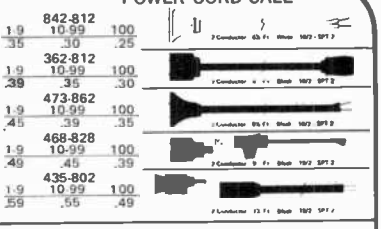

842-812	1-9	10-99	100
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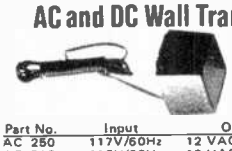

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JE610/DTE-AK (After assembled as pictured above) . . . **$124.95**

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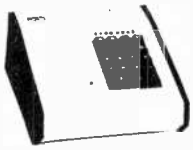
JE600 Hexadecimal Encoder Kit

FULL 8-BIT LATCHED OUTPUT
19-KEY KEYBOARD



The JE600 Encoder Keyboard Kit provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for 8-bit microprocessor or 8-bit memory circuits. Three additional keys are provided for user operations with one having a bistable output available. The outputs are latched and monitored with 9 LED readouts. Also included is a key entry strobe. Features: Full 8-bit latched output for microprocessor use. Three user-define keys with one being bistable operation. Debounce circuit provided for all 19 keys. 9 LED readouts to verify entries. Easy interfacing with standard 16-pin IC connector. Only +5VDC required for operation. Size: 3½"H x 8¼"W x 8¾"D

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74LS27	.35	74LS196	.85
74LS28	.35	74LS197	.85
74LS30	.25	74LS221	1.20
74LS32	.35	74LS240	1.85
74LS33	.55	74LS241	1.85
74LS37	.55	74LS242	1.85
74LS38	.35	74LS243	1.85
74LS40	.25	74LS244	1.75
74LS42	.55	74LS245	2.85
74LS47	.75	74LS247	.76
74LS48	.75	74LS248	1.25
74LS49	.75	74LS249	.99
74LS51	.25	74LS251	1.30
74LS54	.35	74LS253	.85
74LS55	.35	74LS257	.85
74LS63	1.25	74LS258	.85
74LS73	.40	74LS259	2.85
74LS74	.45	74LS260	.65
74LS75	.50	74LS266	.55
74LS76	.40	74LS273	1.65
74LS78	.50	74LS275	3.35
74LS83	.75	74LS279	.55
74LS85	1.15	74LS280	1.98
74LS86	.40	74LS283	1.00
74LS90	.65	74LS290	1.25
74LS91	.89	74LS293	1.85
74LS92	.70	74LS295	1.05
74LS93	.65	74LS298	1.20
74LS95	.85	74LS352	1.55
74LS96	.95	74LS353	1.55
74LS107	.40	74LS363	1.35
74LS109	.40	74LS365	.95
74LS112	.45	74LS366	.95
74LS113	.45	74LS367	.70
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74LS122	.45	74LS373	1.85
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7410	.19	74150	1.35
7411	.25	74151	.65
7412	.30	74152	.65
7413	.35	74153	.55
7414	.55	74154	1.40
7416	.25	74155	.75
7417	.25	74156	.65
7420	.19	74157	.55
7421	.35	74159	1.65
7422	.29	74160	.85
7423	.29	74161	.70
7425	.29	74162	.85
7426	.29	74163	.85
7427	.29	74164	.85
7428	.45	74165	.85
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7444	.69	74177	.75
7445	.69	74178	1.15
7446	.59	74179	1.75
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7454	.23	74186	18.50
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7464	.39	74191	1.15
7465	.39	74192	.79
7470	.35	74193	.79
7472	.29	74194	.85
7473	.34	74195	.85
7474	.35	74196	.79
7475	.49	74197	.75
7476	.35	74198	1.35
7480	.59	74199	1.35
7481	1.10	74221	1.35
7482	.95	74246	1.35
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7486	.35	74251	.75
7489	4.95	74259	2.25
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7493	.49	74279	.75
7494	.65	74283	2.00
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7496	.70	74285	3.75
7497	2.75	74290	.95
74100	1.00	74293	.75
74107	.30	74298	.85
74109	.45	74351	2.25
74110	.45	74365	.65
74111	.55	74366	.65
74116	1.55	74367	.65
74120	1.20	74368	.65
74121	.29	74376	2.20
74122	.45	74390	1.75
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74C14	1.50	74C905	10.95	4023	.35	14412	12.95
74C20	.35	74C906	.95	4024	.75	14419	2.95
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8185-2	39.95
8741	39.95
8748	69.95
8755	49.95

IC SOCKETS

	1-100	100pcs
8 pin ST	.13	.11
14 pin ST	.15	.12
16 pin ST	.17	.13
18 pin ST	.20	.18
20 pin ST	.29	.27
22 pin ST	.30	.27
24 pin ST	.30	.27
28 pin ST	.40	.32
40 pin ST	.49	.39
ST = SOLDERTAIL		
8 pin WW	.59	.49
14 pin WW	.69	.52
16 pin WW	.69	.58
18 pin WW	.99	.90
20 pin WW	1.09	.98
22 pin WW	1.39	1.28
24 pin WW	1.49	1.35
28 pin WW	1.69	1.49
40 pin WW	1.99	1.80
WW = WIREWRAP		

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800-538-5000

800-662-6233

(CALIFORNIA RESIDENTS)

SEPTEMBER SPECIALS

4116	150ns	NEC	8 for 19.95
4116	200ns		8 for 17.50
2708		2.99	8 for 2.75ea
2716	Intel and NEC	5.95	8 for 5.50ea
2732	Intel	16.50	8 for 15.95ea
2532	Ti and Hitachi		19.95ea
Z80A			6.00ea
Z80A	PIO		6.00ea
Z80A	SIO/1		15.00ea
8251A	Intel		4.75ea
UPD 765	(8272)		35.00ea
LM323K		3.50ea	10 for 3.00ea

LS SPECIALS

LS240	.99	LS245	1.90
LS241	.99	LS373	.99
LS244	.99	SL374	1.75

(Sale Ends September 30, 1981)

LEDS

Jumbo Red	10/1.00
Jumbo Green	6/1.00
Jumbo Yellow	6/1.00
5082-7760 .43"CC	.79
MAN74 .3"CC	.99
MAN72 .3"CA	.99

DYNAMIC RAMS

			100pcs
4027	(250ns)	2.50	2.00
4116-150	(150ns)	8/21.95	2.65
4116-200	(200ns)	8/19.95	2.35
4116-300	(300ns)	8/16.95	2.00
4164	(200ns)	CALL	CALL

EPROMS

				8pcs
1702		256 × 8	(1us)	4.95	4.50
2708		1024 × 8	(450ns)	3.95	3.50
2716	(5v)	2048 × 8	(450ns)	6.95	5.95
2758	(5v)	1024 × 8	(450ns)	9.95	8.95
2716-1	(5v)	2048 × 8	(350ns)	12.95	11.95
TMS2716		2048 × 8	(450ns)	9.95	8.95
TMS2532	(5v)	4096 × 8	(450ns)	21.95	19.95
2732	(5v)	4096 × 8	(450ns)	17.95	16.95

STATIC RAMS

				100pcs
2101		(450ns)	1.95	1.85
2102-1		(450ns)	.89	.85
21L02-1	(LP)	(450ns)	1.29	1.15
2111		(450ns)	2.99	2.49
2112		(450ns)	2.99	2.79
2114		(450ns)	8/18.95	2.25
2114L-2	(LP)	(200ns)	8/22.95	2.45
2114L-3		(300ns)	8/21.95	2.45
2114L-4	(LP)	(450ns)	8/18.95	2.25
4044-4		(450ns)	3.49	3.25
4044-3		(300ns)	3.99	3.75
TMM2016		(200ns)	CALL	CALL
MB6116		(200ns)	CALL	CALL

LP = LOW POWER

PROMS

74S188	(82S23)	OC	32 × 8	3.95
74S287	(82S129)	TS	256 × 4	4.75
74S288	(82S123)	TS	32 × 8	4.45
74S387	(82S126)	OC	256 × 4	5.75
74S471		TS	256 × 8	9.95
74S472	(82S147)	TS	512 × 8	16.85
74S474	(82S141)	TS	512 × 8	17.85
74S570	(82S130)	OC	512 × 4	7.80
74S571	(82S131)	TS	512 × 4	7.80

master charge VISA®

JDR MICRODEVICES, INC.
1101 South Winchester Blvd.
San Jose, California 95128
800-538-5000 800-662-6263 (Calif.)
408-247-4852

TERMS: For shipping include $2.00 for UPS Ground; $3.00 for UPS Blue Label Air; $10.00 minimum order. Bay Area Residents add 6½% sales tax Calif. Residents add 6% sales tax. We reserve the right to limit quantities and substitute manufacturer. Prices subject to change without notice.

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7400 SERIES

PART #	EBC	'A'	'B'	'C'	'D'	'E'	'F'	'G'	'H'	'I'	'J'	'K'	'L'	SAVINGS RANGE
7400	.15	.22	.19	---	.20	.32	.20	.25	.19	---	.17	.28	.24	11.76%-53.13%
7401	.15	.22	.22	---	---	.32	.20	.20	---	---	.17	.28	.24	11.76%-53.13%
7402	.15	.24	.22	---	.22	.32	.20	.25	.19	---	.17	.28	.24	11.76%-53.13%
7403	.15	.24	.22	---	---	.32	.20	.25	---	---	.17	.28	.24	11.76%-53.13%
7404	.17	.24	.22	---	.22	.35	.25	.25	.24	---	.24	.35	.26	22.73%-51.43%
7405	.17	.24	.23	---	---	.35	.20	.29	---	---	.24	.35	.26	15.00%-51.43%
7406	.20	.36	.23	---	---	.41	.29	.35	.29	---	.33	.35	.32	13.04%-51.22%
7407	.20	.36	.23	---	---	.41	.29	.35	.29	---	.35	.86	.32	13.04%-76.74%
7408	.17	.24	.26	---	.24	.35	.22	.29	.24	---	.27	.35	.26	22.73%-51.43%
7409	.17	.24	.21	---	---	.37	.22	.29	---	---	.24	.35	.26	22.73%-54.05%
7410	.15	.24	.22	---	.22	.32	.20	.25	.19	---	.17	.28	.24	11.76%-53.13%
7411	.17	---	.29	---	---	.35	.25	.29	---	---	.22	.35	.26	22.73%-51.43%
7412	.17	.36	.29	---	.28	---	.25	.35	---	---	.22	.33	---	22.73%-52.78%
7413	.24	.39	.39	---	.35	.48	.39	.40	---	---	.42	.51	.40	31.43%-52.94%
7414	.35	.39	.59	---	.49	.85	.70	.65	---	---	.90	.60	.39	10.26%-61.11%
7416	.19	.36	.29	---	.29	.41	.25	.29	---	---	.33	.88	.27	24.00%-78.41%
7417	.19	.36	.29	---	.29	.41	.25	.29	---	---	.37	.88	.27	24.00%-78.41%
7420	.15	.29	.22	---	---	.32	.20	.25	.19	---	.17	.28	.24	11.76%-53.13%
7421	.17	---	.35	---	---	---	.25	.25	---	---	---	.35	---	32.00%-51.43%
7422	---	.36	.29	---	---	---	---	.45	---	---	---	---	---	------------
7423	.18	.36	.29	---	.28	.40	.25	.29	---	---	---	---	.26	28.00%-55.00%
7425	.18	.32	.29	---	.25	.37	.29	.29	---	---	.35	.49	.26	28.00%-63.27%
7426	.18	.39	.29	---	---	.37	.29	.29	---	---	.33	.42	.26	30.77%-57.14%
7427	.18	.32	.29	---	---	.37	.25	.25	---	---	.35	.49	.26	28.00%-63.27%
7428	---	.42	---	---	---	---	---	.49	---	---	---	---	---	------------
7430	.15	.22	.23	---	.23	.32	.20	.25	.19	---	.17	.28	.24	11.76%-53.13%
7432	.18	.39	.29	---	---	.37	.25	.29	.29	---	.27	.40	.26	28.00%-55.00%
7433	---	.39	---	---	---	---	---	---	---	---	---	---	---	------------
7437	.18	.36	.29	---	.29	.41	.25	.25	---	---	.27	.62	.28	28.00%-70.97%
7438	.18	.36	.29	---	.24	.41	.40	.40	---	---	.27	.62	.28	25.00%-70.97%
7439	.18	---	.29	---	---	---	.29	.25	---	---	---	---	---	28.00%-37.93%
7440	.15	.22	.24	---	.22	.32	.20	.20	.19	---	.17	.33	.24	11.76%-54.55%
7441	.60	---	.79	---	---	---	.88	.89	---	---	.85	1.46	.90	24.05%-58.90%
7442	.31	.44	.57	---	.57	.73	.59	.59	.49	---	.50	.55	.37	16.22%-57.53%
7443	.50	---	.79	---	.78	---	.75	1.10	---	---	---	---	---	33.33%-54.55%
7444	.50	---	.79	---	---	---	.75	1.10	---	---	---	---	---	33.33%-54.55%
7445	.50	.84	.79	---	.78	.93	.75	.89	.69	---	.70	.70	.93	27.54%-46.24%
7446	.46	.84	.79	---	---	1.06	.69	.79	.69	---	.75	1.53	.66	33.33%-69.93%
7447	.46	.65	.59	---	---	1.06	.65	.69	.59	---	.75	1.30	.86	22.03%-64.62%
7448	.46	---	.79	---	---	1.06	.79	.79	.69	---	.75	1.43	.86	33.33%-67.83%
7450	.15	.22	.23	---	---	.32	.20	.20	.19	---	.17	.28	.24	11.76%-53.13%
7451	.15	.29	.23	---	.20	.32	.20	.20	---	---	---	.28	.21	25.00%-53.13%
7453	.15	.29	.23	---	---	.32	.20	.20	---	---	---	.28	.24	25.00%-53.13%
7454	.15	.29	.23	---	.20	.32	.20	.20	---	---	---	.28	.24	25.00%-53.13%
7459	.15	---	.29	---	---	---	.20	.25	---	---	---	---	---	25.00%-48.28%
7460	.15	---	.23	---	---	.35	.20	.20	---	---	---	---	.24	25.00%-57.14%
7470	.21	---	.39	---	---	.49	.29	.29	---	---	---	.49	.37	27.59%-57.14%
7472	.21	.36	.34	---	---	.49	.29	.29	.29	---	.35	.46	.31	27.59%-57.14%
7473	.21	.36	.38	---	---	.46	.32	.35	.34	---	.35	.46	.31	32.26%-54.35%
7474	.21	.36	.36	---	.32	.46	.35	.35	.35	---	.42	.44	.31	32.26%-54.35%
7475	.27	.39	.38	---	.32	.62	.49	.49	.49	---	.49	.55	.38	15.63%-56.45%
7476	.21	.38	.36	---	---	.46	.35	.35	.35	---	.45	.40	.31	32.26%-54.35%
7479	---	---	4.60	---	---	---	---	5.00	---	---	---	---	---	------------
7480	.22	---	.59	---	---	---	.40	.50	---	---	.49	---	---	45.00%-62.71%
7481	---	---	1.10	---	---	---	---	---	---	---	---	---	---	------------
7482	.34	---	1.10	---	1.05	---	.63	.99	---	---	---	---	---	46.03%-69.09%
7483	.41	.48	.55	---	---	.85	.69	.69	.65	---	.60	1.32	.47	12.77%-68.94%
7484	---	1.36	---	---	---	---	---	---	---	---	---	---	---	------------
7485	.50	.66	.65	---	---	.85	.89	.89	---	---	.75	1.90	.53	5.66%-73.68%
7486	.20	.39	.39	---	---	.46	.40	.35	.35	---	.42	.55	.26	31.03%-63.64%
7489	.95	---	1.75	---	---	1.75	1.75	1.75	---	---	1.60	---	2.00	40.63%-52.50%
7490	.30	.32	.39	---	---	.53	.43	.49	.49	---	.50	.42	.35	6.25%-43.40%
7491	.36	.42	.65	---	---	.86	.59	.50	.69	---	.55	.70	---	14.29%-58.55%
7492	.30	.38	.52	---	.50	.60	.43	.45	.59	---	.50	.54	.47	21.05%-50.00%
7493	.30	.38	.49	---	.48	.57	.43	.45	.49	---	.50	.49	.34	11.76%-47.37%
7494	.38	.68	.72	---	---	---	.65	.69	---	---	.60	---	---	36.67%-47.22%
7495	.34	.54	.65	---	.60	.71	.65	.69	---	---	.60	.58	.38	10.53%-52.11%
7496	.38	.59	.72	---	.70	.79	.65	.69	.74	---	.60	1.30	.45	15.56%-70.77%
7497	1.08	1.89	3.10	---	---	---	2.90	3.00	---	---	---	3.43	---	42.86%-68.51%
74100	---	1.18	.99	---	---	---	---	1.49	1.19	---	---	---	---	------------
74104	.47	.64	---	---	---	---	.59	---	---	---	---	---	---	20.34%-26.56%
74107	.20	.44	.32	---	---	.46	.34	.35	.34	---	.35	.62	.34	17.50%-67.74%
74109	.22	.44	.53	---	---	.46	.45	.39	---	---	---	---	.34	35.29%-58.49%
74110	---	.45	---	---	---	---	---	---	---	---	---	---	---	------------
74111	---	.58	---	---	---	---	---	---	---	---	---	---	---	------------
74116	---	1.20	1.95	---	---	---	---	1.95	---	---	---	2.90	---	------------
74120	.60	1.25	---	---	---	---	1.55	---	---	---	---	---	---	52.00%-61.29%
74121	.24	.48	.29	---	---	.55	.34	.39	.34	---	.35	.58	.33	17.24%-58.62%
74122	.27	.52	.39	---	.39	---	.39	.55	---	---	.39	.55	---	30.77%-50.91%
74123	.35	.48	.59	---	---	.71	.58	.59	.59	---	.42	.44	.43	16.67%-50.70%

PART #	EBC	'A'	'B'	'C'	'D'	'E'	'F'	'G'	'H'	'I'	'J'	'K'	'L'	SAVINGS RANGE
74125	.30	.48	.39	---	---	.64	.49	.49	---	---	.45	.70	.44	23.08%-57.14%
74126	.30	.48	.44	---	---	.64	.49	.49	---	---	.45	.70	.44	31.82%-57.14%
74128	---	.64	.59	---	---	---	---	---	---	---	---	---	---	------------
74132	.35	.45	.69	---	---	.82	.75	.75	---	---	---	1.90	.47	22.22%-81.58%
74136	---	.52	.95	---	.95	---	---	.75	---	---	---	---	---	------------
74141	.53	.84	.69	---	.69	1.19	.79	.99	---	---	---	---	.95	23.19%-55.46%
74142	---	2.98	2.95	---	---	---	---	3.25	---	---	---	---	---	------------
74143	---	3.44	2.95	---	---	---	---	3.49	---	---	---	---	---	------------
74144	---	3.44	2.95	---	---	---	---	3.49	---	---	---	---	---	------------
74145	.45	.67	.62	---	---	.93	.79	.79	---	---	.75	1.32	.79	27.42%-65.91%
74147	.89	1.24	1.95	---	---	1.73	1.70	1.95	---	---	---	---	1.15	22.61%-54.36%
74148	.67	.89	1.20	---	---	1.33	1.29	1.29	---	---	1.50	---	.74	16.22%-58.67%
74150	.54	1.25	.99	---	---	1.12	1.10	1.25	---	---	1.10	1.43	1.10	45.45%-62.24%
74151	.32	.42	.67	---	.65	.73	.59	.69	.69	---	.65	.51	.39	17.95%-56.16%
74152	.32	---	.67	---	---	---	.59	.69	---	---	---	---	---	45.76%-53.62%
74153	.32	.36	.67	---	.65	.73	.59	.79	.59	---	.55	1.21	.39	11.11%-73.98%
74154	.53	1.29	1.19	---	1.25	1.21	1.15	1.25	1.49	---	1.10	1.58	1.08	50.93%-66.46%
74155	.32	.48	.82	---	.80	.79	.69	.79	---	---	.75	.58	.39	17.95%-60.98%
74156	.38	---	.89	---	---	.79	.69	.79	.69	---	---	---	.47	19.15%-57.30%
74157	.38	.48	.69	---	.69	.73	.64	.69	.69	---	.65	.51	.46	17.39%-47.95%
74158	.38	---	1.65	---	---	---	.64	---	---	---	---	---	---	40.63%-76.97%
74159	---	1.52	---	---	---	---	---	---	---	---	---	---	---	------------
74160	.48	.48	.95	---	.96	.93	.87	.89	---	---	.85	---	.61	.00%-49.47%
74161	.48	.64	.95	---	.65	1.02	.87	.89	.79	---	.80	.67	.61	21.31%-52.94%
74162	.48	.64	.89	---	---	.93	.87	.89	---	---	1.20	---	.61	21.31%-60.00%
74163	.48	.64	.87	---	.85	.93	.87	.89	.89	---	.95	.67	.86	25.00%-49.47%
74164	.51	.64	.97	---	.87	.98	.87	.89	.89	---	.85	.63	.61	16.39%-47.96%
74165	.51	.64	.97	---	.87	1.15	.87	.89	---	---	.85	.72	.64	20.31%-55.65%
74166	.54	.68	1.20	---	---	1.26	1.22	1.25	---	---	1.05	1.85	.64	15.63%-70.81%
74167	1.06	---	1.95	---	---	---	1.95	2.79	---	---	---	3.43	---	45.64%-69.10%
74170	.84	1.98	1.69	---	---	1.87	1.58	1.95	---	---	1.60	4.04	1.57	46.50%-79.21%
74172	---	4.95	5.95	---	---	---	---	4.95	---	---	---	---	---	------------
74173	.58	.79	.79	---	---	1.35	1.24	1.39	1.39	---	1.30	1.32	.74	21.62%-58.27%
74174	.41	.58	.89	---	.95	.90	.89	.99	.89	---	.85	1.76	.51	19.61%-76.70%
74175	.40	.58	.89	---	.69	.84	.80	.89	.89	---	.75	.56	.47	14.89%-55.06%
74176	.47	.76	.85	---	---	.96	.78	.79	.89	---	.75	---	.86	37.33%-51.04%
74177	.47	---	.85	---	---	.96	.78	.79	---	---	.75	---	.86	37.33%-51.04%
74178	1.00	1.09	---	---	---	---	1.90	---	---	---	---	---	---	8.26%-47.37%
74179	1.00	1.09	1.80	---	---	---	1.90	1.49	---	---	---	---	---	8.26%-47.37%
74180	.48	.75	.75	---	.75	1.00	.79	.79	---	---	.75	.79	.61	21.31%-52.00%
74181	1.02	---	1.75	---	1.15	2.00	1.95	2.25	---	---	1.90	2.20	1.62	11.30%-54.67%
74182	.48	.52	.75	---	---	1.10	.78	.79	---	---	---	1.23	---	7.69%-60.98%
74184	1.06	2.36	1.95	---	---	---	1.95	2.49	---	---	---	---	2.46	45.64%-57.43%
74185	1.06	2.36	1.95	---	---	---	1.95	2.49	---	---	---	---	2.46	45.64%-57.43%
74186	---	---	9.95	---	---	---	---	---	---	---	---	---	---	------------
74188	2.10	---	3.90	---	---	---	3.85	---	---	---	---	---	---	45.45%-46.15%
74190	.50	.68	1.15	---	---	1.01	.99	1.25	---	---	1.20	.69	.74	26.47%-60.00%
74191	.50	.68	1.15	---	---	1.01	.99	1.25	---	---	1.20	.77	.74	26.47%-60.00%
74192	.50	.68	.85	---	---	1.03	.80	.89	.79	---	.79	.63	.58	13.79%-51.46%
74193	.50	.64	.85	---	---	.95	.80	.89	.79	---	.79	.63	.58	13.79%-47.37%
74194	.48	.64	.85	---	---	.93	.87	.89	---	---	.85	1.40	.66	25.00%-65.71%
74195	.36	.48	.85	---	---	.88	.87	.69	---	---	.65	.60	.41	12.20%-59.09%
74196	.47	.78	.85	---	---	.91	.87	.89	.79	---	.85	1.20	.79	39.74%-60.83%
74197	.47	.72	.85	---	---	.91	.87	.89	---	---	.87	1.20	.79	34.72%-60.83%
74198	.63	1.39	1.39	---	---	1.49	1.45	1.49	---	---	---	---	1.43	54.68%-57.72%
74199	.63	1.39	1.39	---	---	1.49	1.45	1.49	---	---	---	---	1.43	54.68%-57.72%
74221	.40	.68	1.39	---	---	---	1.20	1.25	---	---	---	---	---	41.18%-71.22%
74246	---	1.36	---	---	---	---	---	---	---	---	---	---	---	------------
74247	---	1.24	---	---	---	---	---	---	---	---	---	---	---	------------
74251	.57	.76	.95	---	---	1.12	1.09	.99	---	---	---	---	.72	20.83%-49.11%
74259	---	1.89	---	---	---	---	---	---	---	---	---	---	---	------------
74273	---	1.99	1.05	---	---	---	---	---	---	---	---	---	---	------------
74276	---	.98	---	---	---	---	---	1.95	---	---	---	---	---	------------
74278	---	2.38	---	---	---	---	---	---	---	---	---	---	---	------------
74279	.50	.59	.89	---	---	---	.79	.79	---	---	.95	.79	---	15.25%-47.37%
74283	.99	.98	2.15	---	---	---	2.20	1.49	---	---	---	1.44	---	-1.02%-55.00%
74284	---	---	3.90	---	---	---	---	3.95	---	---	---	---	2.85	------------
74285	---	---	3.90	---	---	---	---	3.95	---	---	---	---	2.85	------------
74290	.54	---	1.25	---	---	---	.99	---	---	---	---	.83	---	34.94%-56.80%
74293	.54	.72	---	---	---	---	.99	---	---	---	---	---	---	25.00%-45.45%
74298	.50	.84	.95	---	---	---	.92	---	---	---	---	1.06	---	40.48%-52.83%
74351	---	2.20	---	---	---	---	---	---	---	---	---	---	---	------------
74365	.36	.58	.68	---	---	.80	.67	.69	---	---	.80	---	.50	28.00%-55.00%
74366	.36	.69	.68	---	---	.80	.67	.69	---	---	---	---	.50	28.00%-55.00%
74367	.36	.58	.79	---	---	.80	.67	.69	---	---	.80	---	.50	28.00%-55.00%
74368	.36	.58	.79	---	---	.80	.67	.69	---	---	.65	---	.50	28.00%-55.00%
74390	---	.96	1.90	---	---	---	---	1.49	---	---	1.50	---	---	------------
74393	---	1.29	1.90	---	1.69	---	---	1.49	---	---	---	---	---	------------

74LS00 SERIES

PART #	EBC	'A'	'B'	'C'	'D'	'E'	'F'	'G'	'H'	'I'	'J'	'K'	'L'	SAVINGS RANGE
74LS00	.15	.17	.35	.21	.26	.36	.34	.29	.32	.35	.22	.28	.24	11.76%-58.33%
74LS01	.15	.17	.28	---	---	.36	.34	.29	.28	.28	.22	---	.24	11.76%-58.33%
74LS02	.15	.22	.28	---	.26	.36	.34	.29	.38	.28	.22	.28	.24	31.82%-60.53%
74LS03	.15	.22	.28	.23	.26	.36	.34	.29	.32	.28	.22	.28	.24	31.82%-58.33%
74LS04	.17	.22	.39	.26	.26	.38	.38	.35	.35	.39	.27	.30	.26	22.73%-56.41%
74LS05	.17	.22	.28	---	---	.38	.38	.35	.28	.28	.27	.33	.26	22.73%-55.26%
74LS08	.16	.17	.39	.27	.28	.36	.36	.29	.38	.39	.27	.28	.26	5.88%-58.97%
74LS09	.16	.24	.39	---	.26	.38	.36	.35	.38	.39	.27	.39	.26	33.33%-58.97%
74LS10	.15	.19	.28	.24	.26	.36	.34	.29	.32	.28	.25	.28	.24	21.05%-58.33%
74LS11	.17	.24	.39	.31	---	.38	.36	.75	.29	.39	.35	.33	.26	29.17%-77.33%
74LS12	.17	.24	.39	---	---	.36	.36	.35	.29	.39	.35	---	.24	29.17%-56.41%
74LS13	.21	.25	.47	---	---	.59	.55	.59	.38	.47	.60	.44	.56	16.00%-65.00%
74LS14	.35	.39	1.25	---	---	1.25	1.10	.99	.99	1.25	.80	.60	1.50	10.26%-76.67%
74LS15	.15	---	.39	---	---	.38	.34	.35	.35	.39	.35	.33	.24	37.50%-61.54%
74LS20	.15	.18	.26	.24	.26	.36	.34	.29	.26	.26	.30	.32	.24	16.67%-58.33%
74LS21	.15	.18	.38	---	.28	.38	.36	.35	.30	.38	.25	.33	.24	16.67%-60.53%
74LS22	.15	---	.38	.34	.26	.36	.36	.35	.34	.38	.25	---	.33	40.00%-60.53%
74LS26	.18	.39	.39	.39	.49	.37	.36	.35	.40	.39	.35	.40	.26	30.77%-63.27%
74LS27	.16	.29	.39	.29	.26	.36	.36	.35	.35	.39	.45	.33	.26	38.46%-64.44%
74LS28	---	---	.39	---	---	---	---	.35	.39	.39	.45	.51	---	------------
74LS30	.15	.18	.26	---	.28	.36	.34	.29	.35	.26	.30	.28	.26	16.67%-58.33%
74LS32	.17	.29	.39	.34	.32	.41	.40	.35	.39	.39	.40	.28	.26	34.62%-58.54%
74LS33	.32	---	---	---	---	---	---	.59	.56	---	---	.51	---	37.25%-45.76%
74LS37	.18	.29	.79	.36	---	.37	.36	.45	.78	.79	.35	.40	.26	30.77%-77.22%
74LS38	.18	.29	.39	---	.32	.37	.36	.49	.39	.39	.35	.40	.26	30.77%-63.27%
74LS40	.15	---	.28	.34	---	.38	.34	.35	.25	---	.40	.32	.24	37.50%-62.50%
74LS42	.37	.44	.79	.45	.65	.85	.82	.89	.79	.79	.55	.53	.62	15.91%-58.43%
74LS47	.60	.68	.79	---	---	1.08	1.05	.89	.78	.79	.75	.86	1.15	11.76%-47.83%
74LS48	.51	.99	.79	---	.78	1.08	1.05	1.15	.78	.79	---	---	1.15	34.62%-55.65%
74LS49	.54	---	---	---	---	1.18	1.05	1.15	---	---	---	---	1.15	[illegible]
74LS51	.15	.21	.26	---	.25	.36	.34	.29	.35	.38	.25	.30	.24	28.57%-58.33%
74LS54	.15	.21	.35	---	.35	.36	.34	.29	.35	.35	.25	.33	.24	28.57%-58.33%
74LS55	.15	.24	.35	---	---	.36	.34	.29	.32	.35	---	.33	.24	37.50%-58.33%
74LS73	.21	.32	.45	.38	---	.45	.45	.45	.48	.45	.60	---	.31	32.26%-65.00%
74LS74	.21	.32	.54	.54	.38	.46	.45	.45	.48	.59	.85	.37	.31	32.26%-75.29%
74LS75	.29	.35	.68	---	.40	.59	.57	.59	.58	.68	.75	---	.55	17.14%-61.33%
74LS76	.23	.38	.45	---	---	.54	.52	.45	.50	.45	.45	---	.31	25.81%-57.41%
74LS78	.24	.29	.65	---	---	.49	.48	.49	.59	.65	---	---	.31	17.24%-63.08%
74LS83	.40	.69	.99	---	.44	1.08	1.05	.89	.90	.99	.95	1.23	.91	9.09%-67.48%
74LS85	.54	.84	1.19	---	.95	1.28	1.25	1.25	1.23	1.19	1.10	.90	1.05	35.71%-57.81%
74LS86	.24	.38	.45	.45	.95	.50	.49	.45	.45	.45	.45	.37	.41	35.14%-74.74%
74LS90	.33	.39	.75	.44	.69	.73	.71	.59	.70	.75	.90	.56	.60	15.38%-63.33%
74LS91	---	.89	---	---	---	---	---	---	---	---	---	---	---	------------
74LS92	.33	.48	.75	---	---	---	.71	.75	.82	.75	.90	1.18	.41	19.51%-72.03%
74LS93	.33	.39	.75	.42	.69	.73	.71	.75	.71	.75	.90	.62	.60	15.38%-63.33%
74LS95	.40	.48	.88	---	---	---	.99	.99	1.11	.88	---	.70	---	16.67%-63.96%
74LS96	---	.58	.98	---	---	---	---	1.15	.86	.98	.90	---	---	------------
74LS107	.22	.36	.45	---	.45	.46	.44	.45	.43	.45	.47	---	.31	29.03%-53.19%
74LS109	.22	.36	.45	.52	---	---	.44	.45	.49	.45	.45	.53	.31	29.03%-58.49%
74LS112	.24	.36	.49	.42	.38	---	.49	.45	.48	.49	.45	.58	.31	22.58%-58.62%
74LS113	.24	---	.49	---	.48	.49	.49	.49	.48	---	.45	.56	.31	22.58%-57.14%
74LS114	.24	---	.55	---	---	.49	.49	.49	.55	---	.55	---	.31	22.58%-56.36%
74LS122	.41	.48	.55	---	.48	.75	.85	.89	.55	.55	---	---	1.00	14.58%-59.00%
74LS123	.47	.59	1.19	.79	.95	1.03	.98	1.25	.99	1.19	.75	---	1.15	20.34%-62.40%
74LS124	---	---	1.35	---	---	---	---	---	2.99	---	---	---	---	------------
74LS125	.33	.44	.89	.89	---	.64	.62	.89	.99	1.35	.90	.79	.51	25.00%-75.56%
74LS126	.33	.44	.89	.54	.69	.64	.62	.55	.88	.89	.90	.81	.51	25.00%-63.33%
74LS132	.42	.52	.79	.59	---	.93	.91	.99	.69	.79	.60	.72	.80	19.23%-57.58%
74LS133	.26	.98	---	---	---	---	.38	.69	---	---	---	.33	---	21.21%-73.47%
74LS136	.26	.42	.59	.48	---	.49	.48	.49	.58	.59	.80	.44	.48	38.10%-67.50%
74LS138	.45	.48	.89	.66	.69	.84	.93	.89	.79	.89	.75	.58	.63	6.25%-51.61%
74LS139	.45	.48	.89	.66	---	.84	.82	.89	.79	.89	.70	.58	.63	6.25%-49.44%
74LS145	---	1.09	1.25	1.20	---	---	---	---	1.19	1.25	---	---	---	------------
74LS147	---	1.98	---	---	---	---	---	---	---	---	---	---	---	------------
74LS148	---	1.36	1.49	---	---	---	---	---	1.39	1.49	---	---	---	------------
74LS151	.36	.42	.79	.44	.44	.77	.75	.89	.79	.79	1.19	.56	.56	14.29%-69.75%
74LS152	.36	---	---	.75	---	---	.75	---	---	---	---	---	---	52.00%-52.00%
74LS153	.36	.35	.79	.42	.44	.84	.84	.89	.79	.79	1.19	1.40	.56	-2.86%-74.29%
74LS154	.72	---	2.49	---	---	1.44	1.40	1.75	2.39	---	---	---	1.40	48.57%-71.08%
74LS155	.41	.67	1.19	---	1.15	.91	.89	1.19	1.19	1.19	1.19	.77	.60	31.67%-65.55%
74LS156	.41	.72	.99	---	---	.91	.89	1.19	.95	.99	1.19	1.58	.54	24.07%-74.05%
74LS157	.41	.48	.99	---	---	.77	.75	.89	.79	.99	.85	.56	.56	14.58%-58.59%
74LS158	.41	.48	.75	---	.75	.86	.75	.99	.82	.75	---	.53	.47	12.77%-58.59%
74LS160	.51	.69	.98	.95	.95	1.07	1.05	1.15	.94	.98	1.00	.84	1.45	26.09%-64.83%
74LS161	.51	.58	1.15	.80	.85	1.07	1.05	1.15	.99	1.15	1.00	.84	.80	12.07%-55.65%
74LS162	.51	.72	.98	.85	.95	1.07	1.05	1.15	.99	.98	1.00	.84	1.45	29.17%-64.83%
74LS163	.51	.58	.98	.85	1.60	1.07	1.05	1.15	.99	.98	1.00	.84	.80	12.07%-68.13%
74LS164	.51	.58	1.19	.62	.65	1.18	1.15	1.25	.99	1.19	1.00	.88	.61	12.07%-59.20%
74LS165	.51	.89	.89	---	.65	---	---	1.25	.99	.89	---	.88	---	21.54%-59.20%
74LS166	---	1.64	2.48	---	---	---	---	---	2.40	2.49	---	---	---	------------

PART #	EBC	'A'	'B'	'C'	'D'	'E'	'F'	'G'	'H'	'I'	'J'	'K'	'L'	SAVINGS RANGE
74LS168	.57	---	1.89	---	---	1.51	1.45	1.19	1.79	---	1.25	1.76	2.40	52.10%-76.25%
74LS169	.57	---	1.89	---	---	1.51	1.45	1.19	1.79	---	1.75	1.76	2.40	52.10%-76.25%
74LS170	.84	1.59	1.99	2.65	1.75	1.84	1.80	2.49	1.89	1.99	1.70	1.58	2.10	46.84%-68.30%
74LS173	.54	.59	.89	---	---	1.34	1.33	1.39	.82	.89	.90	.67	.64	8.47%-61.15%
74LS174	.35	.39	.99	.49	.75	1.22	1.20	.99	1.19	.99	1.00	.65	1.40	10.26%-75.00%
74LS175	.35	.39	.99	.49	.75	.90	.89	.99	1.09	.99	1.00	.65	1.30	10.26%-73.08%
74LS181	1.36	1.98	2.20	2.30	---	---	2.50	2.95	2.19	2.20	2.50	2.99	---	31.31%-54.52%
74LS189	---	4.45	---	---	---	---	---	---	---	---	---	---	3.84	------------
74LS190	.58	.72	1.15	1.20	.75	1.30	1.25	1.25	1.15	1.15	1.25	1.44	.74	19.44%-59.72%
74LS191	.56	.72	1.15	.89	---	1.30	1.25	1.25	1.31	1.15	1.15	.97	.74	22.22%-57.25%
74LS192	.56	.64	.98	---	---	1.17	1.15	1.15	.88	.98	.90	.92	2.20	12.50%-74.55%
74LS193	.56	.64	.98	.89	.95	1.17	1.15	1.15	.98	.98	.90	.77	2.20	12.50%-74.55%
74LS194	.64	.64	1.15	.85	---	---	1.35	1.15	1.80	1.15	1.10	.81	.68	.00%-64.44%
74LS195	.40	---	.95	.65	.95	---	1.35	1.15	1.39	.95	.90	.67	.68	38.46%-71.22%
74LS196	.56	.88	.89	---	.85	1.34	1.25	---	.82	.89	1.00	1.58	1.44	31.71%-64.56%
74LS197	.56	.88	.89	---	---	1.34	1.25	1.19	.82	.89	.90	.86	1.44	31.71%-61.11%
74LS221	.58	.89	1.49	.85	1.40	1.37	1.90	1.19	1.28	1.49	---	---	1.13	31.76%-69.47%
74LS240	.63	.89	1.95	.95	1.65	---	2.25	1.95	1.89	1.95	1.60	1.14	.93	29.21%-72.00%
74LS241	.63	.89	1.90	.90	1.65	---	2.25	1.95	1.89	1.90	1.60	1.14	.93	29.21%-72.00%
74LS242	---	.89	1.95	---	---	---	---	1.95	1.89	1.95	1.60	---	.93	------------
74LS243	---	.89	1.95	.95	1.45	---	---	1.95	1.89	1.95	1.60	---	.93	------------
74LS244	.63	.89	1.95	.95	1.45	---	2.25	1.95	1.79	1.95	1.60	1.14	.93	29.21%-72.00%
74LS245	.63	1.65	4.95	2.20	2.25	---	---	2.95	2.89	4.95	2.25	2.02	---	61.82%-87.27%
74LS247	.59	.76	1.10	---	---	1.19	1.08	1.19	---	1.10	.75	.86	1.15	21.33%-50.42%
74LS248	.59	1.09	1.10	---	---	1.19	1.08	1.19	---	1.10	1.10	---	1.15	45.37%-50.42%
74LS249	---	.96	1.69	---	---	1.19	---	1.19	---	1.69	---	---	1.15	------------
74LS251	.40	.54	1.79	2.20	---	---	1.01	1.49	1.32	1.79	1.29	.65	.52	23.08%-81.82%
74LS253	.49	.54	.98	.59	.95	1.02	1.01	.99	.89	.98	1.00	.70	.60	9.26%-51.96%
74LS257	.41	.56	.98	.80	.95	.89	.86	.89	.89	.98	.90	.67	.46	10.87%-58.16%
74LS258	.41	.56	.98	.65	.95	.97	.86	.99	.89	.98	.90	.55	.46	10.87%-58.59%
74LS259	.94	1.29	2.95	---	2.85	---	2.25	---	2.89	2.95	1.50	1.21	---	22.31%-68.14%
74LS260	.21	.89	.69	.65	---	---	.38	.69	.68	.69	---	.39	---	44.74%-76.40%
74LS261	---	---	2.49	---	---	---	---	---	---	2.49	---	---	---	------------
74LS266	.27	.36	.59	.48	---	.50	.49	.69	.68	.59	.70	.40	.47	25.00%-61.43%
74LS273	.88	1.19	1.75	1.35	---	---	---	1.95	1.69	1.75	1.25	1.23	---	26.05%-54.87%
74LS275	---	3.95	4.40	---	---	---	---	---	3.39	4.40	---	---	---	------------
74LS279	.29	.48	.59	---	.44	---	.73	.75	.59	.59	.70	.51	.59	34.09%-61.33%
74LS280	---	1.98	---	---	---	---	---	---	---	1.10	---	---	---	------------
74LS283	.47	.78	1.10	---	1.08	1.03	.99	1.09	1.03	1.10	.80	.72	.60	21.67%-57.27%
74LS290	.58	.72	1.29	---	---	1.12	1.05	.99	1.25	1.29	.80	.88	1.45	19.44%-60.00%
74LS293	.58	.88	1.95	---	1.85	1.12	---	.99	1.89	1.95	.80	.88	1.45	27.50%-70.26%
74LS295	.54	---	1.10	---	---	---	.99	---	1.09	1.10	---	1.32	---	45.45%-59.09%
74LS298	.54	.88	1.29	---	1.20	---	---	1.25	1.24	1.29	---	.93	.72	25.00%-58.14%
74LS299	---	2.50	---	2.60	---	---	---	---	---	---	---	2.55	---	------------
74LS320	---	2.75	---	---	---	---	---	---	---	---	---	---	---	------------
74LS321	---	3.95	---	---	---	---	---	---	---	---	---	---	---	------------
74LS322	---	4.95	---	---	---	---	---	---	---	---	---	---	---	------------
74LS323	---	4.95	---	---	---	---	---	---	---	---	---	4.84	---	------------
74LS324	---	2.50	1.75	---	---	---	---	---	---	1.75	---	---	---	------------
74LS347	---	---	1.95	---	---	---	---	---	---	1.95	---	.79	---	------------
74LS348	---	2.65	1.95	---	---	---	---	---	---	1.95	---	---	---	------------
74LS352	.58	1.35	1.65	---	---	1.30	---	1.29	1.59	1.65	---	.88	1.15	34.09%-64.85%
74LS353	.58	1.65	1.65	---	---	1.44	---	1.29	1.59	1.65	---	.88	1.25	34.09%-64.85%
74LS362	---	9.95	---	---	---	---	---	---	---	---	---	---	---	------------
74LS363	---	---	1.49	---	---	---	---	---	1.39	1.49	---	---	---	------------
74LS365	.33	.52	.99	.75	---	.70	.66	.75	.99	.99	.80	.62	.59	36.54%-66.67%
74LS366	.33	.52	.99	.79	.95	.70	.66	.75	.99	.99	.80	.74	.59	36.54%-66.67%
74LS367	.33	.52	.73	.70	.55	---	.66	.75	.99	.73	.80	.46	.59	28.26%-66.67%
74LS368	.33	.52	.73	---	.55	.70	.66	.75	.99	.73	.80	.46	.59	28.26%-66.67%
74LS373	.80	1.25	2.75	1.45	1.39	---	2.25	1.95	1.85	2.75	1.50	1.41	1.20	33.33%-70.91%
74LS374	.80	1.25	2.75	1.40	1.39	---	2.25	1.95	1.81	2.75	---	1.41	1.20	33.33%-70.91%
74LS375	.56	.64	.69	---	---	---	---	.89	---	.69	.95	---	---	12.50%-41.05%
74LS377	.80	1.25	1.95	1.40	---	---	---	---	1.48	1.95	1.50	1.23	---	34.96%-58.97%
74LS378	.70	.99	---	---	---	---	---	---	---	---	---	.88	---	20.45%-29.29%
74LS379	.70	1.09	---	---	---	---	---	---	---	---	---	---	---	35.78%-35.78%
74LS381	---	---	---	2.90	---	---	---	---	---	---	---	---	---	------------
74LS385	---	---	1.95	---	---	---	---	---	1.90	1.95	---	---	---	------------
74LS386	.28	---	.65	---	.65	.55	.53	.69	.65	.65	.50	---	.46	39.13%-59.42%
74LS390	.68	.98	1.95	---	---	---	1.85	---	1.90	1.95	---	2.71	---	30.61%-74.91%
74LS393	.68	.98	1.95	---	---	---	1.89	2.49	1.90	1.95	1.50	.97	---	29.90%-72.69%
74LS395	1.05	1.19	1.70	---	---	---	---	---	1.69	1.70	---	1.94	---	11.76%-45.88%
74LS399	---	---	2.95	---	---	---	---	2.49	---	2.95	---	---	---	------------
74LS424	---	---	2.95	---	---	---	---	---	---	2.95	---	---	---	------------
74LS447	.37	.37	---	---	---	---	---	---	---	---	---	.79	---	.00%-53.16%
74LS490	1.02	1.59	---	1.80	---	---	1.89	---	---	---	---	2.92	---	43.33%-65.07%
74LS668	---	---	1.75	---	---	---	---	---	---	1.75	---	---	---	------------
74LS669	---	.84	---	---	---	---	---	---	---	---	---	---	---	------------
74LS670	1.14	1.64	2.29	---	---	2.59	2.45	2.49	2.20	2.29	2.50	1.76	2.38	30.49%-55.98%

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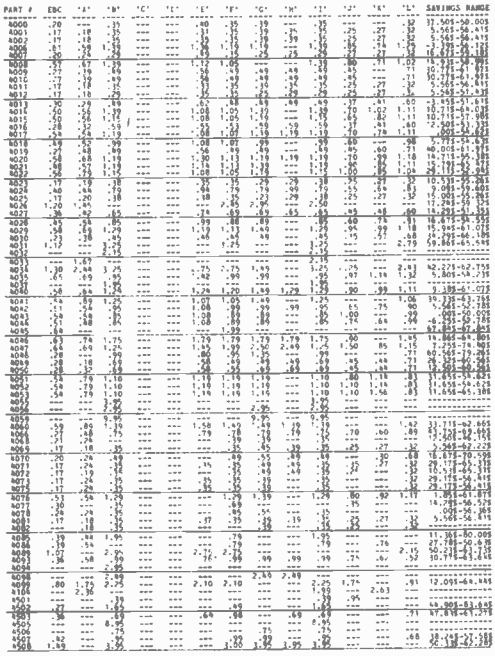

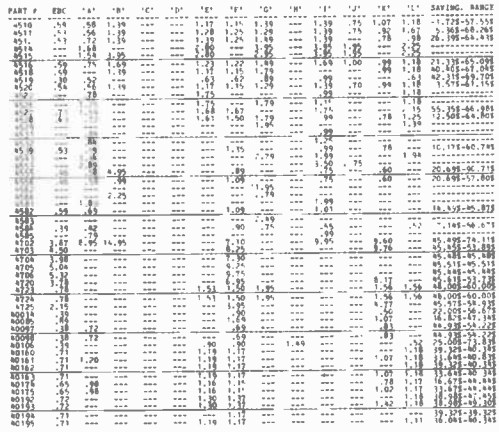

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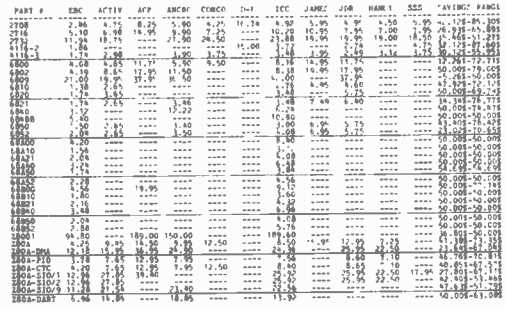

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14	14	24	35
16	16	28	.42
18	27	36	.58
20	29	40	.57

2 level Tin or w 20

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16	.57	28	1.00
18	.67	40	1.23

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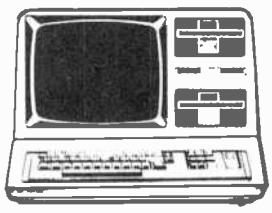

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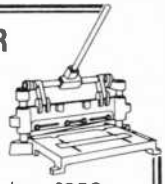

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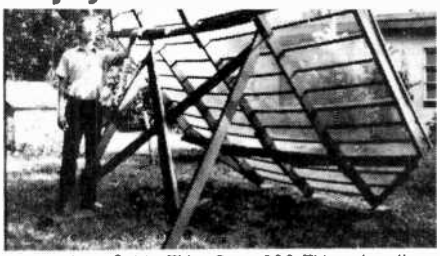

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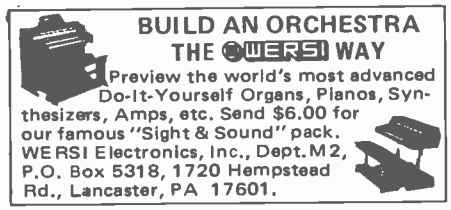

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ELECTRONICS WORLD®

Personal Electronics News

MUSIC, DANCE, AND OPERA video cassettes have been introduced by Dubs Video Corp. (New York, NY). Called "Kultur," the first releases include artists such as Jascha Heifetz, Marian Anderson, and the Bolshoi Ballet. Future cassettes will continue emphasis on opera, classical music, and dance. Price per cassette is in the range of $69.95

CLEAN-ROOM REPAIR SERVICE FOR WINCHESTER DRIVES is available at four locations of Shugart Associates: Hudson, MA; Milpitas, CA; Dallas, TX; and Munich, W. Germany. With what it calls its "under-the-bubble" service, Shugart can unseal the drive's media chamber and read/write head assembly and make repairs, using a complete inventory of spare parts. The repair turnaround goal is 30 days maximum.

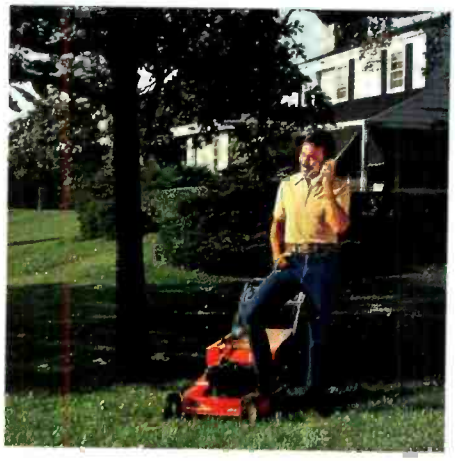
A UNIFIED APPROACH TO VIDEOTEX STANDARDS has been taken by 26 European countries, members of the European Conference on Posts and Telecommunications. The new basic alpha-mosaic system has a high degree of compatibility with existing British, French and German systems and will be able to receive serial and parallel transmission codes, not requiring a space on the screen when attributes change. Additional features include: sixteen colors, full-screen background color, black foreground color, double-width characters, and underlining. The alpha-mosaic viewdata display system is one of two internationally recognized systems—the other being alpha-geometric. In the former, displays are created from a mosaic of dots, while the latter uses geometric lines, arcs, and circles.

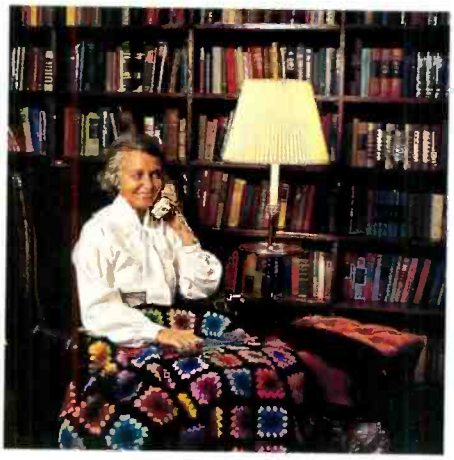
COMPUTER PROGRAMS VIA SHORTWAVE RADIO will be part of an experimental broadcast by Radio Netherlands (Dutch External Service) on Thursday, September 10. The broadcast will include, in English, an introduction to microcomputing and short computer program in three machine-readable formats compatible with Radio Shack's TRS-80, Apple, and Commodore PET computers. If the signal strength is sufficient in the listener's area, the station hopes that the program can be recorded off the air onto cassette tape and played back on a home computer. If the experiment is successful, the idea may be repeated on a regular basis. The broadcast, which will be on the program "Media Network" and last 30 minutes, will be beamed to Eastern North America at 10:47 EDT on 9,490 and 6,165 kHz, and to Western North America at 10:48 PDT on 9,715 and 6,165 kHz. Listeners who hear the broadcast and try the computer program are invited to report their results to: Computer Experiment, Media Network, Radio Netherlands, Box 222, 1200 JG Hilversum, Holland.

A NEW SOLDER FLUX HAS BEEN DEVELOPED to replace natural rosin by Multicore Solders (Westbury, NY). The new material (XERSIN) is claimed to leave residues that are much less corrosive than rosin flux and that need not be removed from a pc board after soldering. Fluxing action, however, is said to be comparable to and compatible with rosin. In addition, fumes resulting from soldering are claimed to contain no aldehydes and are reduced to meet current industry standards.

DOW JONES ADDS WALL STREET NEWS TO COMPUTER SERVICE. In July, the Dow Jones News/Retrieval Service started to deliver transcripts of the half-hour PBS TV program "Wall Street Week," hosted by Louis Rukeyser. Cost to subscribers, who receive business and financial news on command through standard time-sharing terminal or personal computers, is 50 cents per minute during business hours and 25 cents per minute evenings and weekends. Transcripts of the program will be available the Thursday following broadcast, and three previous programs will also be retained in the system.

ROBOTS THAT CAN INTERPRET what they "see" are the subject of a project at the University of Southern California at Los Angeles. Scientists there are preparing computer "brains" for "seeing eye" robots that may soon be performing precision work in military aircraft and space-exploration vehicles. Currently, they are using the robots to perform such image-enhancing tasks as taking the blur out of space exploration photographs, improving the quality of medical x-rays and 3-D brain and body scans, and deciphering fuzzy license plate numbers and other photographic clues for law enforcement.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All in all, these 4-driver Kossfire speakers were created to fill the void between loudspeakers that cost too much and those that promise too much and deliver too little. The superb performance of Kossfire speakers will amaze you. But then, so will their price. And that's a promise!

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